2017 SECONDARY 4
CHEMISTRY
EXAM PAPERS

1	ANGLO-CHINESE SCHOOL (BARKER ROAD)	PRELIM
2	BUKIT BATOK SECONDARY SCHOOL	PRELIM
3	BENDEMEER SECONDARY SCHOOL	PRELIM
4	CHIJ KATONG CONVENT	PRELIM
5	CHIJ SAINT THERESA'S CONVENT	PRELIM
6	FUHUA SECONDARY SCHOOL	PRELIM
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9	ST. GABRIEL'S SECONDARY SCHOOL	PRELIM
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11	ST. PATRICK'S SCHOOL	PRELIM
12	XINMIN SECONDARY SCHOOL	PRELIM

Anglo-Chinese School
(Barker Road)

PRELIMINARY EXAMINATION 2017
SECONDARY 4 EXPRESS

CHEMISTRY
5073/01

TIME: 1 HOUR

INSTRUCTIONS TO CANDIDATES:

Do not open this booklet until you are told to do so.

There are twenty multiple choice questions in this section. Select the best possible answer for each question, and indicate your response by shading the appropriate box in the optical answer sheet (OTAS) provided.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Scientific calculators may be used.
A copy of the Periodic Table is printed on page 17.

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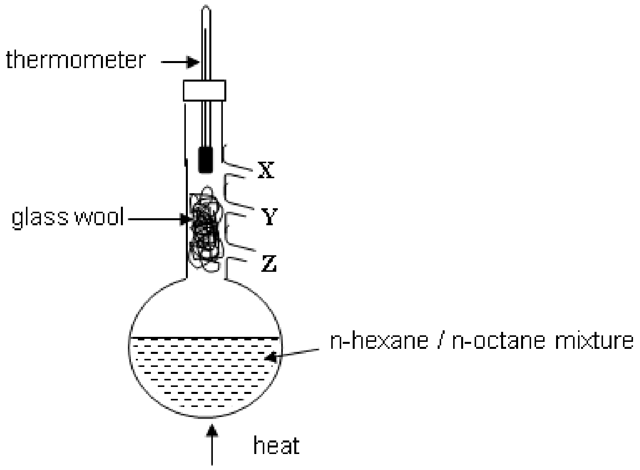
*This question paper consists of **17** printed pages*

Paper 1

Answer all questions on the OTAS sheet provided.

1. A mixture of n-hexane (boiling point 69ºC) and n-octane (boiling point 126ºC) is heated in a fractional apparatus as shown in the diagram. Fractions are drawn off at the points labelled **X**, **Y** and **Z**.



Compared with the fractions drawn off at **Y** and **Z**, the fraction drawn off at **X** is likely to have

A the highest boiling point and the highest proportion of n-hexane.
B the highest boiling point and the lowest proportion of n-hexane.
C the lowest boiling point and the highest proportion of n-hexane.
D the lowest boiling point and the lowest proportion of n-hexane.

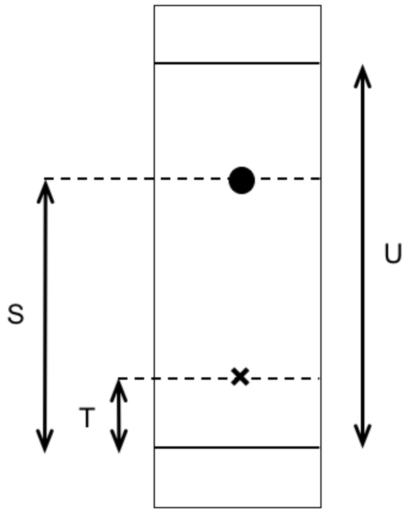
2. The properties of two substances are shown in the table below.

substance	melting point (°C)	boiling point (°C)	solubility in water
1	–8	67	insoluble
2	95	210	soluble

Which is the best method to separate these two substances at room temperature and pressure?

A filtration
B paper chromatography
C separating funnel
D simple distillation

3. A substance is marked on a piece of filter paper at the point marked X, and placed in a solvent for some time. The resulting chromatogram is obtained.



What is the R_f value of the dot obtained?

A $\frac{S}{U}$

B $\frac{T}{S}$

C $\frac{S-T}{U}$

D $\frac{S-T}{U-T}$

4. A new substance was discovered and a series of experiments were conducted on it.

Which observation suggests that the substance **cannot** be an element?

A electrolysis of the molten substance gave two products
B the substance dissolves in water to give a colourless solution
C the substance has a fixed melting point
D when heated in air, the substance can form two types of oxides

5. Which statement about nitrogen atoms is **not** correct?

A All nitrogen atoms have the same atomic number.
B All nitrogen atoms have the same chemical properties.
C All nitrogen atoms have the same electronic configuration.
D All nitrogen atoms have the same mass number.

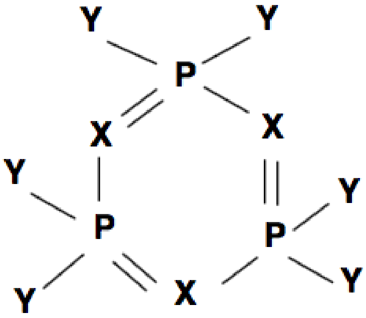
6. The table below shows the number of neutrons and electrons in the following four particles.

particle	number of neutrons	number of electrons
P	18	8
Q^+	12	10
R^{2-}	16	10
S	13	11

Which particle is an isotope of **P**?

A **Q**
B **R**
C **S**
D none of the above

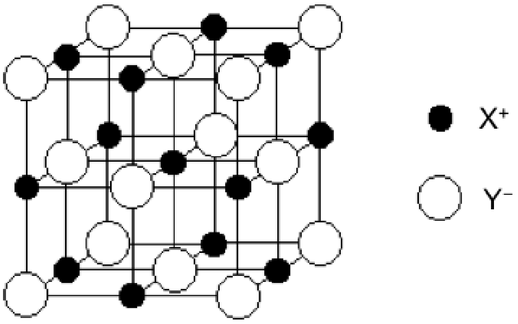
7. A molecule consists of three types of atoms, **P**, **X** and **Y**.



If **P** is phosphorus, what could **X** and **Y** be?

	X	**Y**
A	Al	H
B	N	Cl
C	O	H
D	Si	Cl

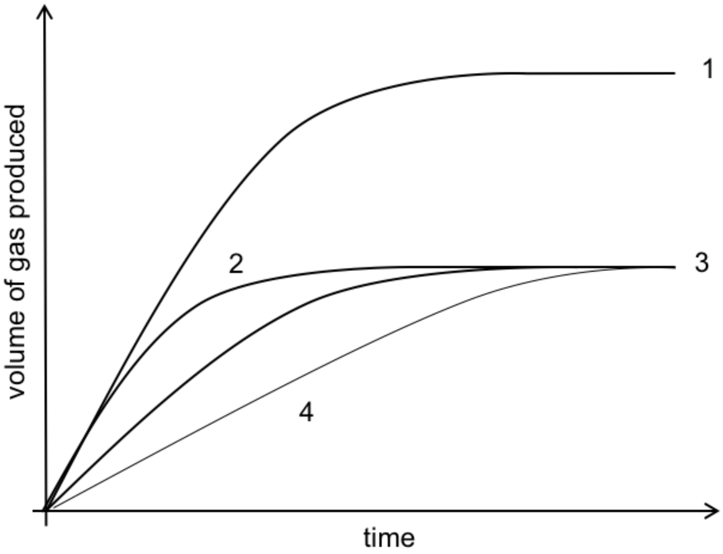
8. The diagram shows part of the structure of a salt, **XY**.



Which statement is correct?

A Each $\mathbf{Y}^-$ ion is bonded to five $\mathbf{X}^+$ ions.
B Each **X** atom is bonded to six **Y** atoms.
C The ratio of $\mathbf{X}^+$ to $\mathbf{Y}^-$ is 1 : 1.
D The structure shown is able to conduct electricity.

9. Sodium carbonate is added to 1.0 mol/dm^3 of excess ethanoic acid, hydrochloric acid and sulfuric acid separately.



Which correctly matches the graph to the acid used in each reaction?

	sulfuric acid	hydrochloric acid	ethanoic acid
A	1	2	4
B	1	4	3
C	2	3	4
D	2	4	3

10. Which pair of reactants is best used to prepare the corresponding salt?

	reactant 1	reactant 2	salt
A	ammonium chloride	nitric acid	ammonium nitrate
B	barium carbonate	sulfuric acid	barium sulfate
C	copper	hydrochloric acid	copper(II) chloride
D	sodium hydroxide	sulfuric acid	sodium sulfate

11. Which pair of reactants, when mixed, will react as shown in the ionic equation below?

$$Pb^{2+} (aq) + SO_4^{2-} (aq) \rightarrow PbSO_4 (s)$$

A lead(II) chloride and sodium sulfate
B lead(II) nitrate and sulfuric acid
C lead(II) oxide and sulfuric acid
D lead(II) sulfate and water

12. Which substance contains the most number of molecules in 1 g?

A O_2
B CO
C NO_2
D SO_2

13. Tin is extracted from its ore cassiterite (which contains SnO_2) by reduction by carbon in a blast furnace according to the equation below.

$$SnO_2 + 2\,C \rightarrow Sn + 2\,CO$$

What is the percentage purity of tin ore if 600g of cassiterite on reduction produces 82g of tin? (M_r of SnO_2 = 151, M_r of Sn = 119)

A $\frac{82}{119} \times \frac{600}{151} \times 100\%$

B $\frac{82}{119} \times \frac{151}{600} \times 100\%$

C $\frac{119}{82} \times \frac{600}{151} \times 100\%$

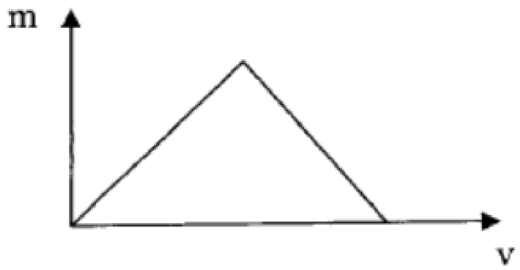
D $\frac{119}{82} \times \frac{151}{600} \times 100\%$

14. When an aqueous salt was warmed with aqueous sodium hydroxide and aluminium foil, a gas which turned moist red litmus paper blue was evolved.

Which of the following could **not** be the aqueous salt?

A ammonium chloride
B ammonium nitrate
C sodium chloride
D sodium nitrate

15. In a test for the presence of a cation in an aqueous salt solution, aqueous sodium hydroxide is added slowly until in excess. The diagram shows how the mass (m) of the precipitate varies with the volume (v) of sodium hydroxide added.



Which of the following could **not** be the aqueous salt?

A aluminium nitrate
B calcium nitrate
C lead(II) nitrate
D zinc nitrate

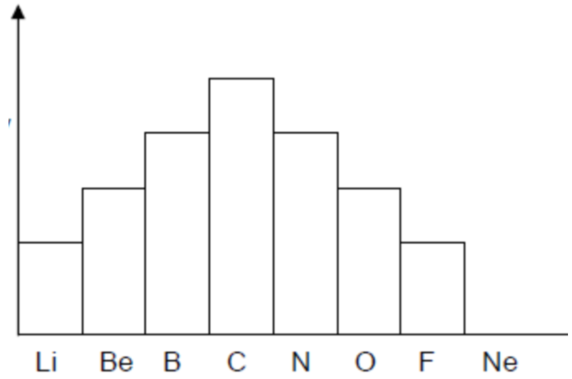
16. A series of tests are carried out on an unknown gas. The table below shows the tests and the results obtained.

test	result
moist blue litmus paper	no change
aqueous bromine	no change
lighted splint	extinguishes

What could the gas be?

A ammonia
B chlorine
C ethene
D oxygen

17. The bar chart shows the period of elements from lithium to neon.



Which is the correct label for the y-axis?

A the atomic number
B the number of electrons involved in bonding
C the number of valence electrons
D the relative atomic mass

18. Astatine can be found in Group VII of the Periodic Table.

Which statement is correct?

A Astatine can conduct electricity.
B Astatine forms a soluble silver salt.
C Astatine can form both ionic and covalent compounds.
D Astatine occupies 24 dm^3 at room temperature and pressure.

19. In which reaction is sulfur dioxide acting as an oxidizing agent?

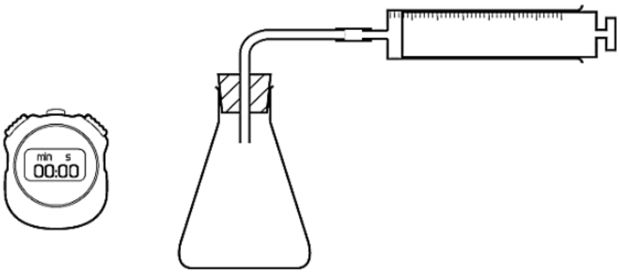
A $SO_2 + 2 H_2O + Cl_2 \rightarrow H_2SO_4 + 2 HCl$
B $SO_2 + 2 NaOH \rightarrow Na_2SO_3 + 2 H_2O$
C $2 SO_2 + O_2 \rightarrow 2 SO_3$
D $SO_2 + H_2S \rightarrow 2 H_2O + 3 S$

20. An unknown substance **Z** is added to aqueous potassium iodide, and there was no visible change observed.

Which statement describing **Z** is definitely true?

A **Z** is a reducing agent.
B **Z** is an oxidizing agent.
C **Z** is not a reducing agent.
D **Z** is not an oxidizing agent.

21. The apparatus shown below can be used to investigate the rate of a reaction.



In which reaction could the rate of reaction be followed using these apparatus?

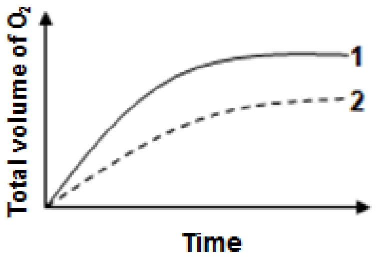
A $AgNO_3$ + HCl
B Mg + HCl
C NaOH + HCl
D NH_4NO_3 + HCl

22. Aqueous hydrogen peroxide decomposes to form water and oxygen gas. Two experiments were carried out to measure the rate of production of oxygen from aqueous hydrogen peroxide.

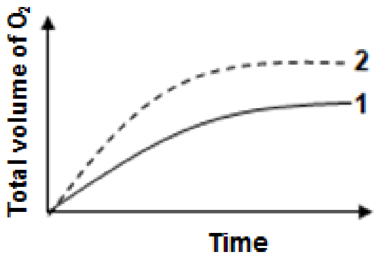
experiment	reagent used
1	400 cm^3 of 0.2 mol/dm^3 of hydrogen peroxide
2	100 cm^3 of 1.0 mol/dm^3 of hydrogen peroxide

Which graph best shows the results obtained?

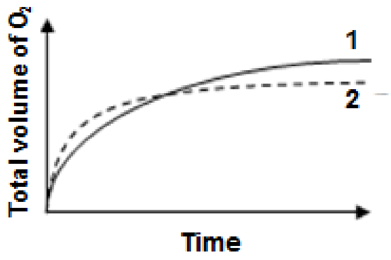
A



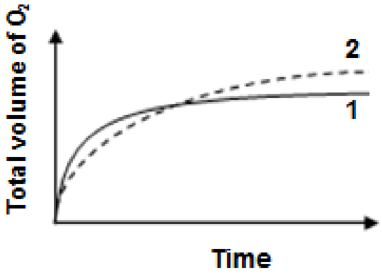
B



C



D



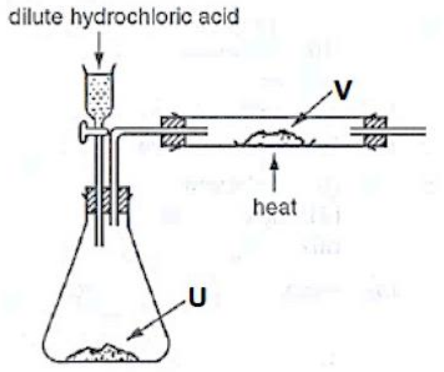
23. Which statement about the manufacture of ammonia via the Haber Process is **not** correct?

A A high pressure will increase the yield of ammonia.
B A high temperature will increase the yield of ammonia.
C An iron catalyst is used to speed up the rate of reaction.
D It is a redox reaction.

24. Which of the following is **not** correct about the type of steel and its use being described?

	type of steel	**use**
A	low carbon steel	cutting tools
B	low carbon steel	used to make car bodies
C	stainless steel	cutlery
D	stainless steel	surgical instruments

25. The diagram shows an experimental set up used to reduce substance **V**. Which of the following pairs could be **U** and **V**?



	U	V
A	copper	copper(II) oxide
B	copper	lead(II) oxide
C	lead	lead(II) oxide
D	magnesium	copper(II) oxide

26. Which statement about transition metals is **not** correct?

A Transition metals can behave as catalysts.
B Transition metals have high melting and boiling points.
C Transition metals can have variable oxidation states.
D Transition metals tend to be coloured.

27. Which correctly matches the air pollutant to its source and effect?

	air pollutant	source	effect
A	carbon monoxide	combustion of fuels	global warming
B	nitrogen dioxide	car engines	acid rain
C	ozone	photochemical smog	depletes the ozone layer
D	sulfur dioxide	lightning activity	acid rain

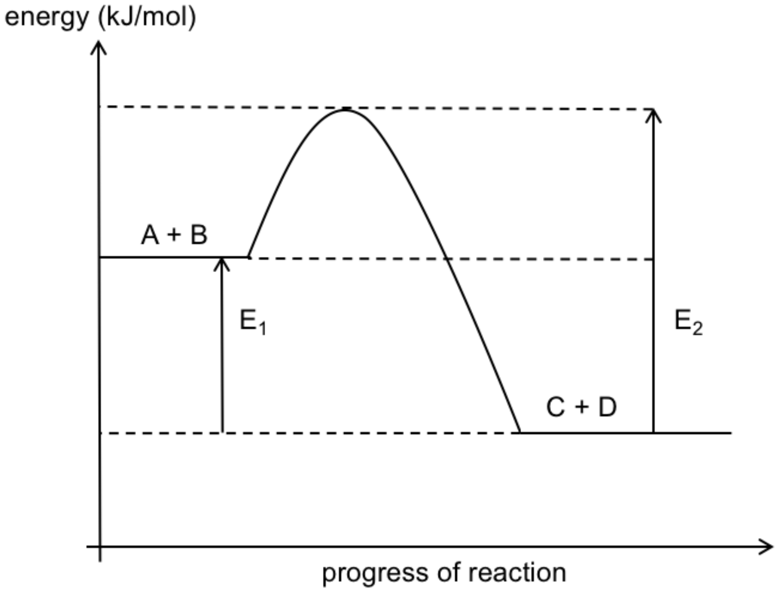
28. Which statement about hydrogen as a fuel is correct?

A Hydrogen can be obtained by fractional distillation of crude oil.
B Hydrogen is the main component found in natural gas.
C Hydrogen is a fuel that is easily transported and stored.
D Hydrogen reacts with oxygen to produce energy and water.

29. The equation below represents a reversible reaction.

$$A + B \rightleftharpoons C + D$$

The energy profile diagram of the reaction shown.



Which statement is correct?

A E_1 is the enthalpy change of the forward reaction.
B E_2 is the enthalpy change of the backward reaction.
C $(E_2 – E_1)$ is the activation energy of the backward reaction.
D $(E_2 – E_1)$ is the activation energy of the forward reaction.

30. Which pair of statements correctly describes the differences between the conduction of electricity by electrolytes and the conduction of electricity by metals during electrolysis?

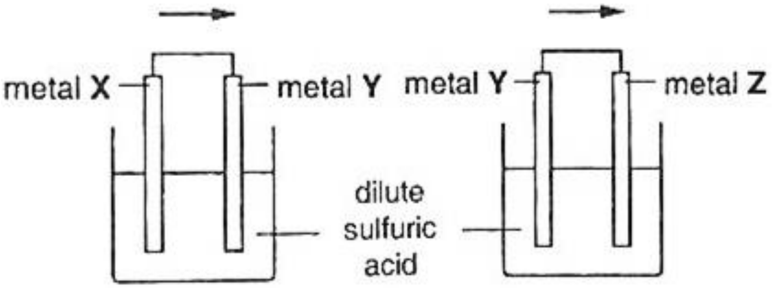
	conduction by electrolytes	conduction by metals
1	the current is due to the movement of ions	the current is due to the movement of electrons
2	charged particles move towards both electrodes	charged particles move in one direction only
3	it always results in a chemical change	it never results in a chemical change

A only 1 is correct
B only 1 and 2 are correct
C only 2 and 3 are correct
D 1, 2 and 3 are correct

31. In electroplating a chromium bracelet with silver, which combination of anode, cathode and electrolyte is most suitable?

	anode	cathode	electrolyte
A	bracelet	silver	chromium(III) nitrate
B	bracelet	silver	silver nitrate
C	silver	bracelet	chromium(III) nitrate
D	silver	bracelet	silver nitrate

32. Two cells were set up as shown below. The arrows show the direction of electron flow in the external circuit.



Which set of metals would cause electron flow in the directions shown?

	metal **X**	metal **Y**	metal **Z**
A	Ag	Zn	Cu
B	Cu	Ag	Zn
C	Zn	Ag	Cu
D	Zn	Cu	Ag

33. Which correctly matches the crude oil fraction to its use?

	fraction	use
A	bitumen	chemical feedstock
B	diesel	paving road surfaces
C	naphtha	fuel for cooking
D	paraffin	aircraft fuel

34. Two hydrocarbons have the same percentage by mass of carbon and hydrogen.

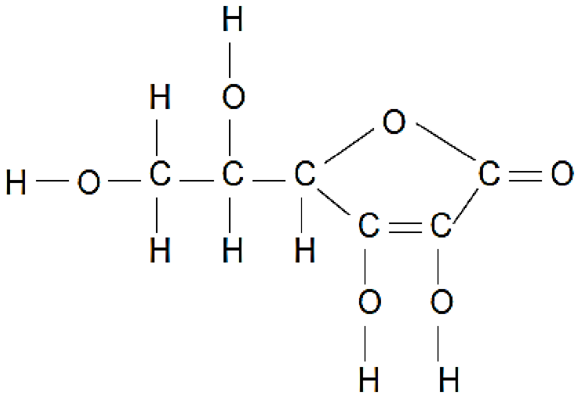
Which statement is true for both hydrocarbons?

A They belong to the same homologous series.
B They have similar chemical properties.
C They have the same empirical formula.
D They have the same molecular formula.

35. In which reaction is water **not** a product?

A combustion
B esterification
C fermentation
D neutralization

36. The structural formula of an organic compound is shown below.



Which substance(s) can react with this compound?

I acidified potassium manganate(VII)
II aqueous bromine
III sodium carbonate

A **I** and **II** only
B **I** and **III** only
C **II** and **III** only
D **I**, **II** and **III**

37. A student investigated the reaction of different vegetable oils with hydrogen.

100 cm^3 of hydrogen was passed through 1 g samples of vegetable oils containing a suitable catalyst. The volume of hydrogen gas remaining in each reaction was recorded in the table below.

vegetable oil	volume of hydrogen remaining (cm^3)
P	100
Q	87
R	0

Which vegetable oil(s) is/are unsaturated?

A **P** only
B **P** and **Q**
C **Q** and **R**
D **R** only

38. The reaction between a carboxylic acid, C_xH_yCOOH and an alcohol, $C_zH_{2z+1}OH$ produces an ester.

How many carbon, hydrogen and oxygen atoms are there in this ester?

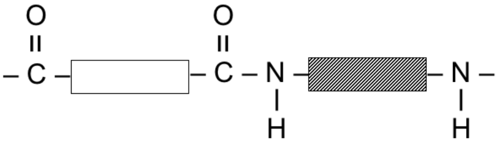
	number of carbon atoms	number of hydrogen atoms	number of oxygen atoms
A	x + z	y + 2z	2
B	x + z	y + 2z + 1	2
C	x + z + 1	y + 2z	2
D	x + z + 1	y + 2z + 1	2

39. In the polymerization of ethene to polyethene, there is **no** change in

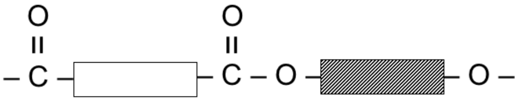
A boiling point.
B density.
C empirical formula.
D molecular formula.

40. What is the correct structure of nylon?

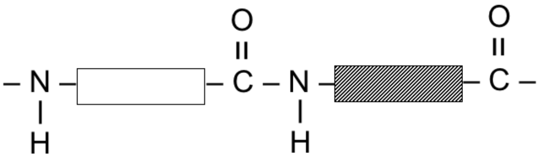
A



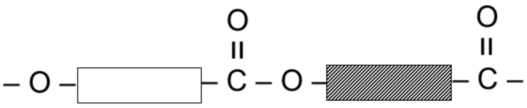
B



C



D



The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 H hydrogen 1										4 He helium 2
7 Li lithium 3	9 Be beryllium 4											11 B boron 5	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	20 Ne neon 10
23 Na sodium 11	24 Mg magnesium 12											27 A*l* aluminium 13	28 Si silicon 14	31 P phosphorus 15	32 S sulfur 16	35.5 C*l* chlorine 17	40 Ar argon 18
39 K potassium 19	40 Ca calcium 20	45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	55 Mn manganese 25	56 Fe iron 26	59 Co cobalt 27	59 Ni nickel 28	64 Cu copper 29	65 Zn zinc 30	70 Ga gallium 31	73 Ge germanium 32	75 As arsenic 33	79 Se selenium 34	80 Br bromine 35	84 Kr krypton 36
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	– Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54
133 Cs caesium 55	137 Ba barium 56	139 La lanthanum 57 *	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80	204 T*l* thallium 81	207 Pb lead 82	209 Bi bismuth 83	– Po polonium 84	– At astatine 85	– Rn radon 86
– Fr francium 87	– Ra radium 88	– Ac actinium 89 †															

*58-71 Lanthanoid series
†90-103 Actinoid series

140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	– Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	162 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
232 Th thorium 90	– Pa protactinium 91	238 U uranium 92	– Np neptunium 93	– Pu plutonium 94	– Am americium 95	– Cm curium 96	– Bk berkelium 97	– Cf californium 98	– Es einsteinium 99	– Fm fermium 100	– Md mendelevium 101	– No nobelium 102	– Lr lawrencium 103

Key

a X b

a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

Exam Index Number	

Anglo-Chinese School (Barker Road)

PRELIMINARY EXAMINATION 2017
SECONDARY 4 EXPRESS

CHEMISTRY
5073/02

TIME: 1 HOUR 45 MINUTES

INSTRUCTIONS TO CANDIDATES:
Write your Exam Index Number in the box provided at the top of this page.
Candidates are reminded that all quantitative answers should include appropriate units.
Candidates are advised to show all their working in a clear and orderly manner.

Sections A
Answer **all** questions in the spaces provided on the question paper.

Sections B
Answer all **three** questions, the last question is in the form either/or.
Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES:

The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page 23.

For Examiner's Use Only	
Section A	
B7	
B8	
B9	
TOTAL	

*This question paper consists of **23** printed pages*

Section A

Answer **all** questions in the spaces provided.
The total mark for this section is 50.

A1. The letters **A**, **B**, **C**, **D**, **E**, **F** and **G** show the oxides of some elements.

A	K_2O
B	CaO
C	Al_2O_3
D	CO
E	NO
F	PbO
G	SiO_2

Use the letters **A**, **B**, **C**, **D**, **E**, **F** and **G** to answer the questions below. The letters can be used once, more than once, or not at all.

(a) Which substance(s) is/are neutral oxides?

……………………………………………………………………………………...[1]

(b) Which substance can be used to control the pH of soil?

……………………………………………………………………………………...[1]

(c) Which substance(s) is/are involved in the Blast Furnace reactions?

……………………………………………………………………………………...[1]

(d) Which two substances can be used to convert naphtha into ethene?

…………………… and …………………… [1]

(e) Give the chemical formula for the compound formed from the reaction between **F** and **G**.

……………………………………………………………………………………...[1]

(f) Describe a test you could carry out in the laboratory to distinguish aqueous solutions of compounds **A** and **B**.

……………………………………………………………………………………...

……………………………………………………………………………………...

……………………………………………………………………………………...[2]

[total = 7 marks]

A2. Chlorofluorocarbons (CFCs) were widely used in refrigerants and aerosol products before the 1990s, until they were phased out by several countries due to their negative impact on the environment.

(a) Describe the negative impact CFCs have on human beings and the environment.

……………………………………………………………………………………...

……………………………………………………………………………………...[1]

(b) Applications of CFCs make use of their volatility and low reactivity.

The table shows the properties of some common CFC refrigerants.

name of CFC	formula of CFC	boiling point (°C)
Freon-11	CCl_3F	23
Freon-12	CCl_2F_2	–30
Freon-31	CH_2ClF	–9

(i) "The boiling point of the CFC increases with the size of the molecule."

Do you agree with this statement? Use the information in the table to explain your reasoning.

………………………………………………………………………………

………………………………………………………………………………

………………………………………………………………………………[2]

(ii) Freon-13, is composed of 11.5% by mass of carbon, 34% by mass of chlorine, and the remainder being fluorine.

Deduce, by calculation, the molecular formula of Freon-13.

[3]

[total = 6 marks]

A3. A catalytic converter is an emissions control device that converts toxic gases and pollutants into less harmful gases.

(a) These days, most cars are installed with catalytic converters that removes carbon monoxide and nitrogen dioxide:

$$2\ NO_2 + 2\ CO \rightarrow N_2 + 2\ CO_2$$

(i) Explain, in terms of oxidation states, why this is a redox reaction.

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………[2]

(ii) A car company advertises that “catalytic converters are 100% environmentally friendly”.

Do you agree with this statement? Explain your reasoning.

…………………………………………………………………………………

…………………………………………………………………………………[1]

(b) In a typical catalytic converter, a powdered catalyst such as platinum is used to speed up the conversion of gases.

Explain, in terms of reacting particles, why the catalyst is powdered.

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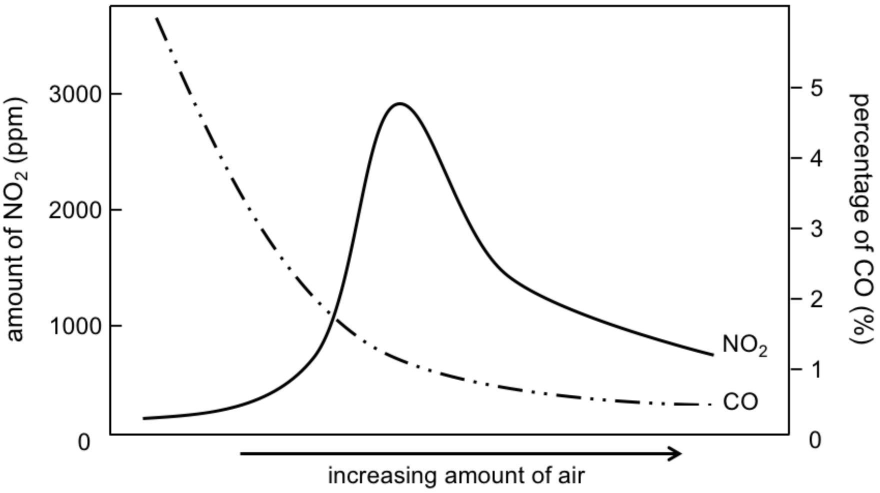
………………………………………………………………………………………...

……………………………………………………………………………………...[2]

(c) The graph shows how the amount of nitrogen dioxide (measured in ppm) and carbon monoxide (measured in %) vary depending on how much air is present in the car engine.



(i) Describe how the amounts of nitrogen dioxide and carbon monoxide vary with the amount of air in the car engine.

…………………………………………………………………………………

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…………………………………………………………………………………

……………………………………………………………………………[2]

(ii) Making use of the redox reaction given in **(a)**, and considering how nitrogen dioxide and carbon monoxide are formed in the car engine, explain why the amounts of nitrogen dioxide and carbon monoxide vary in this way.

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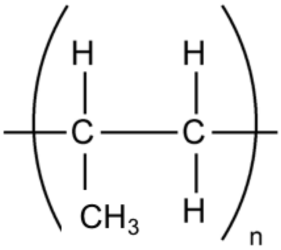
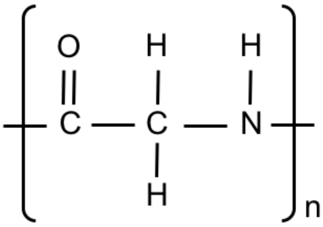
……………………………………………………………………………[3]

[total = 10 marks]

A4. Polymers have several uses, and can be found almost everywhere.

Some information about two polymers are shown below.

name of polymer	polypropene	polyglycine
structural formula		
name of monomer	propene	glycine
average M_r	2000 – 4000	2000 – 5000

(a) Polyglycine is a polyamide, which is made by the condensation polymerization of the amino acid monomer, glycine.

(i) Draw the full structural formula of the monomer, glycine.

[1]

(ii) Describe one similarity and one difference between the **structures** of the addition polymer, polypropene, and the condensation polymer, polyglycine.

…………………………………………………………………………………

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…………………………………………………………………………………

…………………………………………………………………………………[2]

(iii) The condensation polymerization of glycine to produce one molecule of polyglycine eliminates 990 g of water.

Calculate the relative molecular mass of this molecule of polyglycine, showing all your working (M_r of glycine is 75).

[2]

(b) Propene is the monomer used to prepare polypropene, which is widely used to make plastics.

(i) In terms of bonding and structure, explain why propene is a gas but polypropene is a solid at room temperature.

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………………………………………………………………………………………

………………………………………………………………………………………[2]

(ii) Explain how aqueous bromine can be used to monitor the conversion of propene to polypropene.

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………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………[2]

[total = 9 marks]

A5. Acid-base titration is often carried out in the laboratory, and the progress of the titration can be monitored using a data logger (pH meter).

The graph below shows the resulting pH curve when 1.0 mol/dm^3 of aqueous sodium hydroxide is added to 10 cm^3 of 2.0 mol/dm^3 of dilute hydrochloric acid.

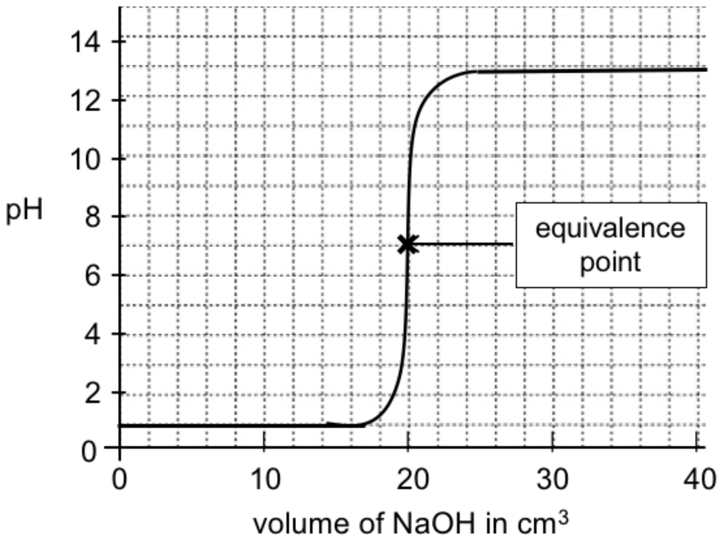

Fig. 3.1

The equivalence point is the point where all the hydrogen ions in the acid have reacted with the hydroxide ions in the alkali.

For the neutralization reaction between aqueous sodium hydroxide and dilute hydrochloric acid, the equivalence point occurs at a pH value of 7.

(a) With the aid of an ionic equation, explain why the equivalence point for a strong acid-strong base titration occurs at a pH value of 7.

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………………………………………………………………………………………..

………………………………………………………………………………………...[2]

(b) Without a pH meter, the progress of the titration can also be monitored using an appropriate indicator, which indicates the end-point of the titration.

Explain why the use of the universal indicator would not be appropriate to monitor the progress of the titration.

………………………………………………………………………………………..

………………………………………………………………………………………...[1]

(c) When a strong alkali is titrated against a weak acid, the equivalence point occurs at a pH value above 7.

The graph below shows the resulting pH curve when 1.0 mol/dm^3 of aqueous sodium hydroxide is added to 10 cm^3 of 2.0 mol/dm^3 of dilute ethanoic acid.

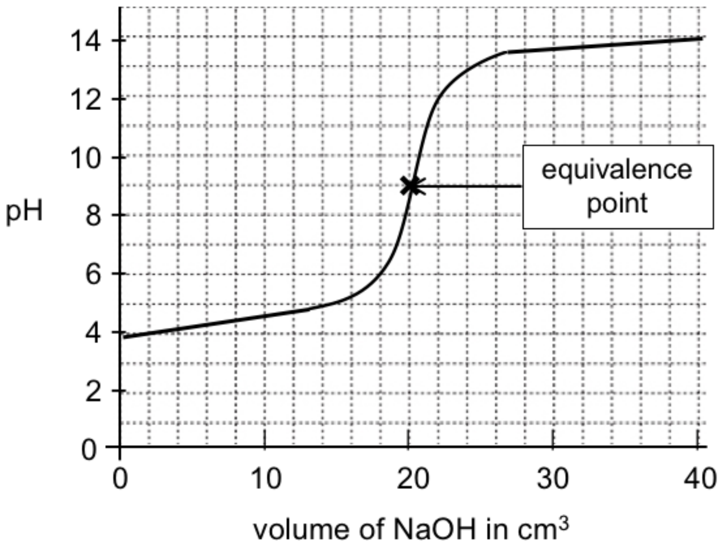

Fig. 3.2

(i) Write the chemical equation for the reaction between aqueous sodium hydroxide and dilute ethanoic acid. State symbols are not required.

……………………………………………………………………………………[1]

(ii) Explain why, in both titration experiments, the equivalence point occurs when 20.0 cm^3 of 1.0 mol/dm^3 aqueous sodium hydroxide is added.

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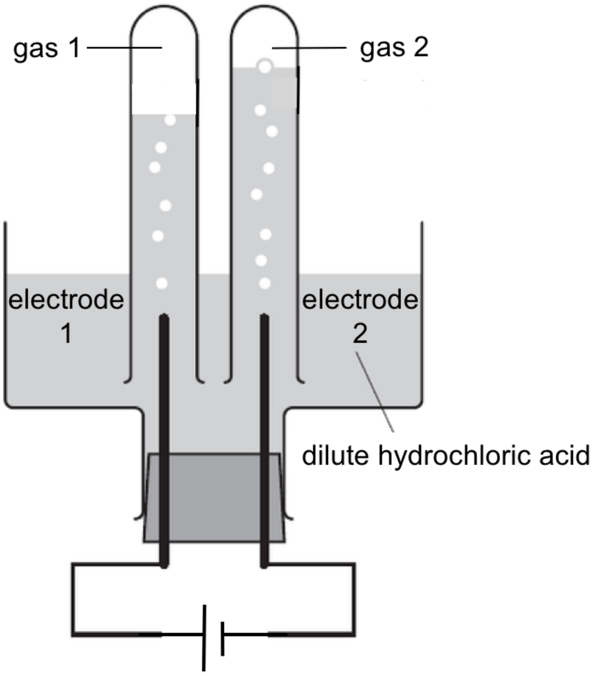
……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………[2]

(d) The diagram below shows a set-up used to electrolyse dilute hydrochloric acid.



(i) Write the half-equations for the reactions occurring at each electrode.

electrode 1:

electrode 2:

[2]

(ii) The actual volume of gas 2 collected is less than expected. Suggest a reason for this.

…………………………………………………………………………………

…………………………………………………………………………………[1]

(iii) Describe and explain, with the aid of a half-equation, any difference you would expect to observe if the electrolyte was changed to concentrated hydrochloric acid.

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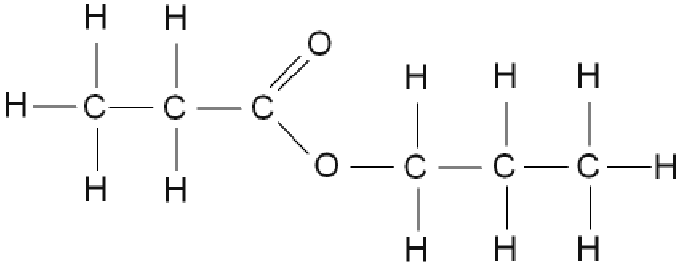
…………………………………………………………………………………[2]

[total = 11 marks]

A6. The structure of an ester that is commonly found in pineapples is shown below.



(a) Draw the full structural formulae of the alcohol and carboxylic acid used to make this ester.

full structural formula of alcohol:

full structural formula of carboxylic acid:

[2]

(b) Besides using litmus or universal indicator, describe another test you could carry out in the laboratory to distinguish the alcohol from the carboxylic acid.

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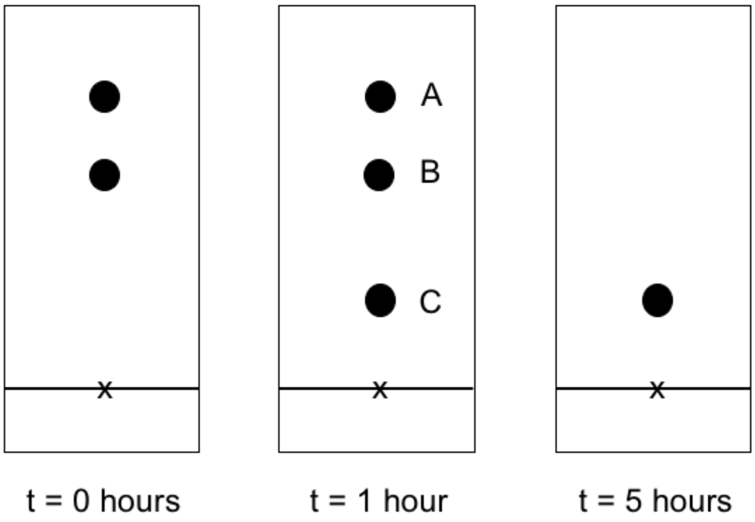
………………………………………………………………………………………………...

………………………………………………………………………………………………..[2]

(c) The conversion of the alcohol and carboxylic acid into this ester can be monitored using paper chromatography.

A small sample of the reacting mixture was extracted at three separate time intervals and run through the chromatography process. The three chromatograms below show the mixture before the reaction (t = 0 hours), during the reaction (t = 1 hour) and after a long period of time (t = 5 hours).



(i) Suggest the identities of the three dots **A**, **B** and **C** on the chromatogram at t = 1 hour, and explain why there are three dots on the chromatogram at this time, compared to t = 0 hours and t = 5 hours.

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………………………………………………………………………………

………………………………………………………………………………[2]

(ii) Make a conclusion about dot **C** based on the results shown in the chromatogram.

………………………………………………………………………………

………………………………………………………………………………[1]

[total = 7 marks]

Section B

Answer all **three** questions in the spaces provided.

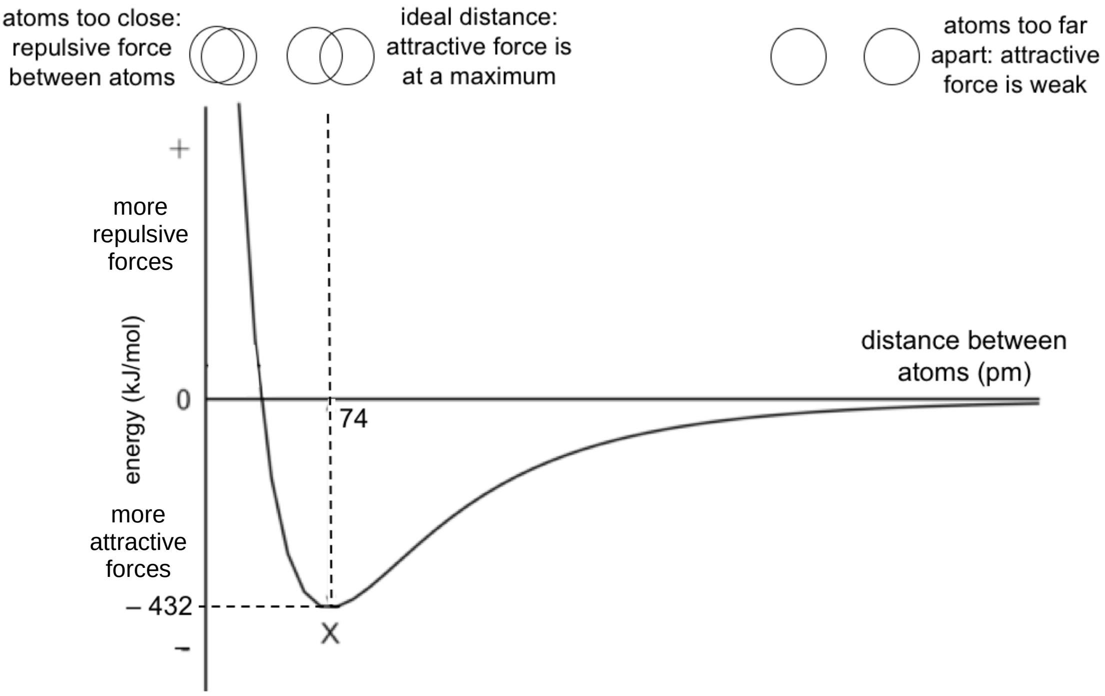
The last question is in the form of an either/or and only one of the alternatives should be attempted.

The total mark for this section is 30.

B7. The formation of a covalent bond involves the sharing of electrons between atoms, forming a stable balance between attractive and repulsive forces between the two atoms being bonded.

In a hydrogen molecule, H_2, the hydrogen atoms share two electrons via covalent bonding. The bond energy is the amount of energy needed to break one mole of a covalent bond. The bond energy of a H – H bond is 432 kJ/mol.

The graph below shows how the bond energy between the two hydrogen atoms varies with the distance between their nuclei.



A positive energy value means that repulsive forces between the atoms' nuclei are dominant.
A negative energy value means that attractive forces between the atoms' nuclei are dominant.

The bond length is the average distance between the nuclei of two bonded atoms in a molecule where the attractive force is greatest. For a hydrogen molecule, this distance is 74 picometres (pm).

The table below shows how the H–H bond compares with the number of bonds, bond lengths and bond energies of some elements in Period 2.

type of bond	number of bonds	average bond energy (kJ/mol)	bond length (picometres)
H – H	1	432	74
O – O	1	142	148
O = O	2	494	121
N – N	1	167	145
N = N	2	418	▨
N ≡ N	3	942	110
F – F	1	155	142

(a) **(i)** Use the graph to describe how the H–H bond energy changes with the distance between the two hydrogen atoms.

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……………………………………………………………………………………[3]

(ii) With consideration of how the sub-atomic particles are arranged in an atom, suggest why the bond energy is lowest at 74 picometres.

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……………………………………………………………………………………..

……………………………………………………………………………………[2]

(b) **(i)** Draw dot-and-cross diagrams to show the covalent bonding in nitrogen and fluorine, showing all the electrons.

nitrogen molecule:

fluorine molecule:

[2]

(ii) "The greater the number of bonds, the shorter the bond length."

Do you agree with this statement? Use the information in the table to explain your reasoning.

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……………………………………………………………………………….[2]

(iii) Use the information in the table to predict the length of the N=N bond.

……………………………………………………………………………….[1]

(c) When nitrogen reacts with oxygen to produce nitrogen monoxide, the reaction is endothermic.

The bond energy of the N=O bond is 607 kJ/mol, and the enthalpy change of reaction is +222 kJ/mol.

Explain, in terms of bonds broken and formed, why this reaction is endothermic.

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………………………………………………………………………………………...[2]

[total = 12 marks]

B8. A metal verifier is an electronic device that can test for precious metals such as gold, silver and platinum. The verifier works by measuring the resistivity (how much each metal opposes the flow of current) of each metal, which is different for each metal and can therefore easily be distinguished.

The table below shows some information about the resistivity of some common materials. The lower the resistivity, the more readily electric current can flow through that metal.

metal	resistivity (Ωm) at 20 °C
carbon (diamond)	1.00×10^{12}
carbon (graphite)	▨
gold	2.44×10^{-8}
platinum	1.06×10^{-7}
silver	1.59×10^{-8}

(a) Using their structures, explain the difference in resistivity between diamond and the three precious metals.

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…………………………………………………………………………………………..[2]

(b) Will graphite's resistivity be more similar to the metals or diamond? Briefly explain your reasoning.

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…………………………………………………………………………………………..[1]

(c) Precious metals sold commercially often have a purity of about 90-99.9%.

Explain why precious metals are sold commercially in the form of alloys instead of the pure metal.

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……………………………………………………………………………………………..

……………………………………………………………………………………………..[2]

(d) In the table above, the resistivity values are measured at 20 °C.

Using kinetic particle theory, describe and explain how you would expect the resistivity of the materials to change if the temperature was raised to 40 °C.

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……………………………………………………………………………………………..[2]

(e) Gold and silver can be extracted from old computers or electronic devices to be recycled and sold commercially.

Describe one advantage of recycling precious metals over mining.

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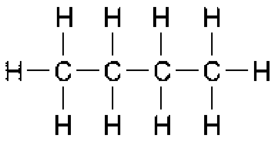
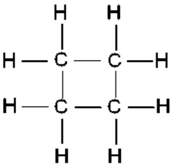
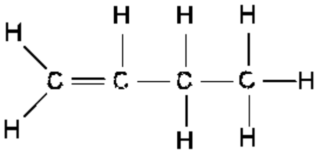
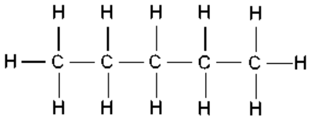
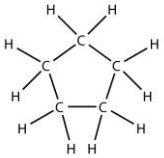
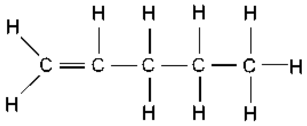
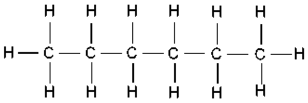
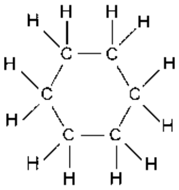
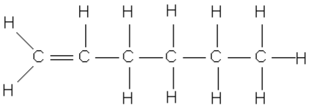
……………………………………………………………………………………………..[1]

[total = 8 marks]

EITHER

B9. The table below shows the names and structural formulae of some hydrocarbons.

number of carbon atoms	alkane	cycloalkane	alkene
4	 $\mathrm{H-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-H}$ butane	 cyclobutane	 butene
5	 $\mathrm{H-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-H}$ pentane	 cyclopentane	 pentene
6	 $\mathrm{H-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-H}$ hexane	 cyclohexane	 hexene

(a) Explain why pentene and cyclopentane are isomers, but pentane and cyclopentane are not.

…………………………………………………………………………………………..

…………………………………………………………………………………………..

…………………………………………………………………………………………..[2]

(b) Do pentene and cyclohexane belong to the same homologous series? Explain your reasoning.

…………………………………………………………………………………………..

…………………………………………………………………………………………..[1]

(c) A cyclic alkene has the molecular formula of C_6H_6. Deduce how many carbon-carbon double bonds C_6H_6 has, showing your working clearly.

…………………………………………………………………………………………..

…………………………………………………………………………………………..[2]

(d) One mole of cyclobutane undergoes an endothermic reaction with one mole of chlorine gas in the presence of UV light.

(i) Write the chemical equation for this reaction, showing all the structural formulae of the reactants and products.

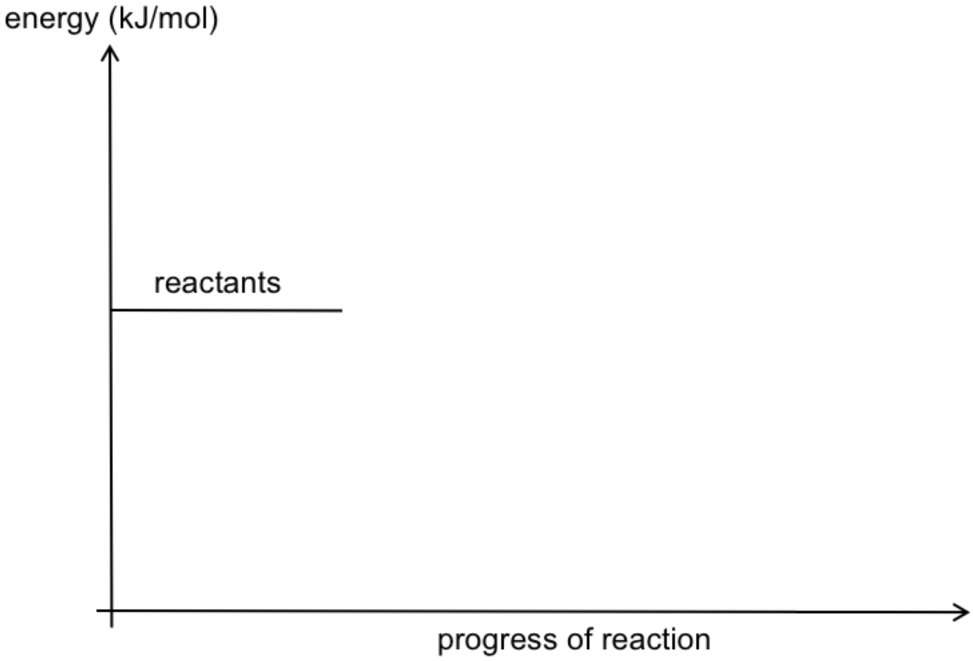
[2]

(ii) How would you expect the rate of reaction to change if cyclobutane was reacted with bromine instead? Explain your reasoning.

……………………………………………………………………………………..

……………………………………………………………………………………..[1]

(iii) Draw the energy profile diagram for reaction of cyclobutane and chlorine, labelling the activation energy and enthalpy change for the reaction.

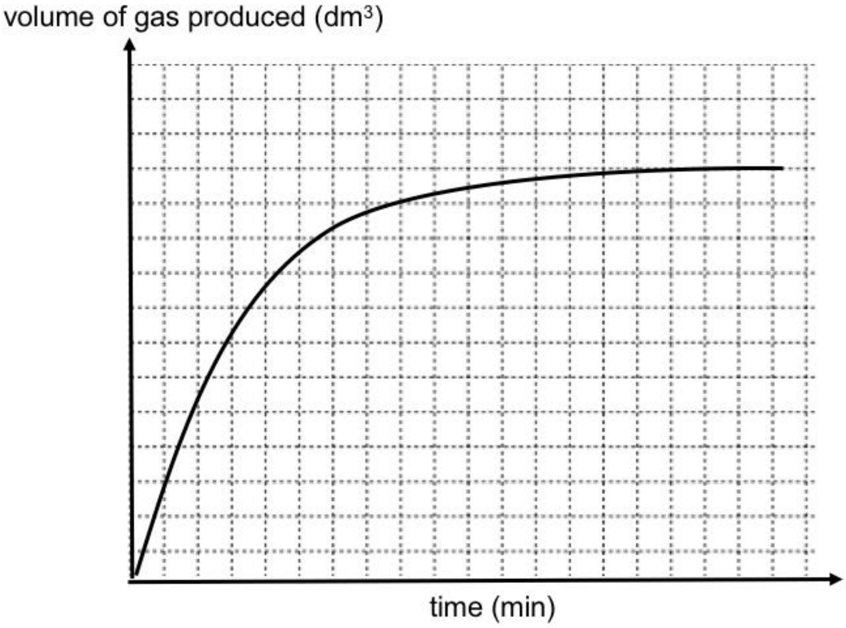


[2]

[total = 10 marks]

OR

B9. The reaction between 24 g of magnesium metal and 750 cm^3 of 2.00 mol/dm^3 sulfuric acid at room temperature and pressure can be monitored in the graph shown below.



(a) Write the chemical equation for the reaction. State symbols are not required.

…………………………………………………………………………………………...[1]

(b) Calculate the maximum volume of gas obtained in this reaction at room temperature and pressure.

[3]

(c) **(i)** On the same axes, sketch the graph you would obtain if 24 g of zinc metal was used instead. [1]

(ii) Describe one variable you would keep constant to ensure that the experiment is fair.

……………………………………………………………………………………..

……………………………………………………………………………………..[1]

(d) When calcium metal is reacted instead, the initial production of gas is the fastest out of the three metals, but the reaction quickly stops.

Explain why this happens.

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………………………………………………………………………………………...

………………………………………………………………………………………...

………………………………………………………………………………………...

………………………………………………………………………………………...[2]

(e) Describe another experiment you could carry out in the laboratory to deduce the order of reactivity of the three metals calcium, magnesium and zinc.

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………………………………………………………………………………………...

………………………………………………………………………………………...

………………………………………………………………………………………...

………………………………………………………………………………………...[2]

[total = 10 marks]

The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 H hydrogen 1										4 He helium 2
7 Li lithium 3	9 Be beryllium 4											11 B boron 5	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	20 Ne neon 10
23 Na sodium 11	24 Mg magnesium 12											27 Al aluminium 13	28 Si silicon 14	31 P phosphorus 15	32 S sulfur 16	35.5 Cl chlorine 17	40 Ar argon 18
39 K potassium 19	40 Ca calcium 20	45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	55 Mn manganese 25	56 Fe iron 26	59 Co cobalt 27	59 Ni nickel 28	64 Cu copper 29	65 Zn zinc 30	70 Ga gallium 31	73 Ge germanium 32	75 As arsenic 33	79 Se selenium 34	80 Br bromine 35	84 Kr krypton 36
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	– Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54
133 Cs caesium 55	137 Ba barium 56	139 La lanthanum 57 *	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80	204 Tl thallium 81	207 Pb lead 82	209 Bi bismuth 83	– Po polonium 84	– At astatine 85	– Rn radon 86
– Fr francium 87	– Ra radium 88	– Ac actinium 89 †															

*58-71 Lanthanoid series
†90-103 Actinoid series

140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	– Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	162 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
232 Th thorium 90	– Pa protactinium 91	238 U uranium 92	– Np neptunium 93	– Pu plutonium 94	– Am americium 95	– Cm curium 96	– Bk berkelium 97	– Cf californium 98	– Es einsteinium 99	– Fm fermium 100	– Md mendelevium 101	– No nobelium 102	– Lr lawrencium 103

Key

a X b

a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

ACS(BR) Preliminary Examinations 2017
Sec 4 Chemistry (5073) Answer Key

PAPER 1

		Feedback
Q1	**C**	
Q2	**C**	
Q3	**D**	
Q4	**A**	
Q5	**D**	
Q6	**B**	
Q7	**B**	
Q8	**C**	
Q9	**C**	
Q10	**D**	
Q11	**B**	
Q12	**B**	
Q13	**B**	
Q14	**C**	
Q15	**D**	
Q16	**A**	
Q17	**B**	
Q18	**C**	
Q19	**D**	
Q20	**D**	
Q21	**B**	
Q22	**B**	
Q23	**B**	
Q24	**A**	
Q25	**D**	
Q26	**D**	
Q27	**B**	
Q28	**D**	
Q29	**D**	
Q30	**B**	
Q31	**D**	
Q32	**D**	
Q33	**D**	
Q34	**C**	
Q35	**C**	
Q36	**A**	
Q37	**C**	
Q38	**D**	
Q39	**C**	
Q40	**A**	

Bukit Batok Secondary School

GCE O Level Preliminary Examination

Sec 4 Express

CHEMISTRY **5073/01**

Paper 1 Multiple Choice

24 August 2017
0745hr to 0845hr

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, index number and class on the Answer Sheet in the spaces provided.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A, B, C** and **D.**
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

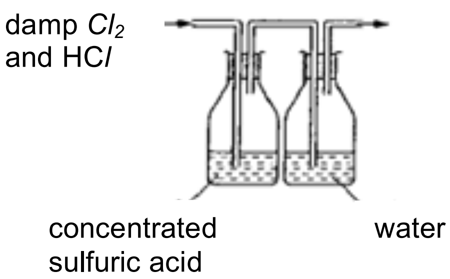
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed at the end of the question paper.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **16** printed pages.

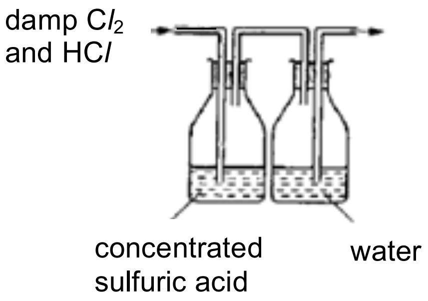
1 Hydrogen chloride, HCl, is very soluble in water, whereas chlorine, Cl_2, is only slightly soluble in water. Both gases can be dried using concentrated sulfuric acid.

Which diagram represents the correct method of obtaining dry chlorine from damp chlorine containing a small amount of hydrogen chloride?

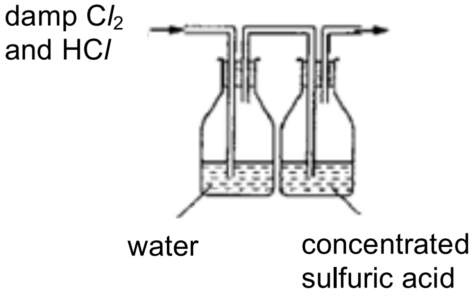
A



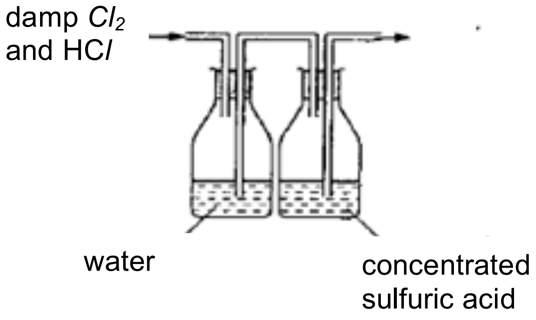
B



C



D



2 A liquid is required to dry a piece of wet copper foil. The liquid must have two properties.

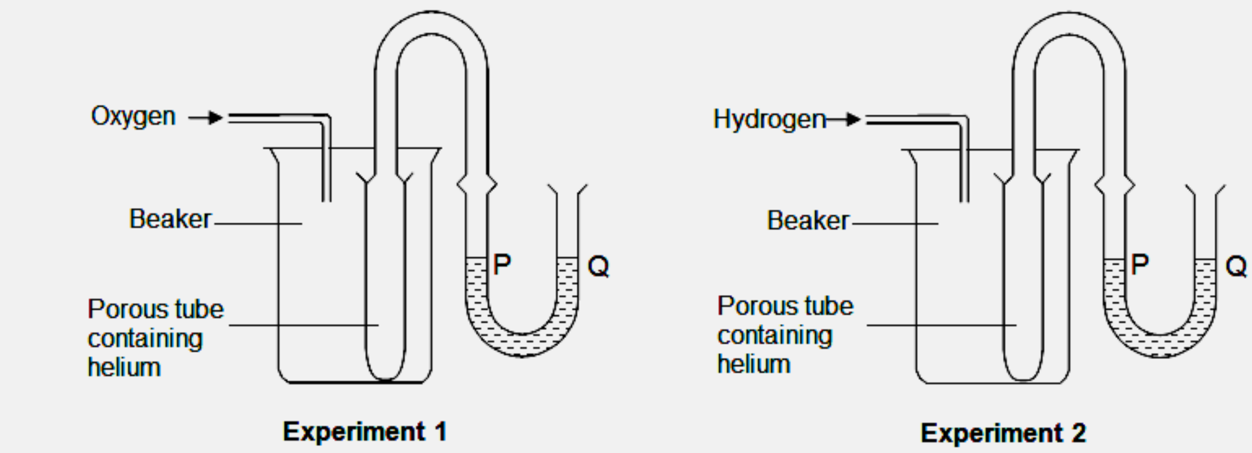
1 able to evaporate quickly in air, and
2 miscible in water

Which one of the liquids below would be most suitable for this purpose?

	boiling point / °C	solubility in water
A	36	insoluble
B	56	very soluble
C	98	very soluble
D	290	insoluble

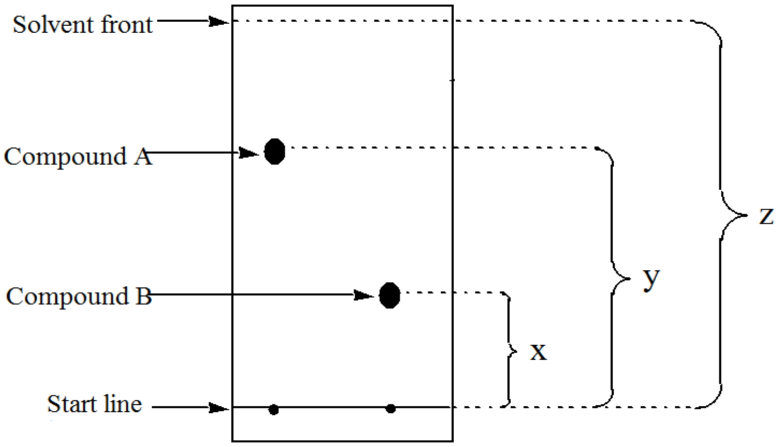
3 Two experiments, experiment **1** and **2**, are set up to demonstrate the diffusion of gases.

What would happen to the water levels at **P** and **Q** in both experiments?



	Experiment 1	Experiment 2
A	**P** is higher than **Q**	**P** and **Q** remain the same
B	**P** is higher than **Q**	**Q** is higher than **P**
C	**P** and **Q** remain the same	**P** and **Q** remain the same
D	**P** and **Q** remain the same	**P** is higher than **Q**

4 A paper chromatogram of two compounds **A** and **B** is shown in the diagram below:



Which statement regarding the paper chromatogram must be correct?

A Compound **A** has a lower R_f value than compound **B**.

B Compound **A** is less soluble in the solvent than compound **B**.

C The R_f value of **A** is $\frac{y}{z}$.

D The solvent level is placed above the starting line.

5 Two reactions were allowed to take place as shown by the equations below :

Equation **I**: $AgNO_3(aq) + KCl(aq) \rightarrow AgCl(s) + KNO_3(aq)$

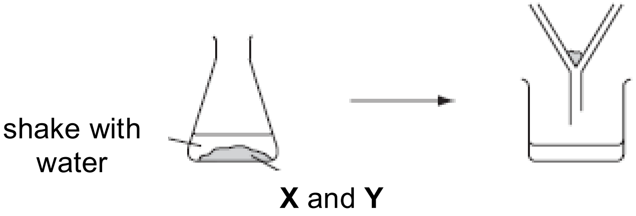
Equation **II** : $Pb(NO_3)_2(aq) + 2NaOH(aq) \rightarrow Pb(OH)_2(s) + 2NaNO_3(aq)$

The products shown in both equations **I** and **II** were mixed together.
Which of the following method is the best separation to obtain a sample of silver chloride from the mixture?

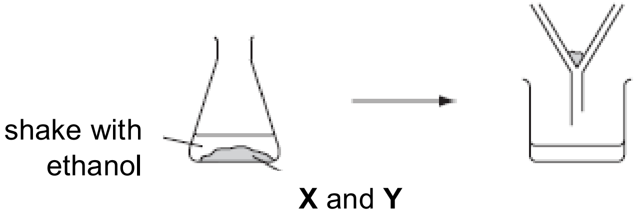
A Add aqueous ammonia to the mixture, filter to obtain the residue of silver chloride.
B Add excess dilute sulfuric acid to the mixture and filter the residue to obtain silver chloride.
C Decant off the aqueous layer and heat the residue to obtain the silver chloride.
D Filter the mixture and add excess dilute nitric acid to the residue. Filter to obtain the silver chloride.

6 A solid mixture contains an ionic salt, **X**, and a covalent organic compound, **Y**.
Two students suggest methods of separating the mixture as shown.

method 1



method 2



Which methods of separation are likely to work?

	method 1	method 2
A	√	√
B	√	X
C	X	√
D	X	X

7 C*l* -35 and C*l* - 37 are two isotopes of chlorine.

Which statements are correct?

1 Both isotopes have the same mass number.
2 Both isotopes have the same electronic configuration.
3 Both isotopes have the same physical properties.
4 Both isotopes have the same chemical properties.

A 1 and 2 only
B 1 and 3 only
C 2 and 3 only
D 2 and 4 only

8 Carbon disulfide is a simple covalent compound used in manufacturing polymers and fibres.

A student made the following statements:

- Carbon disulfide has a low boiling point.
- Carbon disulfide has good electrical conductivity when molten.
- Carbon disulfide is very soluble in water.
- Carbon disulfide is a crystalline solid at room temperature.

How many statement(s) is/are correct about the compound?

A 1 **B** 2 **C** 3 **D** 4

9 What is the total number of shared pair electrons in a propene molecule?

A 8 **B** 9 **C** 10 **D** 11

10 Which one of the following sets of solid elements includes a giant metallic structure, a macromolecular structure and a simple molecular structure?

A	A*l*	Mg	Si
B	A*l*	Si	S
C	C	Si	Sn
D	Si	P	S

11 Bones contain a complex mixture of calcium salts, proteins and other material. When a piece of bone is strongly heated in a current of air, the only residue is calcium oxide. From a sample of 50.0 g of bone, 14.0 g of calcium oxide was obtained.

What is the percentage by mass of calcium in the bone?

A 10.0% **B** 14.0% **C** 20.0% **D** 28.0%

12 Which volume of 1.0 mol/dm^3 hydrochloric acid is required to react completely with 1.25 g of zinc carbonate?

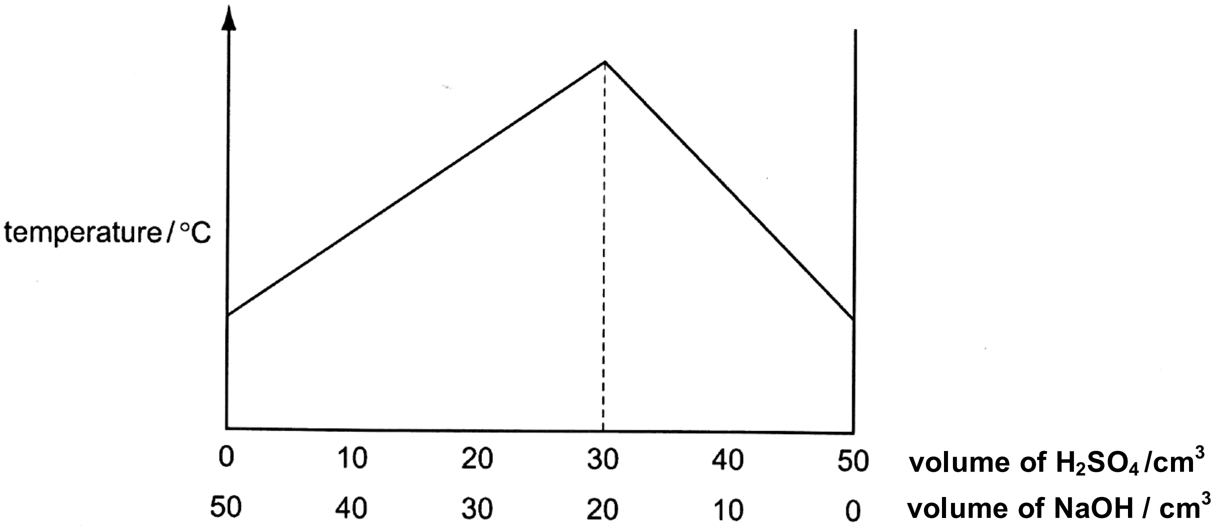
A 10 cm^3 **B** 20 cm^3 **C** 100 cm^3 **D** 200 cm^3

13 5.0 cm^3 of gaseous hydrocarbon reacted with excess oxygen to form 30.0 cm^3 of carbon dioxide and 15.0 cm^3 of water vapour.

What is the formula of the hydrocarbon?

A CH_4 **B** C_2H_4 **C** C_3H_6 **D** C_6H_6

14 An aqueous solution of sulfuric acid has a concentration of 1.0 mol / dm^3
Different volumes of the acid are added to different volumes of aqueous sodium hydroxide.



What is the concentration of the aqueous sodium hydroxide?

A 0.6 mol / dm^3
B 0.75 mol / dm^3
C 1.5 mol / dm^3
D 3.0 mol / dm^3

15 A student writes down four statements about two gases, hydrogen chloride and carbon monoxide.

- One mole of each gas has the same mass.
- One mole of each gas occupies the same volume at room temperature and pressure.
- One mole of each gas has the same number of atoms.
- One mole of each gas has the same number of molecules.

How many of these statements is/are correct?

A 1 **B** 2 **C** 3 **D** 4

16 Which substance has exactly the same number of atoms as 1 g of hydrogen gas?

A 1 g of helium gas at r.t.p
B 24 dm^3 of oxygen gas at r.t.p
C 127 g of solid iodine
D 12000 cm^3 of neon gas

17 Astatine is at the bottom of Group VII in the Periodic Table.

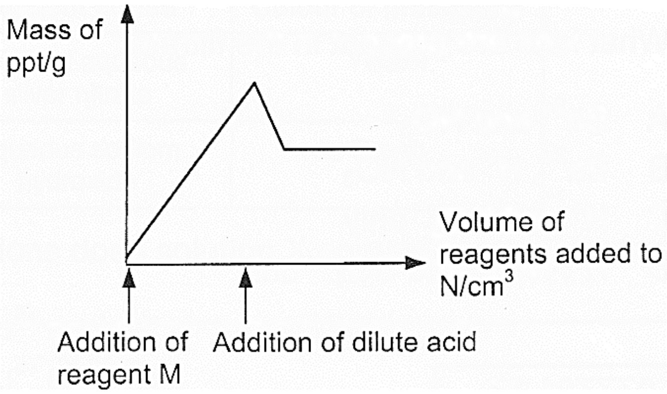
Which row describes the properties of astatine?

	colour	state	reaction with aqueous sodium iodide
A	black	liquid	iodine displaced
B	black	solid	no reaction
C	black	solid	iodine displaced
D	brown	liquid	no reaction

18 Which method is used to prepare copper(II) chloride?

A adding copper to dilute hydrochoric acid at room temperature
B precipitating the salt by adding copper(II) carbonate to aqueous ammonium chloride
C titrating copper(II) hydroxide with dilute hydrochoric acid
D warming copper(II) oxide with dilute hydrochloric acid

19 In a quantitative analysis, reagent M is gradually added to a salt solution N (that contains either 1 or 2 different anions), followed by the addition of a dilute acid. The graph below shows how the mass of precipitate formed changes with the reagents added.



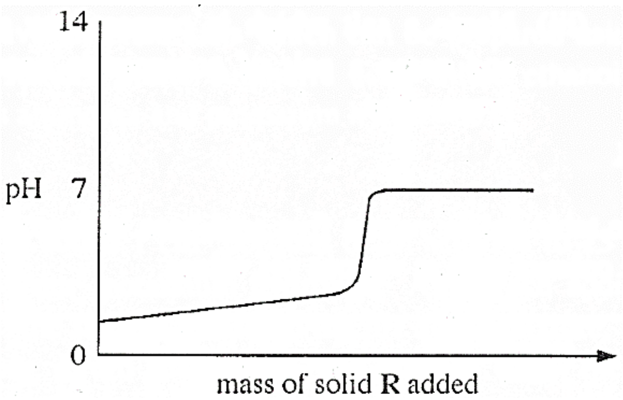
Which of the following combinations would produce the given results?

	anion(s) in N	reagents (M and acid) added
A	CO_3^{2-}	add aqueous silver nitrate, followed by dilute nitric acid
B	Cl^-, CO_3^{2-}	add aqueous barium chloride, followed by dilute hydrochloric acid
C	SO_4^{2-}, CO_3^{2-}	add aqueous silver nitrate, followed by dilute hydrochloric acid
D	SO_4^{2-}, CO_3^{2-}	add aqueous barium chloride, followed by dilute hydrochloric acid

20 When sodium hydroxide solution is added to a solution containing potassium chloride and copper(II) nitrate, which of the following ions will decrease most in concentration?

A Cu^{2+} **B** K^{+} **C** NO_3^{-} **D** Cl^{-}

21 Solid R is gradually added to aqueous solution S. The changes in pH are shown in the graph below.



What are R and S?

	R	S
A	insoluble metal oxide	hydrochloric acid
B	insoluble non-metal oxide	sodium hydroxide
C	soluble metal oxide	hydrochloric acid
D	soluble non-metal oxide	sodium hydroxide

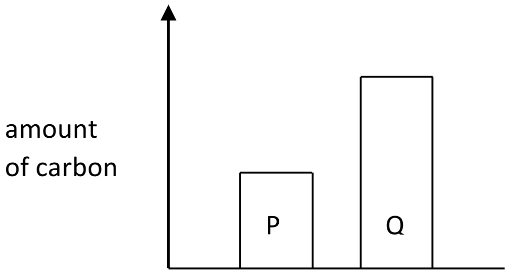
22 A new indicator has just been produced in the laboratory. It changes colour according to the table below:

pH	colour
0 - 3	red
3.5 - 5	green
5 - 14	purple

Which of the following substances can be distinguished using the new indicator?

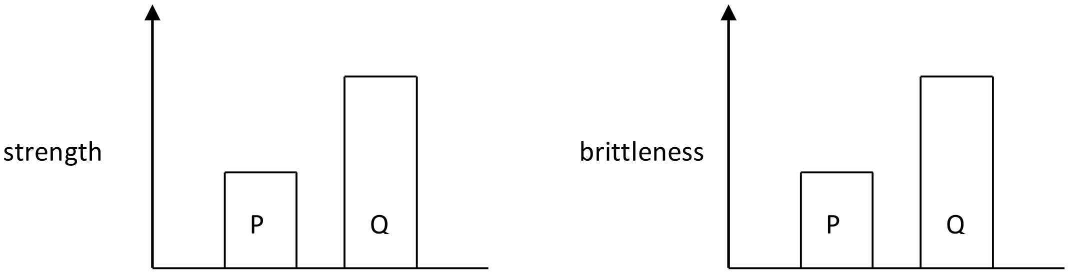
A aqueous ammonia and potassium hydroxide
B aqueous hydrogen chloride and carbon dioxide
C aqueous sodium nitrate and sodium hydroxide
D water and aqueous sodium chloride

23 The diagram compares the amount of carbon in two steels, P and Q.



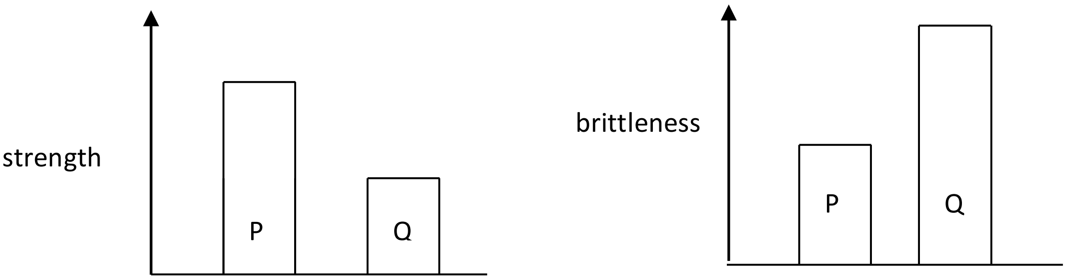
Which two diagrams correctly compare the strength and brittleness of P and Q?

A

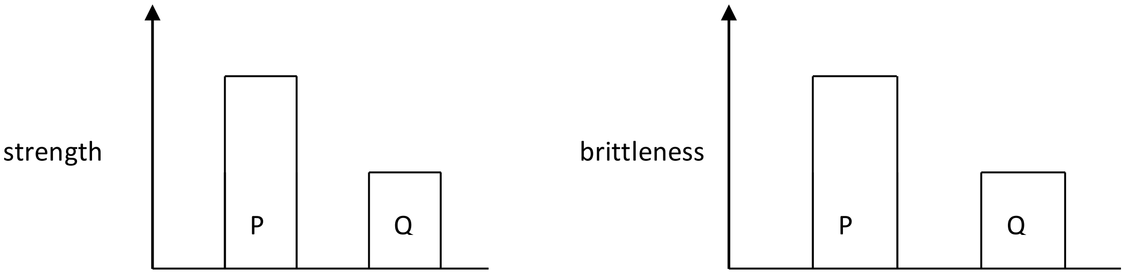


B

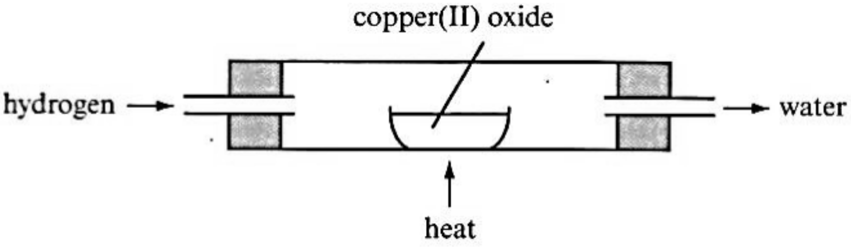
C



D



24 An experiment is set up as shown.



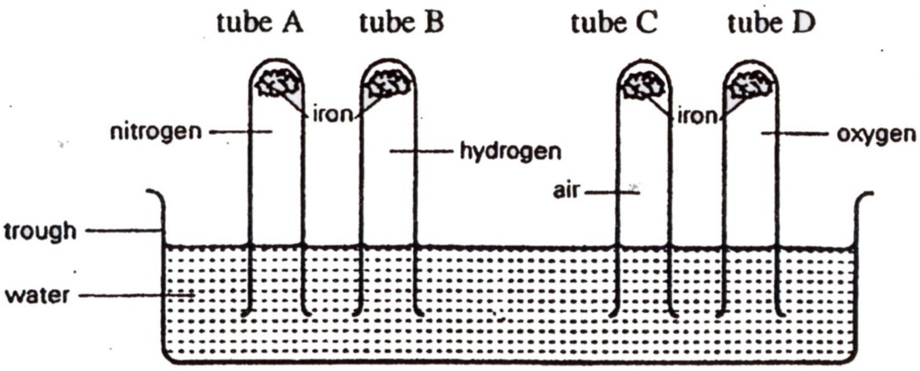
A student recorded these inferences.

1 Hydrogen is a reducing agent.
2 Hydrogen gains oxygen to form water.
3 Copper(II) oxide loses oxygen to form copper metal.
4 Copper(II) oxide gains hydrogen and is reduced.

Which of these inferences are correct?

A 1 and 3 only
B 1, 2 and 3 only
C 1, 2 and 4 only
D 2 and 4 only

25 The experiment shown in the diagram was set up.
Which tube shows the highest increase in water level after a month?



26 Which equation does **not** represent a redox reaction?

A $CuSO_4 + Zn \rightarrow Cu + ZnSO_4$
B $2H_2 + O_2 \rightarrow 2H_2O$
C $H_2S + Cl_2 \rightarrow 2HCl + S$
D $NH_3 + HCl \rightarrow NH_4Cl$

27 The equation below shows the reaction of iron(III) sulfate with potassium iodide.

$$Fe_2(SO_4)_3 \quad + \quad 2KI \quad \rightarrow \quad 2FeSO_4 \quad + \quad I_2 \quad + \quad \text{product X}$$

Which statement about the reaction is **not** correct?

A At the end of the reaction, the solution appears brown.
B Formula of product X is K_2SO_4.
C Iodine is reduced in the reaction.
D The oxidation state of iron decreases from +3 to +2.

28 In the Haber process, nitrogen and hydrogen react to form ammonia.

What is the source of hydrogen?

A air
B limestone
C crude oil
D sulfuric acid

29 In which process is energy released?

A dissolving ammonium nitrate in water
B electrolysis of water
C forming a chlorine molecule from two chlorine atoms
D photosynthesis

30 Which of the following can be deduced from the equation below?

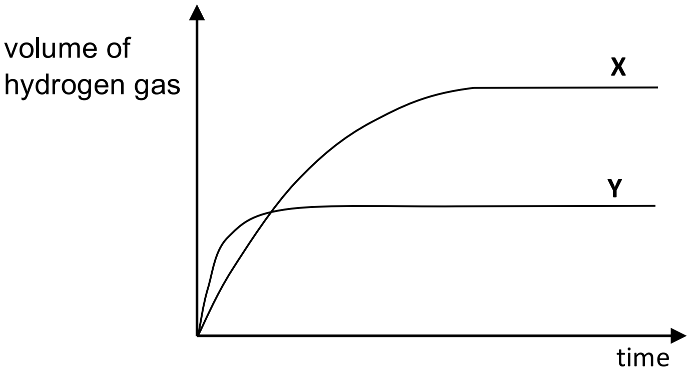
$$2H_2O_2(l) \rightarrow 2H_2O(l) + O_2(g) \qquad \Delta H = \text{-ve}$$

A Addition of a catalyst speeds up the reaction.
B Heat is taken in during the reaction.
C The volume of oxygen produced from 200 cm^3 of aqueous hydrogen peroxide is 100 cm^3.
D When completely decomposed, 17g of hydrogen peroxide forms 9g of water and 8g of oxygen.

31 If the pressure on the reactants in a gaseous reaction is decreased, which of the following is **true**?

	concentration	rate of reaction
A	decreases	increases
B	decreases	decreases
C	increases	increases
D	no effect	decreases

32 Two experiments on the reaction between zinc and sulfuric acid are carried out and their results are given in the graph below.

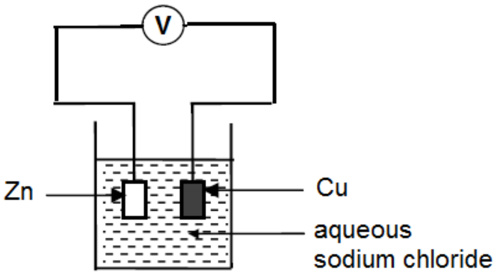


If 10 g of zinc granules reacts with 0.50 dm^3 of 1 mol/dm^3 sulfuric acid to produce graph **X**, which of the following could give rise to graph **Y**?

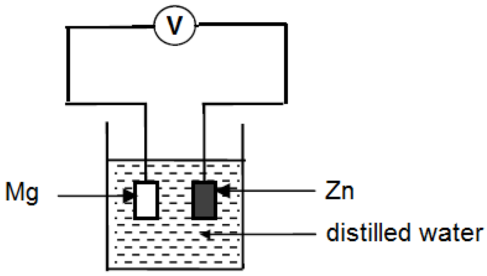
A 5 g zinc granules in 0.500 dm^3 of 1 mol/dm^3 sulfuric acid
B 5 g zinc granules in 0.500 dm^3 of 2 mol/dm^3 sulfuric acid
C 10 g zinc granules in 0.250 dm^3 of 2 mol/dm^3 sulfuric acid
D 10 g zinc granules in 0.125 dm^3 of 2 mol/dm^3 sulfuric acid

33 Which set-up would produce the greatest reading on the voltmeter?

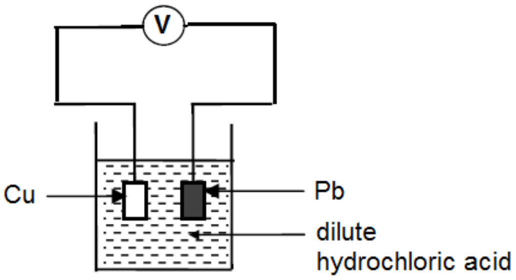
A



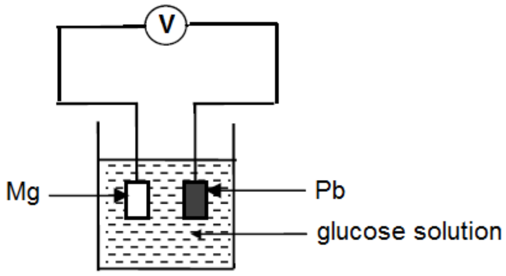
B



C

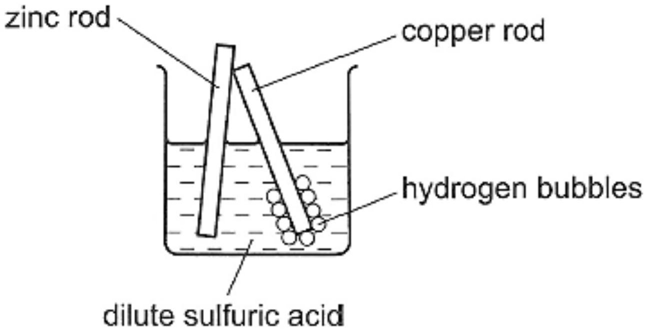


D



34 In an experiment, rods of copper and zinc are dipped into dilute sulfuric acid with their top ends touching.

Hydrogen bubbles collect around the copper rod.



Which statement about the experiment is correct?

A Copper reacts with the acid.
B Electrons flow from zinc to copper.
C The zinc becomes coated with copper.
D The copper becomes smaller.

35 The following three solutions were electrolyzed using inert electrodes.

solution 1 concentrated sodium chloride
solution 2 dilute sulfuric acid
solution 3 silver nitrate

Which of the solution(s) produce oxygen gas at the anode?

A 1 only
B 1 and 2 only
C 1, 2 and 3
D 2 and 3

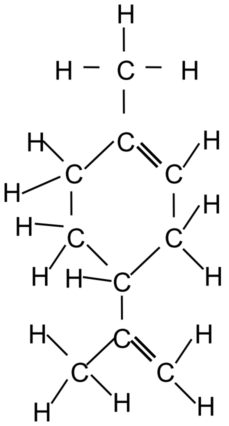
36 Which statement applies to all three of the compounds ethane, ethene and ethanol?

A One mole of each compound contains the same number of hydrogen atoms.
B One molecule of each compound contains the same number of carbon atoms.
C They are obtained from crude oil.
D They are all liquids at room temperature.

37 Which of these acids is polyunsaturated?

A linolenic acid; $CH_3(CH_2CH{=}CH)_3(CH_2)_7CO_2H$
B oleic acid; $CH_3(CH_2)_7CH{=}CH(CH_2)_7CO_2H$
C palmitic acid; $CH_3(CH_2)_{14}CO_2H$
D stearic acid; $CH_3(CH_2)_{16}CO_2H$

38 Liquid limonene may be extracted from oranges. The structure of limonene is shown below.

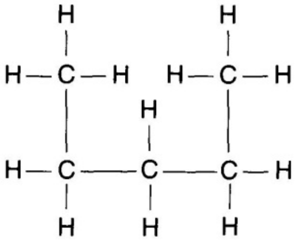


How many moles of hydrogen gas would react completely with one mole of limonene to make it saturated?

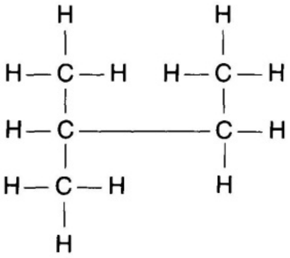
A 1 **B** 2 **C** 3 **D** 4

39 Four structural formulae are shown below.

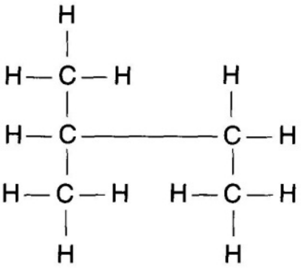
P



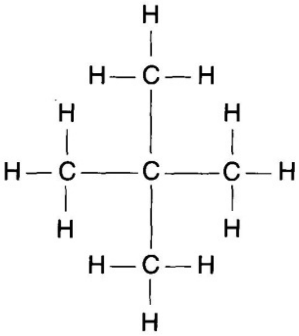
Q



R



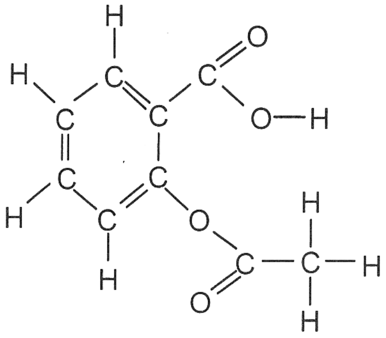
S



Which of the formulae represent the same compound?

A **P**, **Q** and **R**
B **P**, **Q** and **S**
C **Q** and **R**
D **Q** and **S**

40 Aspirin is a drug which is used as a general pain killer. The structural formula of aspirin is shown below.



Which of the following statements about aspirin is **false**?

A Its aqueous solution reacts with sodium carbonate.
B It decolourised aqueous bromine.
C It is formed from an alcohol and a carboxylic acid.
D It turns purple acidified aqueous potassium manganate (VII) colourless.

End of Paper 1

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 **H** Hydrogen 1										4 **He** Helium 2
7 **Li** Lithium 3	9 **Be** Beryllium 4											11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
23 **Na** Sodium 11	24 **Mg** Magnesium 12											27 **Al** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulfur 16	35.5 **Cl** Chlorine 17	40 **Ar** Argon 18
39 **K** Potassium 19	40 **Ca** Calcium 20	45 **Sc** Scandium 21	48 **Ti** Titanium 22	51 **V** Vanadium 23	52 **Cr** Chromium 24	55 **Mn** Manganese 25	56 **Fe** Iron 26	59 **Co** Cobalt 27	59 **Ni** Nickel 28	64 **Cu** Copper 29	65 **Zn** Zinc 30	70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **As** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
85 **Rb** Rubidium 37	88 **Sr** Strontium 38	89 **Y** Yttrium 39	91 **Zr** Zirconium 40	93 **Nb** Niobium 41	96 **Mo** Molybdenum 42	**Tc** Technetium 43	101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47	112 **Cd** Cadmium 48	115 **In** Indium 49	119 **Sn** Tin 50	122 **Sb** Antimony 51	128 **Te** Tellurium 52	127 **I** Iodine 53	131 **Xe** Xenon 54
133 **Cs** Caesium 55	137 **Ba** Barium 56	139 **La** Lanthanum 57 *	178 **Hf** Hafnium 72	181 **Ta** Tantalum 73	184 **W** Tungsten 74	186 **Re** Rhenium 75	190 **Os** Osmium 76	192 **Ir** Iridium 77	195 **Pt** Platinum 78	197 **Au** Gold 79	201 **Hg** Mercury 80	204 **Tl** Thallium 81	207 **Pb** Lead 82	209 **Bi** Bismuth 83	209 **Po** Polonium 84	210 **At** Astatine 85	222 **Rn** Radon 86
223 **Fr** Francium 87	226 **Ra** Radium 88	227 **Ac** Actinium 89 †															

140 **Ce** Cerium 58	141 **Pr** Praseodymium 59	144 **Nd** Neodymium 60	147 **Pm** Promethium 61	150 **Sm** Samarium 62	152 **Eu** Europium 63	157 **Gd** Gadolinium 64	159 **Tb** Terbium 65	162 **Dy** Dysprosium 66	165 **Ho** Holmium 67	167 **Er** Erbium 68	169 **Tm** Thulium 69	173 **Yb** Ytterbium 70	175 **Lu** Lutetium 71
232 **Th** Thorium 90	231 **Pa** Protactinium 91	238 **U** Uranium 92	237 **Np** Neptunium 93	244 **Pu** Plutonium 94	243 **Am** Americium 95	247 **Cm** Curium 96	247 **Bk** Berkelium 97	251 **Cf** Californium 98	252 **Es** Einsteinium 99	257 **Fm** Fermium 100	258 **Md** Mendelevium 101	259 **No** Nobelium 102	260 **Lr** Lawrencium 103

* 58–71 Lanthanoid series
† 90–103 Actinoid series

Key

a **X** b	a = relative atomic mass X = atomic symbol b = atomic (proton) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

Name: ………………………………………………. Index no: ………. Class: ……….

Bukit Batok Secondary School

GCE O Level Preliminary Examination

Sec 4 Express

CHEMISTRY 5073/02

Paper 2

14 August 2017

1030hr to 1215hr

1 hour 45 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class in the spaces provided at the top of this page.
Write in dark blue or black pen
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions in the spaces provided.

Section B
Answer all **three** questions, the last question is in the form of either/or.
Answer **all** questions in the spaces provided.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is given at the end of the paper.

The use of an approved scientific calculator is expected, where appropriate
.

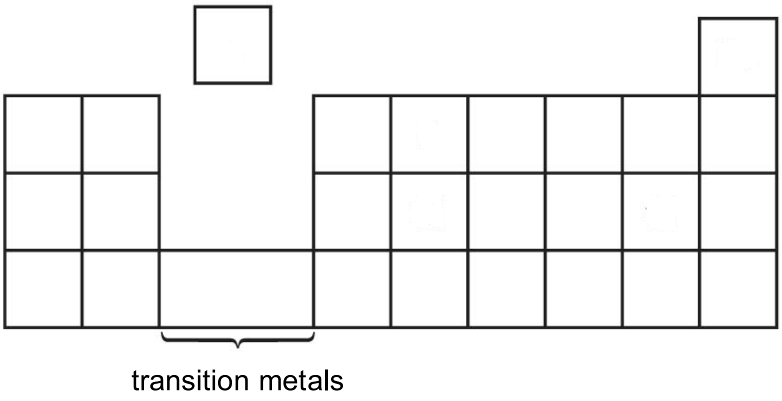
For Examiner's Use	
Section A	
Section B	
Total	

This document consists of **21** printed pages.

Section A [50 marks]

Answer all questions in this section in the spaces provided.

A1 The diagram below shows a simplified version of the Periodic Table.



Use the information below to place the elements in their correct position in the Periodic Table above. (The letters do **not** represent the chemical symbols of the elements.)

(a) P has an electronic configuration of 2, 2.

(b) Q has only two electrons.

(c) R is a non-metal that forms a strong acid with Group VII elements.

(d) S forms an ion, S^{3-}, with an electronic configuration of 2, 8, 8.

[Total: 4]

A2 Elements W, X, Y and Z are all in the same period but in different groups of the Periodic Table.
W reacts with oxygen to form W_2O, a strongly basic oxide.
X reacts with oxygen to form XO_2, an acidic oxide and a gas at room temperature.
The oxide of Y is Y_2O_3, which can react with both an acid and a base.
Z produces an ion Z^-.

Use the information given to answer the following questions:

(a) Place X, Y, W and Z to their respective groups in the Periodic Table.

…………………………………………………………………………………………………

…………………………………………………………………………………………………[2]

(b) Write the formulae for the sulfate and hydride of W.

…………………………………………………………………………………………………[1]

(c) What type of bonding is present in the oxide XO_2? Give a reason for your answer.

…………………………………………………………………………………………………

…………………………………………………………………………………………………[2]

(d) Write the formula for the compound formed between Y and Z.

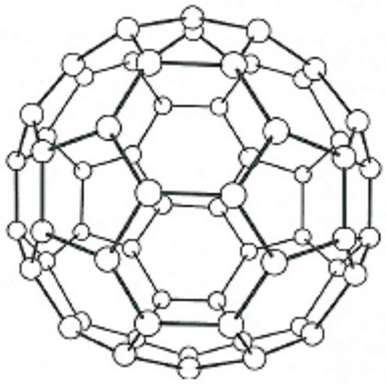
…………………………………………………………………………………………………[1]

(e) Write the equation for the reaction that occurs when element W reacts with oxygen. Include state symbols.

…………………………………………………………………………………………………[2]

[Total: 8]

A3 Until 1985 chemists believed that there were only two allotropes of carbon. In 1985 a third allotrope, buckminsterfullerene, was identified. The diagram shows the structure of a molecule of buckminsterfullerene. Each circle represents one carbon atom.



The molecule has 60 carbon atoms covalently bonded together, to give a structure with a shape similar to a modern football.

(a) Name the other two allotropes of carbon.

……………………………………………………………………………………………[1]

(b) (i) Suggest the formula of buckminsterfullerene.

……………………………………………………………………………………………[1]

(ii) Calculate the number of moles of buckminsterfullerene in 3600 g of the substance.

[2]

(iii) Suggest, in terms of structure and bonding, why buckminsterfullerene might be expected to vapourise at a much lower temperature than the other allotropes of carbon named in **(a) (ii)**.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………[3]

[Total: 7]

A4 An investigation was carried out into the energy changes that occur when different metals were added to copper(II) sulfate solution. 3 cm^3 of copper(II) sulfate solution was added to each of six test tubes and the temperature of each solution was taken. An equal mass of metal was added to each test tube, the contents stirred and the temperature of the mixtures noted after one minute.

metal added	initial temperature of copper(II) sulfate solution / °C	temperature of mixture after 1 min / °C	temperature rise / °C
magnesium ribbon	20.0	29.0	
magnesium powder	20.5	56.0	
zinc granules	19.0	25.0	
zinc powder	21.0	41.0	
iron granules	18.5	20.0	
iron powder	19.5	34.5	

(a) Complete the table by writing down the temperature rise for each metal added. [1]

(b) What common observation, apart from temperature changes, would be made when each metal is added to copper(II) sulfate solution?

……………………………………………………………………………………………......

……………………………………………………………………………………………[1]

(c) State three conclusions that you can draw from all the results to these experiments. Explain how you arrived at each conclusion.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………[6]

(d) (i) Draw an energy profile diagram for any of the reactions that occurred between each metal and copper(II) sulfate solution.

Your diagram should include

- the formulae of the reactants and products,
- a label for the reaction enthalpy change, ΔH and
- a label for the activation energy, E_a.

[3]

(ii) Each of the reaction was repeated in the presence of a catalyst.
What effect does the catalyst have on the activation energy and the enthalpy change?

…………………………………………………………………………………………….

……………………………………………………………………………………………[1]

[Total: 12]

A5 A student buys and tests some tablets that contain aspirin, 🟦-COOH.
He performs a titration experiment using a crushed tablet and 0.10 mol/dm^3 of aqueous sodium hydroxide to determine the mass of aspirin contains in one tablet.

His results show that the volume of aqueous sodium hydroxide needed for neutralisation is 16.70 cm^3. The relative molecular mass of aspirin is 180.

(a) With the help of an equation for the reaction between aspirin and aqueous sodium hydroxide, determine the mass of aspirin contains in one tablet. Show all working.

[3]

(b) Some tablets that contain aspirin also contain citric acid.
The student does another titration using one of these tablets.

Explain why the mass of aspirin you calculate from his titration results is incorrect.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………[2]

[Total: 5]

A6 Potassium chromate is soluble in water, forming a yellow solution. When aqueous silver nitrate is added to aqueous potassium chromate, a red precipitate of silver chromate is formed.

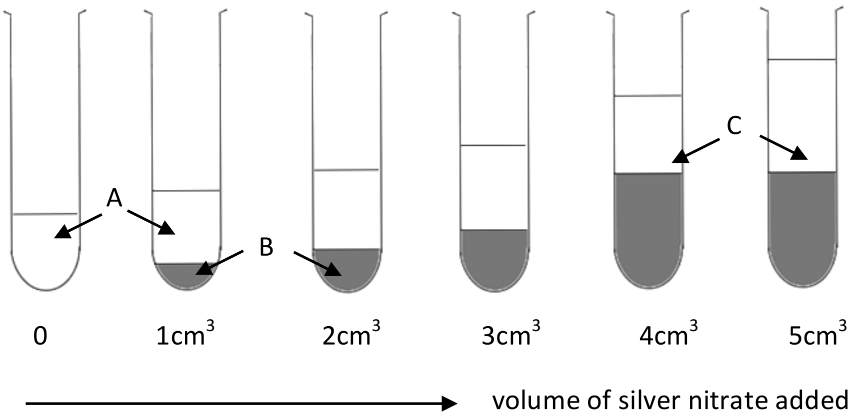
(a) (i) Name another compound that reacts with aqueous silver nitrate to form a yellow precipitate.

……………………………………………………………………………….......................[1]

(ii) Write the ionic equation for the reaction in **(a) (i)**.

………………………………………………………………………………...............[1]

(b) An experiment was carried out in which various volumes of aqueous silver nitrate were added to the same volume of aqueous potassium chromate. The mixtures were stirred and allowed to stand. The results are shown below.



Identify the appearance of A, B and C in the diagrams.

…………………………………………………………………………………………………

………………………………………………………………………………………......[3]

[Total: 5]

A7 When compound **A** (C_2H_6O), an alcohol, was heated with acidified potassium manganate (VII), an organic compound **B** was formed. When a mixture of **A** and **B** was heated in the presence of a catalyst, a sweet smelling liquid **C** ($C_4H_8O_2$) was obtained.

(a) Describe the observation when compound **A** is heated with acidified potassium manganate (VII).

……………………………………………………………………………………………..[1]

(b) (i) Draw the structural equation for the reaction that occurs between **A** and **B**. Identify compound **A**, **B** and **C** and write their respective names next to their structural formula in the equation.

[3]

(ii) State the conditions required for the reaction in (**b) (i)**.

……………………………………………………………………………………[1]

(c) Compound **A** can be used as a car fuel.
In some countries it is produced from the sugars in sugar cane.

(i) Name the process used to produce compound **A** from sugar.

……………………………………………………………………………………[1]

(ii) Suggest why most of the compound **A** is not produced by the process named in **(c) (i)**.

……………………………………………………………………………………..[1]

(iii) An environmentalist makes a comment about using compound **A** as a fuel.

> Compound **A** as a fuel is ‘carbon neutral’ because using it does not add to the amount of carbon dioxide in the atmosphere.

Do you agree with the comment? Explain your reasoning.

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………[2]

[Total:9]

End of Section A

Section B [30 marks]

Answer all **three** questions from this section.
The last question is in the form of either/or and only one of the alternatives should be attempted.

B8 There are a range of atmospheric pollution problems currently threatening the Earth's general environment. The increased use of fossil fuels has a negative effect on the health of the environment in terms of air and water pollution.
Of all the fossil fuels, coal is the least expensive for its energy content. However, burning coal in electric power plants is a major source of carbon dioxide emissions. It also releases substantial amounts of methane. The U.S. Environmental Protection Agency's Clean Power Plan, as well as the low cost of natural gas, is leading older coal plants to close and reducing interest in new coal plants. Alternative sources of energy used as fuels are thus constantly sought after to meet the increasing demands of human activities.

Figure A below shows the changes in the type of fuel used between 1990 and 2002.

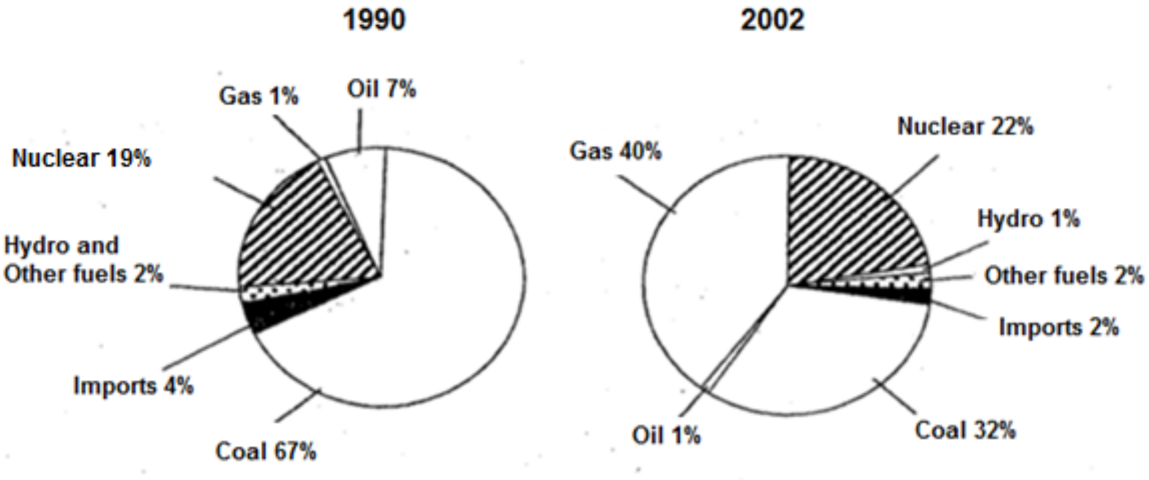


Figure A

Air pollution is caused by solid particles and poisonous gases in the air. These substances are called air pollutants, which include carbon monoxide and unburnt hydrocarbons.

Figure B shows the relationship between the air : fuel ratio and the production of air pollutants by the vehicle engines.

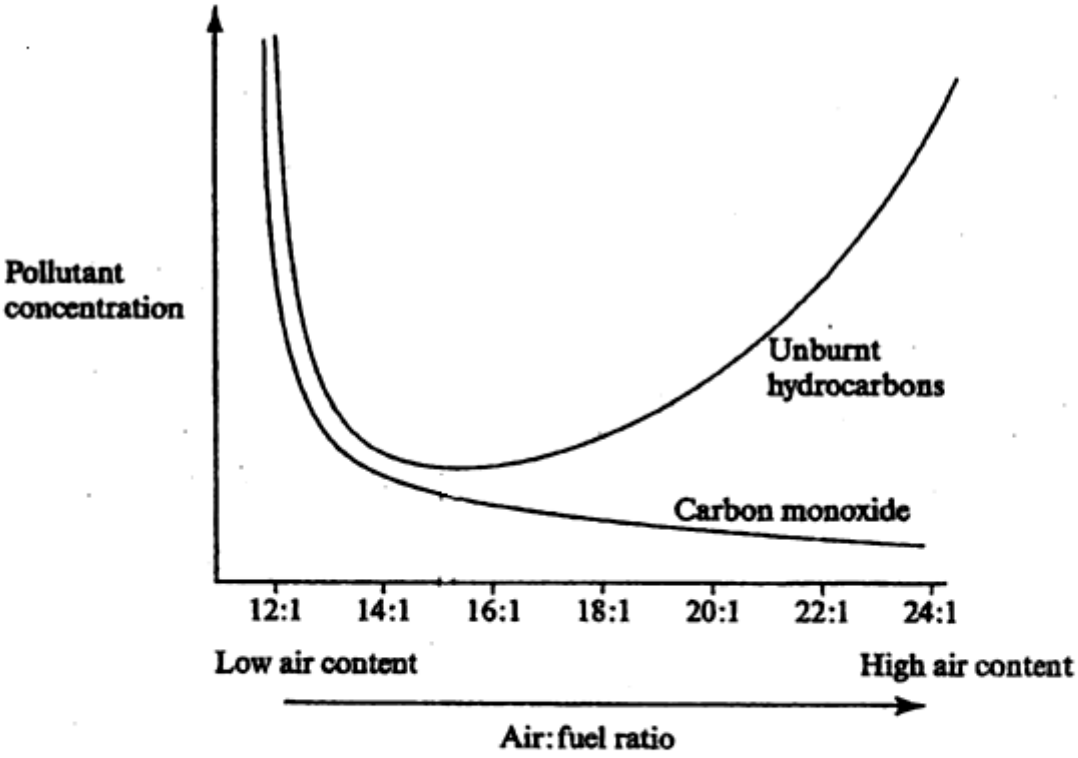


Figure B

(a) Using information provided, give two main changes in the type of fuel used over 12 years from 1990 to 2002. Suggest an explanation for these changes.

…………………………………………………………………………………………………...

…………………………………………………………………………………………………..

…………………………………………………………………………………………………..

…………………………………………………………………………………………………..

…………………………………………………………………………………………………[3]

(b) Using the information from **Figure B**, describe and explain the trend for the carbon monoxide curve.

…………………………………………………………………………………………………….

…………………………………………………………………………………………………….

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

…………………………………………………………………………………………………..[3]

(c) Estimate the optimum air : fuel ratio to minimise pollution by carbon monoxide and unburnt hydrocarbons.

……………………………………………………………………………………………….[1]

(d) (i) Name another air pollutant not mentioned in the graphs which is also produced by the vehicle engines.

……………………………………………………………………………………………..[1]

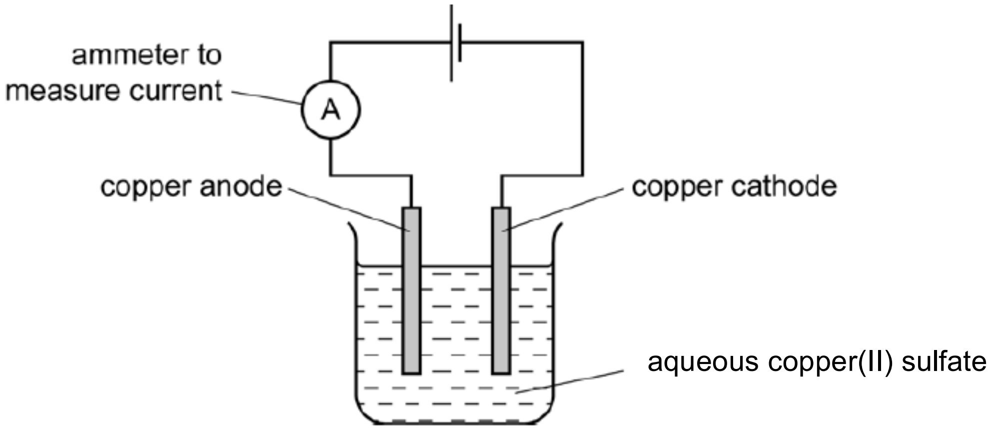
(ii) Name the device fitted in cars which is used to remove both the emissions of carbon monoxide and the pollutant you named in **(d) (i)** from the car engine. Write an equation for this reaction.

…………………………………………………………………………………………………..

…………………………………………………………………………………………………..[2]

[Total: 10]

B9 A student carries out a series of experiments. In each experiment, he electrolyses aqueous copper(II) sulfate solution using the apparatus shown.



He uses the same concentration of aqueous copper(II) sulfate each time, but changes the current he passes through the solution. He runs each electrolysis for 10 minutes. The student weighs the negative electrode before and after each experiment and works out the mass of copper deposited.

The table shows the results of his experiments.

experiment	time / mins	current / Amps	mass of copper deposited / g
1	10	1.0	0.21
2	10	2.0	0.40
3	10	3.0	0.58
4	10	4.0	0.81

(a) Use data from the table to plot a graph to show the relationship between current and mass of copper deposited.
Draw a straight line of best fit, taking into account all of your plotted points. [3]

(b) Describe the relationship that your graph shows.

……………………………………………………………………………………………

…………………………………………………………………………………………….[1]

(c) The student carries out another experiment. He passes an electric current of 6.0 A through a solution of copper(II) sulfate for 5 minutes.

Use your graph and the information above to predict the mass of copper that would form in the experiment.

……………………………………………………………………………………………...

…………………………………………………………………………………………….[1]

(d) At the end of the electrolysis, the student removes a sample of the electrolyte and puts it in a test tube. He then adds aqueous ammonia dropwise to the sample until there is no more further change. Describe and explain what the student sees.

……………………………………………………………………………………………

…………………………………………………………………………………………….[2]

(e) The student carries out another electrolysis using aqueous silver nitrate and silver electrodes. His results are shown in the table.

electrolyte	time / mins	current / Amps	mass of silver deposited / g
aqueous silver nitrate	10	4.0	2.7

(i) Write an ionic half equation for the reaction that happens at the cathode.

…………………………………………………………………………………………….[1]

(ii) Carry out calculations to compare the difference in the number of moles of copper and the number of moles of silver that are formed when a current of 4.0 A is used for 10 minutes. Suggest an explanation for the difference in the number of moles of each metal formed.

[2]

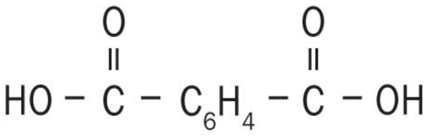
[Total: 10]

EITHER

B10 In the early 1970s, a polymer known as Kevlar was invented by Stephanie Kwolek, an American chemist. Kevlar fibre is used for making bulletproof vests, army helmets and ‘puncture-proof’ tyres. Kevlar fibre is also used in the protective clothing worn by firefighters.

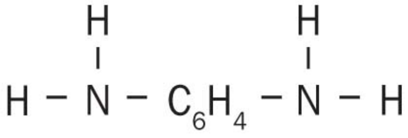
Kevlar is made by condensation polymerisation from two different monomers – 1,4-benzenedicarboxylic acid and 1,4-diaminobenzene.

The structural formulae of these monomers are shown below.



$$HO-\overset{\overset{\displaystyle O}{\|}}{C}-C_6H_4-\overset{\overset{\displaystyle O}{\|}}{C}-OH$$

1,4-benzenedicarboxylic acid



$$H-\overset{\overset{\displaystyle H}{|}}{N}-C_6H_4-\overset{\overset{\displaystyle H}{|}}{N}-H$$

1,4-diaminobenzene

(a) (i) Draw the structural formula of the organic compound formed when 1,4 benzenedicarboxylic acid is reacted with an excess of sodium carbonate.

[1]

(ii) Write the formula of the gas produced in reaction **(a) (i)** and describe a simple laboratory test to confirm the identity of the gas produced.

…………………………………………………………………………………………

…………………………………………………………………………………………[2]

(b) Explain what is meant by condensation polymerisation.

…………………………………………………………………………………………

…………………………………………………………………………………………[1]

(c) **(i)** Draw the structural formula of one repeat unit of Kevlar.

[1]

(ii) Suggest two possible gases produced on the combustion of Kevlar.

……………………………………………………………………………………….[1]

(d) Suggest the name of a synthetic polymer that has the same functional group as Kevlar. Give a reason for your choice.

…………………………………………………………………………………............

……………………………………………………………………………………….[2]

(e) Sea fishing nets used to be made from natural fibres. Many nets are now made from synthetic fibres. Suggest one **advantage**, other than strength, and one **disadvantage** of using synthetic fibres named in **(d)** rather than natural fibres to make sea fishing nets.

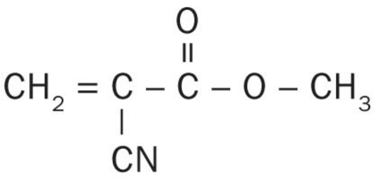
…………………………………………………………………………………………

……………………………………………………………………………………….[2]

[Total: 10]

OR

B10 Superglue is a very strong adhesive used to fasten materials, such as wood, together. The active ingredient in superglue is methyl cyanopropenoate, commonly known as methyl cyanoacrylate. The structure of methyl cyanopropenoate is shown below.



$$CH_2 = \underset{\displaystyle CN}{\underset{|}{C}} - \overset{\displaystyle O}{\overset{||}{C}} - O - CH_3$$

methyl cyanopropenoate

Superglue polymerises when exposed to moisture in the air. This causes the glue to set.

(a) Draw the structural formulae of the two functional groups present in methyl cyanopropenoate. Name the two functional groups.

[2]

(b) What type of polymerisation does methyl cyanopropenoate undergo when it forms superglue?

……………………………………………………………………………………………[1]

(c) Draw the structural formula of the polymer formed, showing two repeat units.

[1]

(d) Other than superglue, suggest another name for the polymer formed in **(c)**.

……………………………………………………………………………………………..[1]

(e) Name two possible gases that are produced when the polymer formed in **(c)** is burnt in excess oxygen.

……………………………………………………………………………………………[1]

(f) **(i)** A sample of methyl cyanopropenoate is shaken with bromine water. Describe what you would observe.

…………………………………………………………………………………………….

……………………………………………………………………………………………[1]

(ii) What type of reaction has occurred in **(f) (i)**?

……………………………………………………………………………………………[1]

(iii) Write the formula of the organic product formed in **(f) (i)**. Hence calculate the mass of one mole of the organic product formed

[2]

[Total: 10]

- End of Paper 2 –

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 **H** Hydrogen 1										4 **He** Helium 2
7 **Li** Lithium 3	9 **Be** Beryllium 4											11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
23 **Na** Sodium 11	24 **Mg** Magnesium 12											27 **Al** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulfur 16	35.5 **Cl** Chlorine 17	40 **Ar** Argon 18
39 **K** Potassium 19	40 **Ca** Calcium 20	45 **Sc** Scandium 21	48 **Ti** Titanium 22	51 **V** Vanadium 23	52 **Cr** Chromium 24	55 **Mn** Manganese 25	56 **Fe** Iron 26	59 **Co** Cobalt 27	59 **Ni** Nickel 28	64 **Cu** Copper 29	65 **Zn** Zinc 30	70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **As** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
85 **Rb** Rubidium 37	88 **Sr** Strontium 38	89 **Y** Yttrium 39	91 **Zr** Zirconium 40	93 **Nb** Niobium 41	96 **Mo** Molybdenum 42	**Tc** Technetium 43	101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47	112 **Cd** Cadmium 48	115 **In** Indium 49	119 **Sn** Tin 50	122 **Sb** Antimony 51	128 **Te** Tellurium 52	127 **I** Iodine 53	131 **Xe** Xenon 54
133 **Cs** Caesium 55	137 **Ba** Barium 56	139 **La** Lanthanum 57 *	178 **Hf** Hafnium 72	181 **Ta** Tantalum 73	184 **W** Tungsten 74	186 **Re** Rhenium 75	190 **Os** Osmium 76	192 **Ir** Iridium 77	195 **Pt** Platinum 78	197 **Au** Gold 79	201 **Hg** Mercury 80	204 **Tl** Thallium 81	207 **Pb** Lead 82	209 **Bi** Bismuth 83	209 **Po** Polonium 84	210 **At** Astatine 85	222 **Rn** Radon 86
223 **Fr** Francium 87	226 **Ra** Radium 88	227 **Ac** Actinium 89 †															

140 **Ce** Cerium 58	141 **Pr** Praseodymium 59	144 **Nd** Neodymium 60	147 **Pm** Promethium 61	150 **Sm** Samarium 62	152 **Eu** Europium 63	157 **Gd** Gadolinium 64	159 **Tb** Terbium 65	162 **Dy** Dysprosium 66	165 **Ho** Holmium 67	167 **Er** Erbium 68	169 **Tm** Thulium 69	173 **Yb** Ytterbium 70	175 **Lu** Lutetium 71
232 **Th** Thorium 90	231 **Pa** Protactinium 91	238 **U** Uranium 92	237 **Np** Neptunium 93	244 **Pu** Plutonium 94	243 **Am** Americium 95	247 **Cm** Curium 96	247 **Bk** Berkelium 97	251 **Cf** Californium 98	252 **Es** Einsteinium 99	257 **Fm** Fermium 100	258 **Md** Mendelevium 101	259 **No** Nobelium 102	260 **Lr** Lawrencium 103

* 58–71 Lanthanoid series
† 90–103 Actinoid series

Key

a **X** b	a = relative atomic mass X = atomic symbol b = atomic (proton) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

Bukit Batok Secondary School
Sec 4 Express 2017
Chemistry 5073

PRELIMINARY EXAMINATIONS – ANSWERS

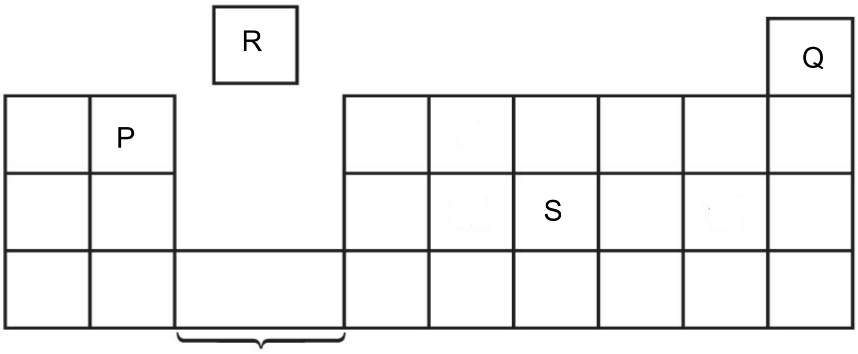
Paper 1 : Multiple Choice Questions

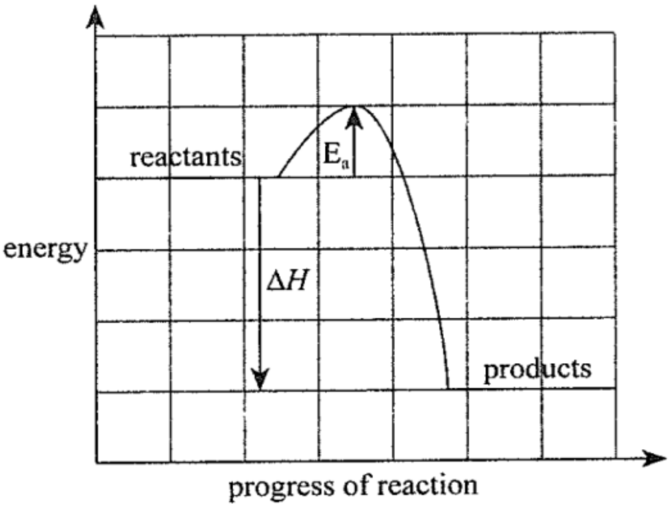
1 **C**	2 **B**	3 **B**	4 **C**	5 **D**	6 **A**	7 **D**	8 **A**	9 **B**	10 **B**
11 **C**	12 **B**	13 **D**	14 **D**	15 **C**	16 **C**	17 **B**	18 **D**	19 **D**	20 **A**
21 **A**	22 **B**	23 **A**	24 **B**	25 **D**	26 **D**	27 **C**	28 **C**	29 **C**	30 **D**
31 **B**	32 **B**	33 **A**	34 **B**	35 **D**	36 **B**	37 **A**	38 **B**	39 **C**	40 **D**

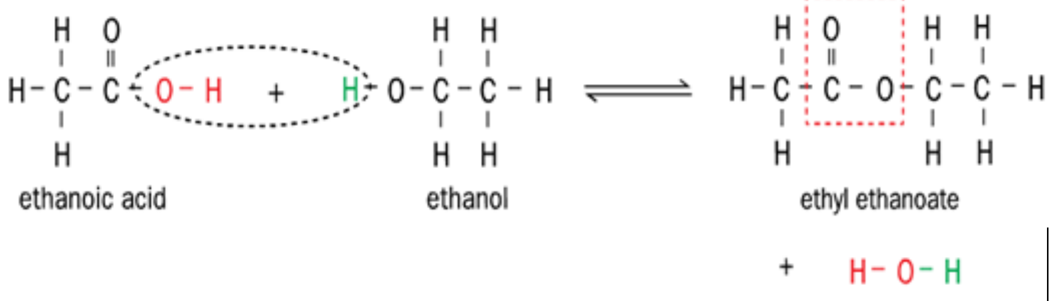
5	D	By filtration, lead(II) hydroxide and silver chloride are obtained as residue. To remove lead(II) hydroxide, add excess nitric acid. Neutralisation takes place between lead(II) hydroxide and nitric acid to form lead(II) nitrate solution. Silver chloride remains as precipitate. By filtration, silver chloride is obtained as residue.
11	C	Mass of Ca in CaO = (Ar of Ca / Mr of CaO) x mass of CaO =(40 / 56)x14 =10g % by mass of Ca = (10/50) x 100 =20.0 %.
12	C	No of moles of $ZnCO_3$ = 1.25/125 = 0.01 mol $2HCl + ZnCO_3 \rightarrow ZnCl_2 + CO_2 + H_2O$ No of moles of HCl = 2 x no of moles of $ZnCO_3$ = 2 x 0.01 = 0.02 Vol of HCl = mol / conc = 0.02 / 1.0 = 0.02 dm^3 = 20 cm^3
13	D	C_xH_y + O_2 → $6CO_2$ + $3H_2O$ 5 cm^3 30 cm^3 15 cm^3 From the equation, the hydrocarbon has 6 carbon atoms and 6 hydrogen atoms.
15	C	Only statement 1 is wrong as mass of one mole of HCl is 36.5 g and one mole of CO is 28 g.
16	C	No of moles of H_2 = ½ = 0.5 mol One molecule of H_2 has 2 atoms. No of moles of I_2 = 127/254 = 0.5 mol. = no. of moles of hydrogen gas. Each molecule of I_2 also has 2 atoms. Hence iodine has the same no. of atoms as hydrogen.
19	D	Barium chloride reacts with sulfate ions and carbonate ions to form insoluble barium sulfate and insoluble barium carbonate. This causes the mass of ppt to increase. When an acid is added, it reacts with barium carbonate but not barium sulfate. Hence the mass of ppt decreases with the removal of insoluble barium carbonate.
20	A	Copper(II) nitrate reacts with sodium hydroxide to form insoluble copper(II) hydroxide, thus decreasing the concentration of copper(II) ions.
21	A	S is an acid as it has a pH less than 7. The metal oxide is insoluble as it does not increase the pH after neutralisation has taken place. If it is soluble, by adding excess of it, pH should show > 7.
24	B	$H_2 + CuO \rightarrow Cu + H_2O$
25	D	Rusting of iron uses up oxygen in the test tube. Water enters the tube to occupy the space left vacant by O_2.
26	D	Neutralisation is not a redox reaction as there is no change in oxidation state of all the elements in the reactants.
28	C	One source of H_2 is from the cracking of alkane which is obtained from the fractional distillation of crude oil.
31	B	A decrease in pressure causes a decrease in the no of particles per unit volume which corresponds to a decrease in conc. This reduces the frequency of effective collision between the reactants, hence the decrease in rate of rxn.

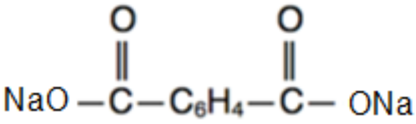
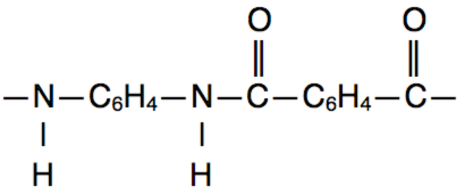
32	B	No. of moles of zinc = 10/65 = 0.154 mol. No. of moles of sulfuric acid = 0.5 mol. $Zn + H_2SO_4 \rightarrow H_2 + ZnSO_4$ Mole ratio of Zn : H_2SO_4 = 1:1 Hence zinc is the limiting reactant. To produce half the volume of gas, mass of zinc is reduced by half. As Y is faster than X, concentration of acid in Y is higher than X
33	A	The further apart the metals in the reactivity series, the greater the voltmeter reading. As glucose solution is not an electrolyte, D is not an option.
34	B	In a simple cell, electrons flow from a more reactive metal (Zn) to a less reactive metal (Cu). As zinc loses electrons to form zinc ions, it becomes smaller.
37	A	Polyunsaturated means the cpd consists of many C=C bonds. Oleic acid consists of only one C=C bond. Stearic acid & palmitic acid do not have any C=C bond.

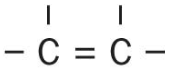
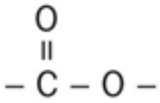
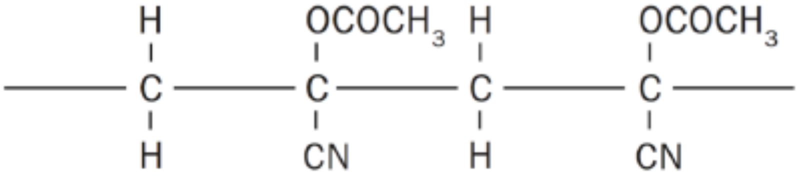
Paper 2

Section A (50 marks)		
A1		4
	Total	4
A2a	X – Group VI, Y – Group III, W – Group I, Z – Group VII [4√ – 2m, 3√ – 2√ - 1m, 1√ – 0m] [reject X – Gp IV as carbon is in different period from Y, W and Z]	2
b	W_2SO_4 and WH [reject HW] [both answer must be correct to score 1m]	1
c	covalent bonding [1] As XO_2 forms an acidic oxide, X must be a non-metal. Covalent bond is formed between non-metallic elements. Or Covalent compound has a low boiling point as it exists as a gas at room temperature. [1]	2
d	YZ_3	1
e	$4W (s) + O_2 (g) \rightarrow 2W_2O (s)$ [1m for balanced equation; 1m for correct state symbols]	2
	Total	8
A3a	diamond and graphite [both answers must be correct to score1 m]	1
b i	C_{60}	1
ii	Mr = 12 x60 = 720 [1] no. of moles of bunkminsterfullerene = mass/Mr = 3600/720 = 5 mol [1] [allow e.c.f. from b i]	2
iii	Diamond and graphite are both giant molecular structure whereas buckminsterfullerene has a simple molecular structure. [1]	3

	More energy is required to break the strong covalent bonds between the carbon atoms throughout the giant structure [1] than overcoming the weak intermolecular forces of attraction between the simple buckminsterfullerene molecules. [1]	
	Total	7
A4 a	9.0, 35.5, 6.0, 20.0, 1.5, 15.0 [1] [All answers must be to 1 d.p.]	1
b	A pinkish brown solid would be seen / would form on each metal. [Reject: Blue solution turns colourless as iron(II) sulfate solution is pale green]	1
c	Any three of the following: (i) All the three metals are more reactive than copper, [1]. They all displace copper from copper(II) sulfate solution as shown by the temperature rise in each reaction. [1] (ii) The reactions are exothermic [1] as there is an increase in temperature for each reaction. [1] (iii) Powdering the metals produces a faster reaction. [1] The temperature increases during the first minute is greater for each powdered metal. [1] (iv) The reactivity of the metals in order of increasing reactivity is : iron < zinc < magnesium. [1] The temperature rise is greatest for magnesium and least for iron. [1]	6
d i	 • 1m for correct Ea • 1m for correct ΔH • 1m for correct shape of graph and labelling of formulae of reactants and products. Note: Formulae of reactants and products depend on the reaction of metal used.	3
d ii	Activation energy decreases and enthalpy change is unchanged. [both answers must be correct to score 1 m]	1
	Total	12
A5 a	equation : 🟦-COOH + NaOH → 🟦-COONa + H_2O [1] No. of mole of NaOH = conc x vol = 0.10 x 0.0167 = 0.00167 mol From the equation, 1 mole of sodium hydroxide reacts with 1 mole of aspirin. No. of mole of aspirin = 0.00167 mol [1]	3

	Mass of aspirin = mol x Mr = 0.00167 x 180 = 0.3006 g = 0.301 g (3 s.f.) [1] [accept 301 mg]	
b	Citric acid also reacts with aqueous sodium hydroxide. The volume of aqueous sodium hydroxide used is higher than expected. [1] Hence the calculated mass of aspirin would be higher than the actual mass. [1]	2
	Total	5
A6ai	Potassium iodide / sodium iodide	1
aii	$Ag^{+} (aq) + I^{-} (aq) \rightarrow AgI (s)$	1
b	A – yellow solution [potassium chromate solution] B – red precipitate [silver chromate precipitate] C –colourless solution [silver nitrate colourless]	3
	Total	5
A7a	Purple potassium manganate(VII) is decolourised / turns colourless.	1
bi	Compound A is ethanol, B is ethanoic acid and C is ethyl ethanoate. [2] [3√ – 2m; 2√ – 1m; 1√ – 0m]  Structural equation -1m [minus 1m if no label of A, B or C for each compound but correct naming of each structural compound]	3
bii	Add concentrated sulfuric acid as a catalyst and heat the mixture.	1
ci	Fermentation	1
cii	The process is very slow. / The yield is very low.	1
ciii	The amount of carbon dioxide emitted during the combustion of ethanol [1] is balanced by the taking in of carbon dioxide by sugar cane during photosynthesis [1]. As there is no net gain in carbon dioxide, the environmentalist is correct.	2
	Total	9
Section B (30 marks)		
B8a	In 1990, solid fuel like coal was the most common type of fuel used because usage of coal dropped by 2 times (67% in 1990 to 32% in 2002) [1] In 2002, usage of gaseous fuel increased because usage increased by 39% (1% in 1990 and 40% in 2002) [1] Reason:**Burning of coal produces more carbon dioxide and methane than gas fuels.** These are greenhouse gases which can contribute to global warming.	3
b	• High concentration of carbon monoxide at air : fuel ratio of 12:1 due to low level of oxygen present, leading to higher tendency of incomplete combustion.[1] • Concentration of carbon monoxide decreased sharply from air : fuel ratio of 12:1 to 14:1 and decreased gradually after air fuel ratio of 14.1. [1]	3

	- As air content increased to 24:1, greater amount of oxygen is available for complete combustion, thus decreasing the concentration of carbon monoxide. [1]	
c	15:1 (accept range between 14: 1 to 16: 1)	1
di	Oxides of nitrogen / nitrogen dioxide / nitrogen monoxide [1]	1
dii	**Use of catalytic converter** [1] $2NO + 2CO \rightarrow N_2 + 2CO_2$ [1]	2
	Total	10
B9a	Correct axes labelled with units [1] Correct plotting of all points [1] Draw best-fit line through origin [1]	3
b	Mass of copper formed increases proportionally to the increase in current.	1
c	Student extrapolates the graph to show a mass of 1.2g obtained when a current of 6.0 A is used. In 10 mins, 1.2 g of copper is produced. In 5 mins, 0.6 g of copper is produced. [1]	1
d	A blue precipitate is formed which dissolves in excess aqueous ammonia to form a dark blue solution. [1] There is no change in the electrolyte. / There is copper(II) ions present in the solution. [1]	2
ei	$Ag^+(aq) + e^- \rightarrow Ag(s)$	1
eii	no. of moles of copper = 0.81 / 64 = 0.0127 mol (3 s.f.) no. of moles of silver = 2.7 / 108 = 0.0250 mol [1 m for both correct moles of copper and silver] $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ From the calculation, no. of moles of copper is about half that of the no. of moles of silver. Each copper(II) ion needs two electrons to form a copper atom whereas each silver ion needs one electron to form a silver atom. [1] [explanation – 1m]	2
	Total	10
EITHER B10ai	 $NaO-\overset{\overset{O}{\Vert}}{C}-C_6H_4-\overset{\overset{O}{\Vert}}{C}-ONa$	1
aii	CO_2 [1] Bubble the gas through limewater. White precipitate formed indicates the presence of carbon dioxide gas. [1]	2
b	Condensation polymerisation is a process whereby monomers with different functional groups are joined together to form a large molecule with the removal of small molecules such as water.	1
ci	 $-\underset{\underset{H}{\vert}}{N}-C_6H_4-\underset{\underset{H}{\vert}}{N}-\overset{\overset{O}{\Vert}}{C}-C_6H_4-\overset{\overset{O}{\Vert}}{C}-$	1
cii	Any two of the following: [both gases must be correct to score 1m] carbon dioxide, carbon monoxide, nitrogen dioxide, water vapour	1
d	Nylon. [1]	2

	Both nylon and Kevlar contains amide linkages. [1]	
e	**Advantage:** It is durable / light / waterproof [1] **Disadvantage**: Any one of the following [1] It is non-biodegradable as It cannot be decomposed naturally by the bacteria in the soil. / It can remain buried in landfills for a long period of time which means more lands are needed for landfill sites. / It can cause water pollution as it may clog up rivers and drains which might become breeding ground for mosquitoes / when thrown into sea, it can endanger marine animals. / It can cause air pollution when burnt as it produces toxic gas like carbon monoxide.	2
	Total	10
OR B10a	 $-\overset{\mid}{C}=\overset{\mid}{C}-$ carbon-carbon double bond  $-\overset{\overset{O}{\Vert}}{C}-O-$ ester	2
b	Addition polymerisation	1
c	 $-\underset{H}{\overset{H}{C}}-\underset{CN}{\overset{OCOCH_3}{C}}-\underset{H}{\overset{H}{C}}-\underset{CN}{\overset{OCOCH_3}{C}}-$	1
d	Poly(methyl cyanopropenoate)	1
e	Any two of the following gases: Carbon dioxide, water vapour, nitrogen dioxide [both gases must be correct to score 1m]	1
f i	Reddish brown aqueous bromine turns colourless.	1
f ii	Addition reaction / addition of bromine / bromination	1
f iii	$CH_2BrCBrCNCOOCH_3$ [1] Mass of one mole = (12 x 5) + 5 + (80 x 2) + 14 + (16 x 2) = 271 g [1]	2
	Total	10

The End

Name	Register No.	Class
		4E1

BENDEMEER SECONDARY SCHOOL
2017 PRELIMINARY EXAMINATION 2
SECONDARY 4 EXPRESS
CHEMISTRY PAPER 1
5073/01

DATE : 24 Aug 2017
DURATION : 1 hour

READ THESE INSTRUCTIONS FIRST

Write in 2B pencil.
Do not use paper clips, glue or correction fluid.
Write your name, class and register number on the question paper and OTAS sheet in the spaces provided.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **2B pencil** on the OTAS sheet.

Read the instructions on the OTAS sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

A copy of the Periodic Table can be found on page **15**.

40

This document consists of **15** printed pages.

[Turn over

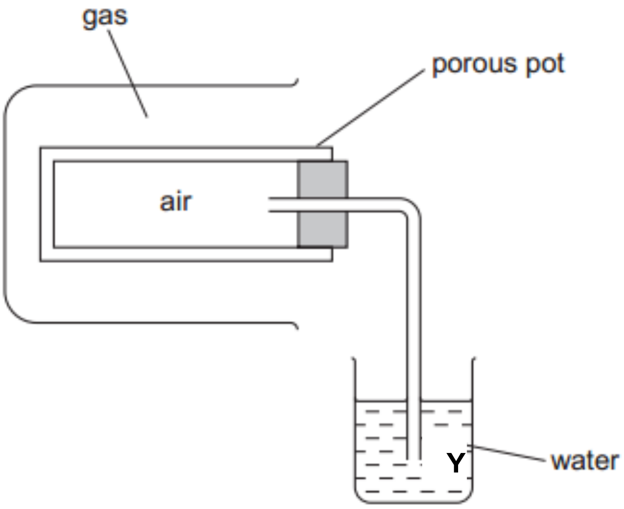
1 Camphor is a substance used in skin ointments and a natural sample of it is found to contain impurities like iron(III) oxide, iron and sodium chloride.
The effects of these substances with three different types of liquids are shown below.

substance	water	ethanol	dilute nitric acid
camphor	no effect	dissolves	no effect
iron	no effect	no effect	reacts to give a solution
iron(III) oxide	no effect	no effect	reacts to give a solution
sodium chloride	dissolves	no effect	dissolves

Which is the best method to obtain pure camphor?

A Add dilute nitric acid, filter and crystallise.
B Add dilute nitric acid, filter, rinse and dry.
C Add ethanol, filter, rinse and dry.
D Add water, filter, add dilute nitric acid to filtrate and crystallise.

2 The apparatus shown in the diagram is used to compare the rate of diffusion of a gas with the rate of diffusion of air.

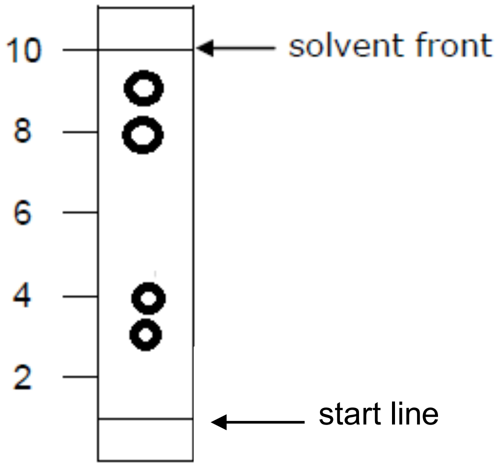


A beaker containing the gas was placed over the porous pot. Which gas is formed at Y?

A carbon dioxide
B hydrogen
C oxygen
D sulfur dioxide

[Turn over

3 A food dye is suspected to contain components which are harmful to the human body. The chromatogram of the food dye is obtained, as shown below. A reference table of R_f values of harmful components is provided.



R_f values of harmful components	
component	R_f value
K101	0.8
K110	0.6
K151	0.3
K122	0.1

Identify the harmful components present in the food dye.

A K101, K122
B K101, K151
C K101, K151, K122
D K101, K151, K122, K110

4 Why is the commercial preparation of pure oxygen from air possible?

A Oxygen has a different boiling point from nitrogen.
B Oxygen is denser than nitrogen.
C Oxygen is more soluble in water than nitrogen.
D Oxygen reacts more quickly than nitrogen.

5 The boiling points of some elements are given in the table.

element	boiling point (°C)
X	- 138
Y	- 155
Z	- 143

A mixture of X, Y and Z is heated from – 162 °C to – 142 °C.
Which element(s) would still remain as a liquid at – 142 °C?

A X only **B** X and Y **C** Y and Z **D** X, Y and Z

6 Which of the following decreases as the solid is being heated to become a liquid?

A the forces of attraction between the molecules
B the reactivity of the molecules
C the shape of the molecules
D the strength of the covalent bonds in the molecules

7 An ion of formula X^{2-} contains 18 electrons. If the relative atomic mass of X is 32, what is the composition in the nucleus of the ion?

A 14 protons and 18 electrons
B 16 protons and 16 neutrons
C 16 protons and 18 electrons
D 18 protons and 14 neutrons

8 An element has two isotopes with mass numbers 34 and 35. Its relative atomic mass is 34.3. What is the relative abundance of the isotope with mass number 34?

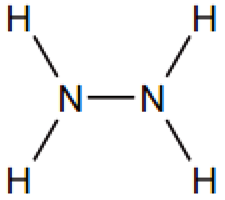
A 0.3 **B** 0.4 **C** 0.6 **D** 0.7

9 An investigation of the properties of the chlorides of Period III elements shows that the boiling points of sodium chloride and silicon tetrachloride are 1465°C and 57°C respectively. This difference in boiling points is a result of

A covalent bonds being weaker than ionic bonds.
B sodium chloride having strong metallic bonds.
C silicon tetrachloride having weak intermolecular forces of attraction.
D silicon forming weaker bonds with chlorine than does sodium.

[Turn over

10 The diagram shows the structural formula of the covalent molecule hydrazine, N_2H_4.



Which statement is true of the number of electrons in the molecule?

	total number of electrons involved in bonding	total number of electrons not involved in bonding
A	5	4
B	5	8
C	10	4
D	10	8

11 What does a solution of hydrogen chloride in ethanol contain?

A ethanol molecules and hydrogen chloride molecules
B ethanol molecules, hydrogen ions and chloride ions
C ethanol ions, hydrogen chloride molecules
D ethanol ions, hydrogen ions and chloride ions

12 Which sample contains the most number of atoms?

A 0.5 mol of C_2H_6
B 1.0 mol of SO_3
C 1.5 mol of CO_2
D 3.0 mol of He

13 20 cm^3 of oxygen reacts with 20 cm^3 of carbon monoxide. What is the volume of gases remaining? All volume is measured at room temperature and pressure.

	oxygen (cm^3)	carbon monoxide (cm^3)	carbon dioxide (cm^3)
A	0	0	20
B	0	0	40
C	10	0	20
D	10	10	20

[Turn over

14 Lead(II) oxide is produced by heating lead(II) carbonate.

$$PbCO_3 \rightarrow PbO + CO_2$$

When 267 g of lead(II) carbonate is heated, 210 g of lead(II) oxide is produced.
What is the percentage yield of lead(II) oxide?

A $\frac{210}{223} \times 100$

B $\frac{223}{210} \times 100$

C $\frac{210}{267} \times 100$

D $267 \times \frac{210}{223} \times 100$

15 Arsine (AsH_3) is a gas that behaves like ammonia. Which of the following ions are produced when Arsine dissolves in water?

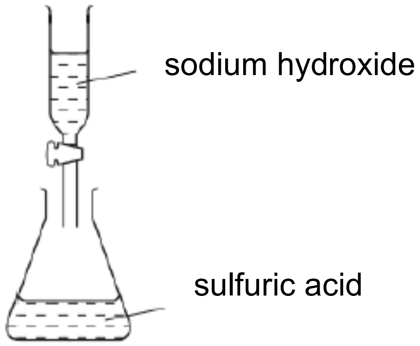
A AsH^+ and H^+
B AsH_3^+ and OH^-
C AsH_4^+ and H^+
D AsH_4^+ and OH^-

16 Which pair of reagents is most suitable in preparing the following salts?

	salt	reagent
A	ammonium nitrate	aqueous ammonia + nitric acid
B	lead(II) chloride	lead(II) oxide + hydrochloric acid
C	magnesium sulfate	magnesium nitrate + lithium sulfate
D	sodium chloride	sodium + dilute hydrochloric acid

[Turn over

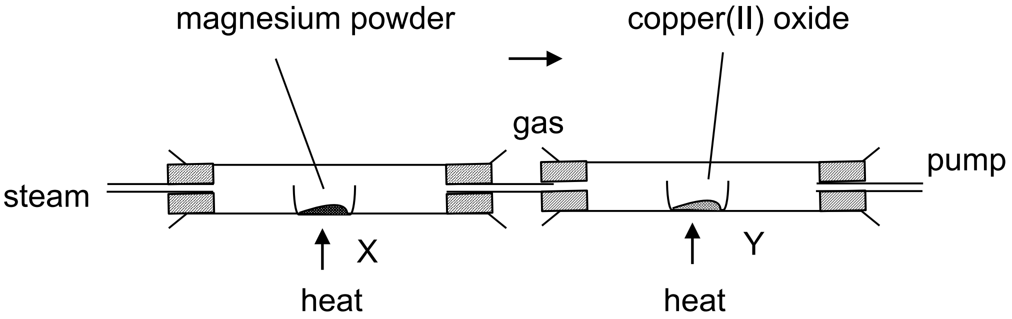
17 During an experiment, 10 cm^3 of 1.0 mol/dm^3 sodium hydroxide, NaOH, is gradually added to 10 cm^3 of 2.0 mol/dm^3 sulfuric acid, H_2SO_4, containing methyl orange indicator.



Which change occurs in the mixture?

A A precipitate is formed.
B Water molecules are formed.
C The concentration of the OH^- ions increases.
D The methyl orange changes colour.

18 In the experiment shown below, steam is passed into the combustion tube for some time.



What are the products at X and Y respectively?

A magnesium hydroxide, copper
B magnesium hydroxide, copper(II) hydroxide
C magnesium oxide, copper
D magnesium oxide, copper(II) hydroxide

[Turn over

19 Which statement about the Periodic Table is correct?

A The colour of the elements becomes darker down Group VII.
B The melting point of the elements increases down Group I.
C The reactivity of the elements increases down Group VII.
D The reactivity of the elements decreases down Group I.

20 What is the use of argon?

A to fill balloons
B to fill light bulbs
C to fill modern airships
D to manufacture advertising lights

21 Which method will not slow down the rusting process of an iron nail?

A electroplate the iron nail with silver metal
B submerge the iron nail in a container completely filled with boiled water
C submerge the iron nail in oil
D weld a piece of copper metal to the iron nail

22 Study the following statements about P, Q, R and S.

- Carbonate of S decomposes to form a compound and a gas only.
- Only oxides of P and R can be reduced by heating with carbon.
- P and Q react with dilute hydrochloric acid but not with cold water.
- R does not react with dilute hydrochloric acid nor water.

The order of increasing reactivity of the four metals is most likely to be:

A $R < P < Q < S$
B $R < S < P < Q$
C $S < Q < P < R$
D $S < R < P < Q$

[Turn over

23 Different forms of steel contain differing amounts of carbon.

Steel I contains a high proportion of carbon.
Steel II contains a low proportion of carbon.

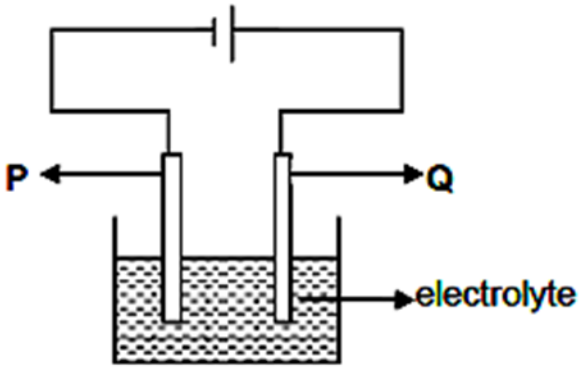
Which statement is correct?

A I is less strong but less brittle than II.
B I is less strong but more brittle than II.
C I is stronger but less brittle than II.
D I is stronger but more brittle than II.

24 Which pair of reagents can be used to test for the presence of chloride ions in an aqueous solution?

A aqueous barium nitrate and nitric acid
B aqueous barium nitrate and sulfuric acid
C aqueous silver nitrate and hydrochloric acid
D aqueous silver nitrate and nitric acid

25 An experiment is set up as shown in the diagram below. Both electrodes P and Q are made of graphite.



Which of the following gives the correct results as electrolysis proceeds?

	electrolytes	mass of P	mass of Q
A	aqueous copper(II) sulfate	increases	remains unchanged
B	aqueous copper(II) sulfate	remains unchanged	increases
C	aqueous sodium chloride	increases	remains unchanged
D	aqueous sodium chloride	remains unchanged	increases

[Turn over

26 The heat-reflecting shields of some space rockets are gold-plated, using electrolysis. Which electrodes and electrolyte would be used to gold-plate the heat shield?

	negative electrode (-)	positive electrode (+)	electrolyte
A	carbon	heat shield	gold compound
B	heat shield	gold	gold compound
C	gold	heat shield	copper compound
D	heat shield	carbon	copper compound

27 A catalytic converter in a car exhaust system changes pollutants into less harmful products. Which change does not occur in a catalytic converter?

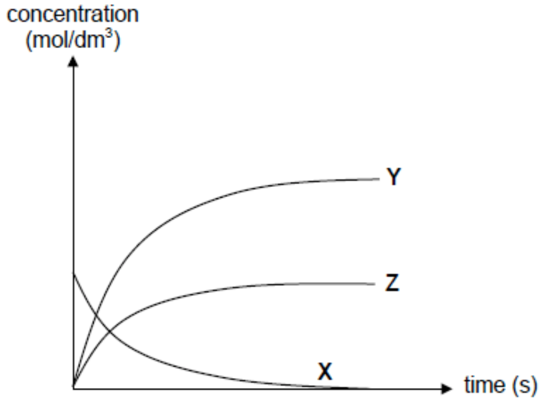
A carbon dioxide → carbon
B carbon monoxide → carbon dioxide
C oxides of nitrogen → nitrogen
D unburnt hydrocarbon →> carbon dioxide and water

28 Which substances can be used to reduce atmospheric pollution caused by flue gases?

A calcium carbonate and calcium oxide
B ammonium sulfate and calcium carbonate
C calcium oxide and ammonium sulfate
D ammonium carbonate and ammonium sulfate

[Turn over

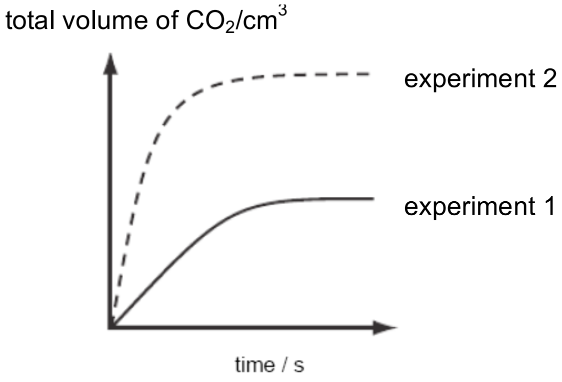
29 The following graph shows the change in reactant and product concentrations with time during a chemical reaction.



Which equation represents the reaction?

A X → Y + Z
B X → 2Y + Z
C Z → 2X + Y
D Z → 2Y + X

30 The reaction of iron(II) carbonate with an excess of dilute hydrochloric acid is investigated.
In experiment 1, 100 cm^3 of 0.10 mol/dm^3 hydrochloric acid and 0.5 g of iron(II) carbonate chips are used.



What conditions will produce the curve for experiment 2?

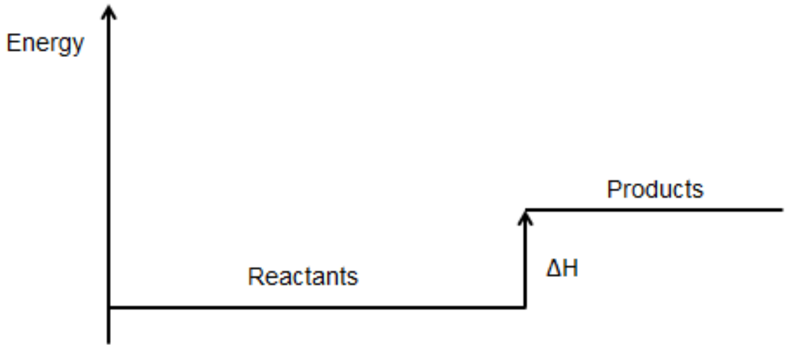
A 100 cm^3 of 0.10 mol/dm^3 of dilute hydrochloric acid and 1.0 g of iron(II) carbonate chips
B 100 cm^3 of 0.20 mol/dm^3 of dilute hydrochloric acid and 0.5 g of iron(II) carbonate chips
C 100 cm^3 of 0.20 mol/dm^3 of dilute hydrochloric acid and 1.0 g of iron(II) carbonate chips
D 200 cm^3 of 0.10 mol/dm^3 of dilute hydrochloric acid and 0.5 g of iron(II) carbonate chips

[Turn over

31 Which process is endothermic?

A addition of aqueous sodium hydroxide to hydrochloric acid
B combustion of butanol
C oxidation of carbon
D sublimation of iodine crystals

32 What can be deduced from the energy level diagram shown below?



A Heat energy is released.
B The reactants are less stable than the products.
C The surrounding temperature increases during the reaction.
D The energy change for bond breaking is higher than the energy change for bond formation.

33 Crysotile, $Mg_3Si_2O_5(OH)_4$ is an asbestos mineral.
What is the oxidation state of silicon in the mineral?

A - 4 **B** - 2 **C** + 2 **D** + 4

34 A reducing agent is added separately to four different reagents and the colour changes are recorded.
What is the correct description of the colour change?

	reagent	colour change
A	aqueous bromine	colourless to brown
B	acidified potassium dichromate(VI)	green to orange
C	aqueous potassium iodide	colourless to brown
D	acidified potassium manganate(VII)	purple to colourless

[Turn over

35 Which is the correct use of the different fractions in crude oil?

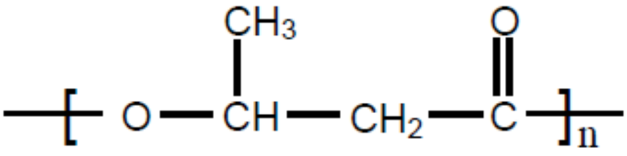
	fraction	use
A	bitumen	lubricating machine parts
B	kerosene	fuel for aircraft
C	naphtha	pave road
D	petrol	making chemicals

36 Which substances have the same number of carbon atoms in each molecule?

I ethyl methanoate
II ethanoic acid
III methyl propanoate
IV butanol

A I and II
B I and III
C II and IV
D III and IV

37 PHB (polyhydroxybutyric acid) is a natural polymer produced by a range of micro-organisms. The structure of this polymer is shown below.



$$\left[O-\overset{\displaystyle CH_3}{\overset{|}{CH}}-CH_2-\overset{\displaystyle O}{\overset{\|}{C}} \right]_n$$

Which statements are true about PHB?

1 PHB is a condensation polymer.
2 PHB molecule contains many ester groups.
3 PHB is made from two different types of unsaturated monomers.

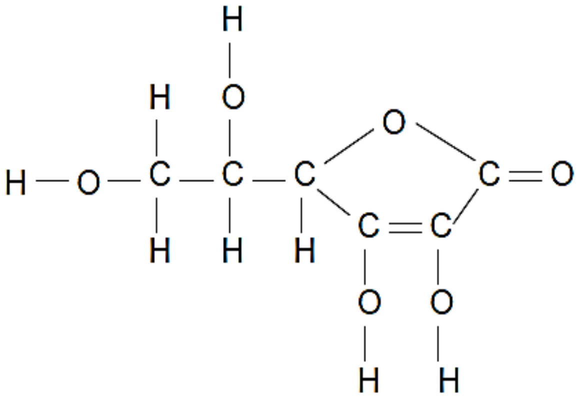
A 1 and 2 **B** 1 and 3 **C** 2 and 3 **D** 1, 2 and 3

[Turn over

38 Arachidonic acid is one of the most abundant polyunsaturated fatty acids in the brain. It has a molecular formula of $C_{19}H_{31}COOH$.
How many C=C double bond(s) is/are present in 1 molecule of arachidonic acid?

A 1 **B** 2 **C** 3 **D** 4

39 The structural formula of Vitamin C is shown below.



Which of the following substances does not react with Vitamin C?

A aqueous bromine
B acidified potassium manganate(VII)
C sodium carbonate
D steam

40 What are the uses of sulfuric acid?

I making fertilizers
II sterilising water
III making detergents
IV used in car batteries

A I and II only
B II and III only
C I, III and IV only
D I, II, III and IV

[Turn over

Name	Register No.	Class
		4E1

BENDEMEER SECONDARY SCHOOL
2017 PRELIMINARY EXAMINATION 2
SECONDARY 4 EXPRESS
CHEMISTRY SPA PAPER 2
5073/02

DATE : **22 Aug 2017**
DURATION : **1 hour 45 minutes**

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on the work you hand in.
Write in dark blue or black pen.
You may use a 2B pencil for any diagrams or graphs.
Do not use paper clips, glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer **all** three questions in the spaces provided. The last question is in the form of either/or and only one of the alternatives should be attempted.

Candidates are reminded that **all** quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

A copy of the periodic table to found on page **22**.

/ 80

This document consists of **22** printed pages.

[Turn over

Section A

Answer **all** questions in this section in the spaces provided.
The total mark for this section is 50.

A1 Use the compounds listed below to answer the following questions.

$Zn(NO_3)_2$	Fe_2O_3	$Pb(NO_3)_2$
NaI	Al_2O_3	KBr

You may use the compound once, more than once or not at all.

(a) State the compound that reacts with excess aqueous ammonia to produce a white precipitate.

.... [1]

(b) State the compound that reacts with aqueous chlorine to form a reddish brown solution.

.... [1]

(c) State the metal oxide that can be reduced by hydrogen gas.

.... [1]

(d) State the compound that reacts with sodium hydroxide to form a salt and water.

.... [1]

(e) Name 2 aqueous salts that can react to form a yellow precipitate.

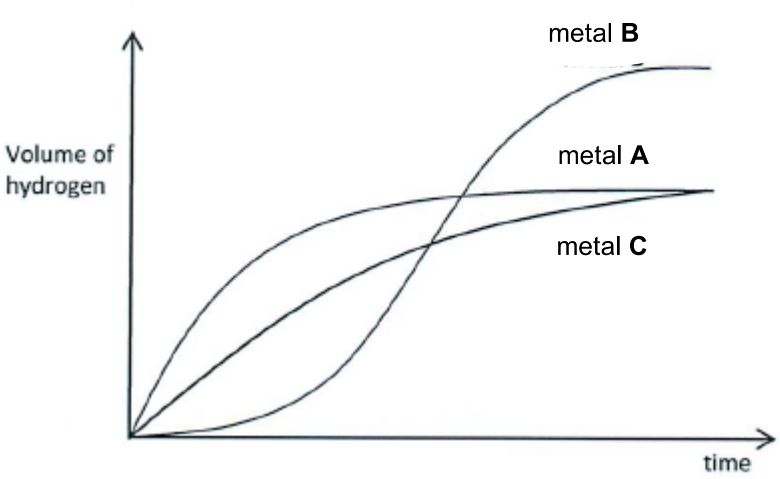
.... [1]

[Total: 5 marks]

[Turn over

A2 Excess sulfuric acid is added to powdered zinc. The hydrogen evolved is collected and its volume measured every 20 seconds. The experiment is repeated at the same temperature using the same number of moles of powdered magnesium and aluminium.

The graph below shows the volume of hydrogen produced from each metal against time.



(a) Identify metal **B** and account for the shape of its graph.

....

....

....

.... [3]

(b) Identify metals **A** and **C**.

.... [1]

(c) Using the concept of moles, explain why metals **A** and **C** form the same volume of hydrogen but metal **B** forms a larger volume of hydrogen.

....

....

....

.... [2]

[Turn over

(d) On the graph above, sketch the curve obtained when excess sulfuric acid is added to powdered calcium of the same mass.
Label this curve as “Ca” and explain the shape of the curve.

....

....

.... [2]

[Total: 8 marks]

A3 The relative positions of the elements rubidium(Rb), beryllium(Be) and bismuth(Bi) in the reactivity series are shown in Table 3.1.

Table 3.1

Position in the reactivity series
Rubidium
Sodium
Magnesium
Beryllium
Zinc
Iron
Hydrogen
Bismuth
Copper

(a) An unknown photo showing specks of silvery deposits with the following caption was posted on social media and has gone viral.

“Pure rubidium found on a tiny island in the Pacific Ocean”

Use your chemistry knowledge to discuss the validity of this post.

....

.... [1]

[Turn over

(b) Predict with reasons, the reactions of beryllium with cold water and with steam.

....

....

.... [3]

(c) Suggest a suitable method to extract bismuth from its ore.

.... [1]

(d) Underground iron pipelines are used in transporting substances such as natural gas from place to place. When underground, these iron pipes will rust relatively rapidly.

(i) Pieces of magnesium are often attached to underground iron pipes. Explain how this helps prevent iron from rusting.

....

....

.... [2]

(ii) A sample of a compound of iron is analysed. The sample contains 0.547 g of potassium, 0.195 g of iron, 0.252 g of carbon and 0.294 g of nitrogen. Determine the empirical formula of this compound.

[2]

[Total: 9 marks]

[Turn over

A4 The Hydra is a 22-person hydrogen fuelled ship that gets its electricity from a hydrogen fuel cell. It converts chemical energy from hydrogen fuel into electricity through a chemical reaction with oxygen, using aqueous sodium hydroxide as the electrolyte.
Fig. 4.1 shows the hydrogen fuel cell.

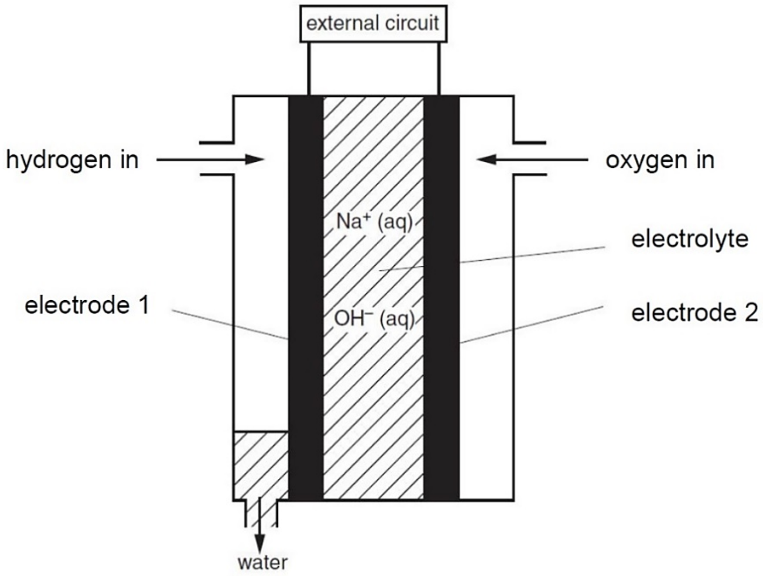


Fig. 4.1

The electrode reactions are:

O_2 (g) + $2H_2O$ (l) + 4e → $4OH^-$
H_2 (g) + $2OH^-$ (aq) → 2e + 2 H_2O (l)

(a) Identify which electrode in Fig. 4.1 is an anode, and which is a cathode.

.... [1]

(b) Describe how electricity is generated in the fuel cell.

....

....

....

.... [2]

[Turn over

(c) Give two reasons why aqueous sodium hydroxide is preferred over molten sodium hydroxide as an electrolyte for the fuel cell.

....

.... [2]

(d) The overall equation of the hydrogen fuel cell is as such:

$2H_2 (g) + O_2 (g) \rightarrow 2H_2O (l)$

(i) Explain, in terms of oxidation states, if the overall reaction is a redox reaction.

....

....

....

.... [2]

(ii) The generation of electrical energy from fuel cell is similar to the exothermic reaction that occurs when hydrogen gas reacts with oxygen gas.
Using ideas about bond breaking and bond making, explain why this reaction generates electrical energy.

....

....

....

.... [2]

(iii) Hence sketch an energy profile diagram for the generation of electrical energy from fuel cells.

[2]

[Turn over

(e) Alternatively, methanol can be used as a fuel to form a methanol fuel cell. Other than in terms of energy produced, suggest a possible advantage of using the methanol fuel cell over the hydrogen fuel cell.

....

.... [1]

[Total: 12 marks]

A5 Fig. 5.1 shows the reactions that lead to the depletion of ozone layer.

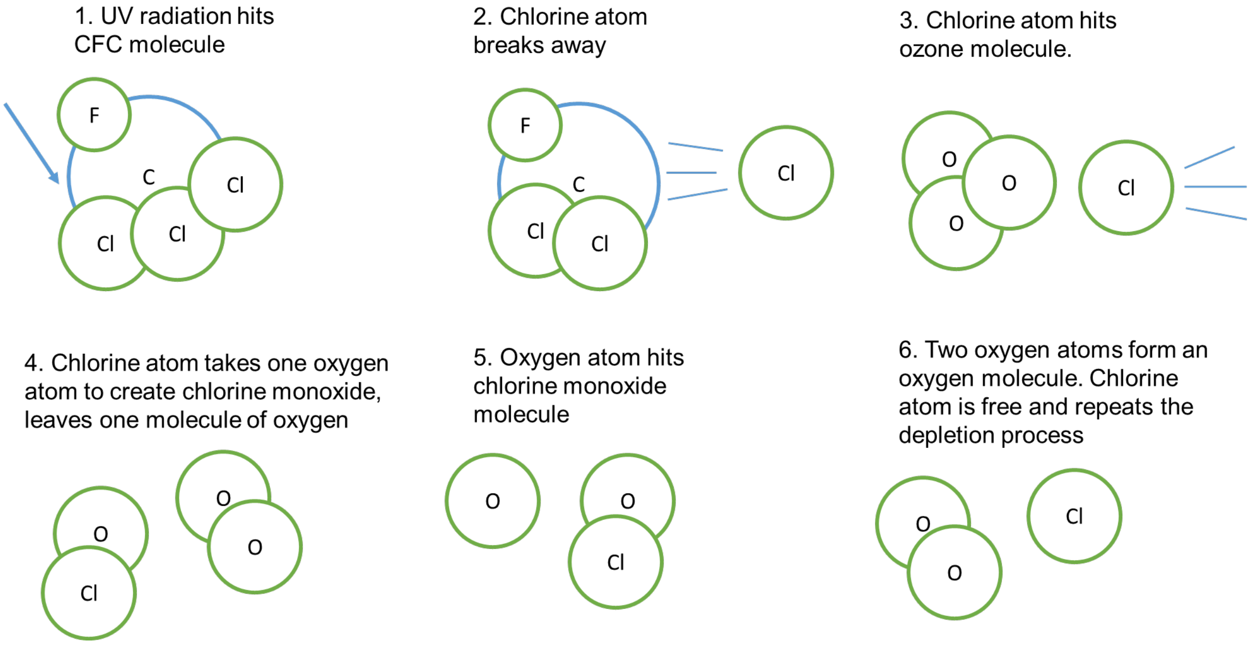


Fig. 5.1

(a) Identify an endothermic reaction in Fig. 5.1 and provide evidence to support your answer.

....

.... [2]

(b) Suggest why a small amount of CFC is sufficient to threaten the depletion of the ozone layer.

....

.... [2]

[Turn over

(c) With reference to Fig. 5.1, suggest whether the C – F bond is stronger or weaker than the C – C*l* bond.

.... [1]

Fig. 5.2 shows an impact of ozone depletion.

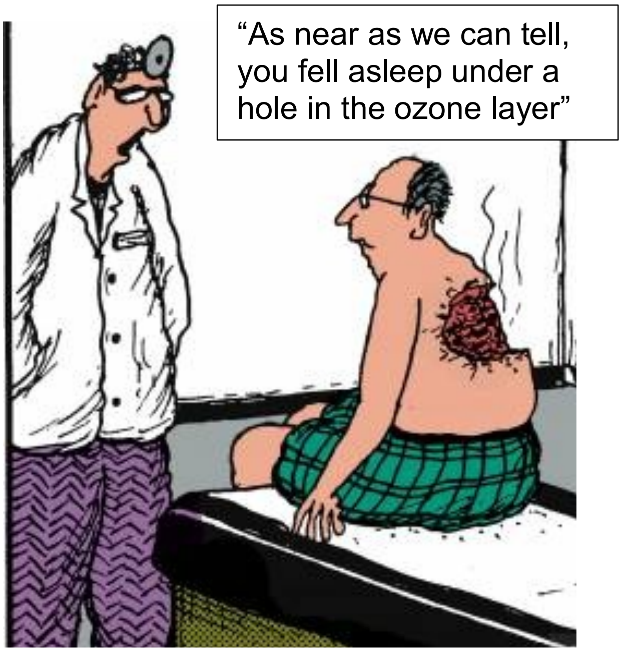


Fig. 5.2

(d) Explain how ozone depletion causes the impact shown in the cartoon.

....

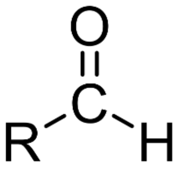
....

.... [2]

[Total: 7 marks]

[Turn over

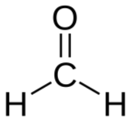
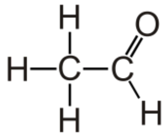
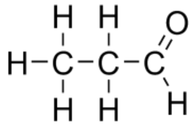
A6 An aldehyde is an organic compound containing a formyl functional group. This functional group, with the structure – CHO, consists of a carbonyl centre (a carbon double bonded to oxygen) bonded to hydrogen.



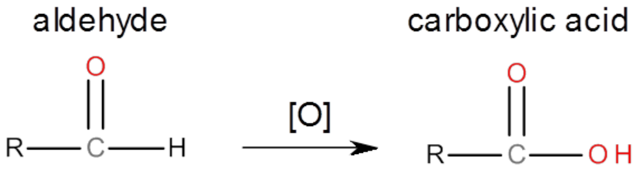
R group - generic alkyl or side chain

Table 6.1 shows some properties of aldehydes.

Table 6.1

chemical name	chemical formula	structural formula	boiling point/°c
methanal	CH_2O		−19
ethanal	CH_3CHO		20
propanal	CH_3CH_2CHO		50

Due to the high reactivity of aldehyde, it can be oxidised easily to form carboxylic acid as shown below.



Possibly because of the high reactivity of the formyl group, aldehydes are not commonly found in nature's building blocks such as amino acids, nucleic acids and lipids. Amino acids are monomers that form protein polymers. Proteins have the same linkage as nylon. An amino acid contains an amine functional group and a carboxyl functional group. These two groups can react to form a condensation polymer.

[Turn over

(a) Use the information above to give two pieces of evidence that suggest that the aldehydes are a homologous series.

....

.... [2]

(b) Deduce the general formula of the aldehydes and hence predict the formula of the aldehyde that contains 8 carbon atoms.

.... [2]

(c) Draw the structural formula of butanal.

[1]

(d) When propanal is reacted with potassium manganate (VII), product **A** is formed.
Product **A** can also be formed by reactant **B** via a two-step process.
Reactant **B** undergoes addition polymerisation to form a polymer.
Name product **A** and draw the polymer of **B**, showing 2 repeat units.

Product **A**: **.....................................** [1]

Polymer **B**:

[2]

[Turn over

Protein is a condensation polymer. Polymer **B** is an addition polymer.
Fig. 6.2 shows a section of a protein structure.

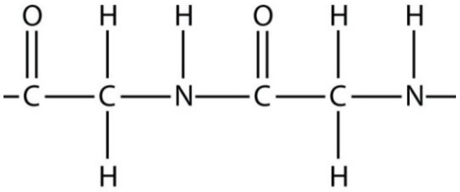


Fig. 6.2

(e) Draw the amino acid that forms this protein structure.

[1]

[Total: 9 marks]

[Turn over

Section B

Answer all **three** questions from this section.
The last question is in the form of an either/or and only one of the alternatives should be attempted.

B1 Read the information about elements in Group VII of the Periodic Table.

Halogens and its properties

Fluorine, chlorine, bromine, iodine and astatine are elements that are found in Group VII of the Periodic Table. They are reactive non-metals which exists as diatomic molecules. Some trends that can be observed as we go down Group VII are atomic radius and ionic radius. Table 1.1 gives the atomic radii and the ionic radii of halogens.

Table 1.1

halogen	atomic radius/ nm	ionic (X^-) radius/ nm
F	0.071	0.133
C*l*	0.099	0.181
Br	0.114	0.196
I	0.133	0.220
At	0.150	-

Electron affinity is a measure of the attraction between the incoming electron and the nucleus. The first electron affinity is the energy released when 1 mole of gaseous atoms each acquire an electron to form 1 mole of gaseous ions. For example, in this reaction,

$X(g) + e^- \rightarrow X^-(g)$

The first electron affinity is the energy released per mole of X when this change occurs. By convention, the negative sign shows a release of energy.

Table 1.2 gives the first electron affinities of Group 7 elements.

Table 1.2

halogen	first electron affinity (kJ/mol)
F	- 328
C*l*	- 349
Br	- 324
I	- 295
At	- 270

[Turn over

Halogens also react with hydrogen to form hydrogen halides.

$$H_2 + X_2 \rightarrow 2HX$$

Table 1.3 gives the bond energies of various H – X bonds.

Table 1.3

bond	bond energy (kJ / mol)
H – F	562
H – C*l*	431
H – Br	366
H – I	299

(a) State the general trend observed in the first electron affinities going down Group VII.

.... [1]

(b) Suggest why the atomic size of the atoms increases down the group and hence use this knowledge to explain the pattern described in **(a)**.

....

....

....

.... [2]

(c) Both chlorine and fluorine are gases at room temperature and pressure.
Using the information in Table 1.1, state and explain which gas is likely to have a lower boiling point.

....

....

....

.... [3]

[Turn over

(d) Two students discuss the information provided.

Student 1: 'I think the atomic size of the halogen attached to H is linked to the strength of the H−X bond.'

Student 2: 'I think the strength of the H−X bond is due to its ionic (X^-) radii.'

Does the information in the data given support the ideas of the students?
Explain your reasoning.

....

....

....

.... [2]

(e) All hydrogen halides dissolve in water to form acids.
Use Table 1.3 to predict the trend in the acid strength of the hydrogen halides.
Explain your answer.

....

....

.... [2]

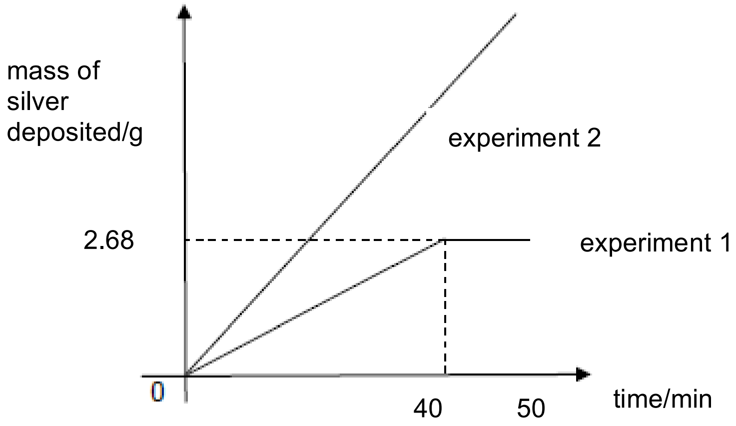
[Total: 10 marks]

[Turn over

B2 A pupil carried out two separate experiments using different electrodes in the laboratory.

In each experiment, he electrolysed 2.00 dm^3 of aqueous silver nitrate containing 2.68 g of silver ions. The same amount of current was passed in both experiments and the increase in mass of the cathode was weighed every 5 minutes for 50 minutes.

The diagram below shows the results of the two experiments.



(a) Describe how the mass of silver deposited at the cathode changes with time in each experiment.

....

....

.... [2]

(b) Write the half equation for the formation of silver at the cathode for both experiments.

.... [1]

(c) Carbon electrodes were used in experiment 1. Using this knowledge, explain the shape of the graph in experiment 1.

....

....

....

.... [2]

[Turn over

(d) Write the half equation for the reaction at the anode of experiment 1.

.... [1]

(e) Suggest another material for the electrodes used in experiment 2 and explain the shape of the graph.

....

....

.... [2]

(f) A circuit was connected as shown in Fig. 2.1 and a current passed through it for a period of time.

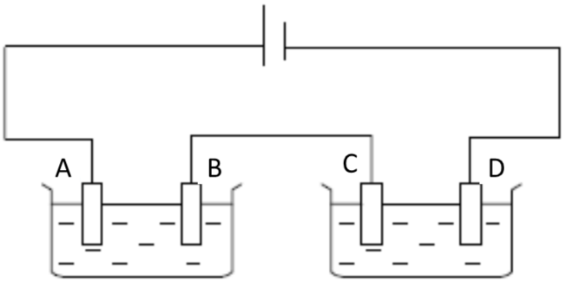


Fig. 2.1

Given that 12.8 g of copper and 14.0 g of cerium were deposited at electrodes **B** and **D** respectively, calculate the charge on a cerium ion.

[2]

[Total: 10 marks]

[Turn over

B3 EITHER

Nylon and Terylene are condensation polymers.

Fig. 3.1 and Fig. 3.2 show the structures of Nylon and Terylene respectively.

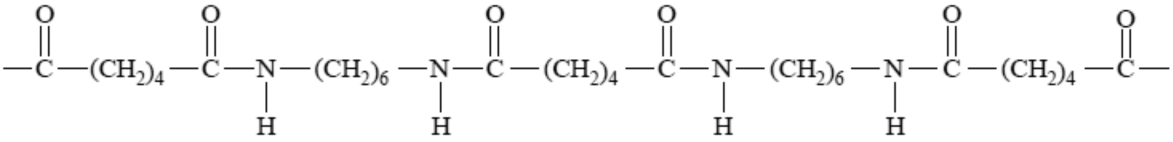


Fig. 3.1

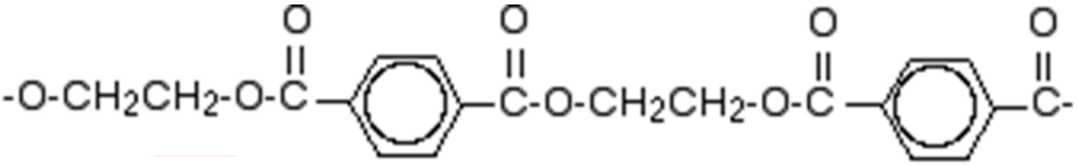


Fig. 3.2

(a) Compare and contrast the two polymers in terms of the following:

- The type of linkage present
- The monomers used in each polymer
- The side product when the polymer forms

....

....

....

....

.... [3]

(b) Both Nylon and Terylene are condensation polymers.
Explain what condensation polymers are.

....

.... [1]

[Turn over

(c) These condensation polymers are non-biodegradable.
Explain why being non-biodegradable is both an advantage and a disadvantage.

....

....

.... [2]

(d) The combustion of these condensation polymers produce a much larger amount of carbon monoxide and soot as compared to the combustion of their respective monomers. Explain the phenomena.

....

....

.... [2]

(e) Lactic acid can be made from corn starch. It polymerises to form the polymer, poly(lactic acid) (PLA).
Suggest two advantages that PLA has compared with a polymer made from petroleum.

....

....

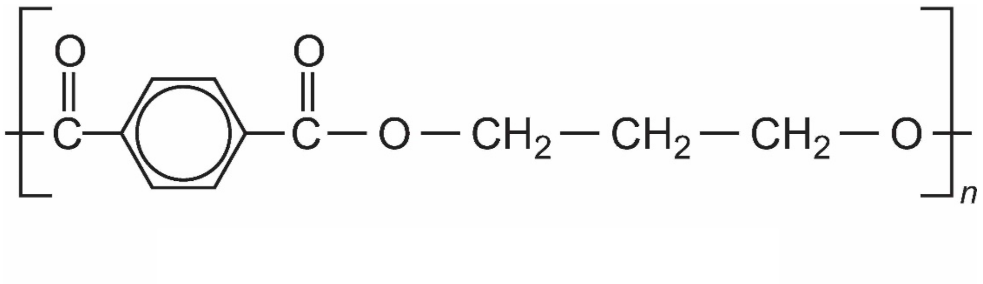
.... [2]

[Total: 10 marks]

[Turn over

B3 OR

Many soft drinks bottles are made of thermoplastics, polyethylene terephthalate (PET), which is formed from polymerisation of two different monomers and has the following structures:



(a) (i) Draw the structural formula of the two monomers that can be polymerised to PET.

[2]

(ii) Name the type of polymerisation involved and give the reason for your choice.

.... [1]

(b) Most environmental friendly green bags are made of 100% non-woven polypropene which is recyclable but not biodegradable.

(i) Write an equation, showing the structural formula, to illustrate the formation of polypropene from its monomer.

.... [1]

(ii) Name the type of polymerization involved.

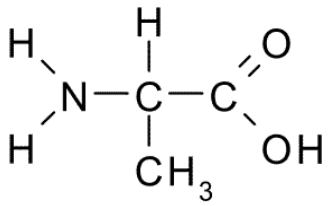
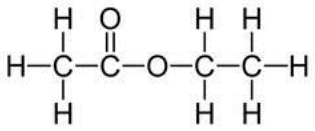
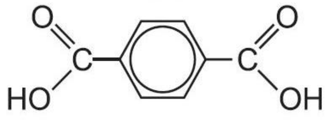
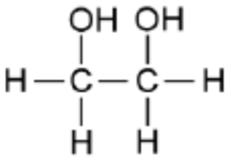
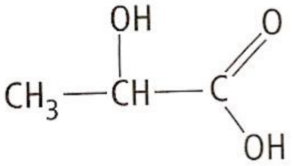
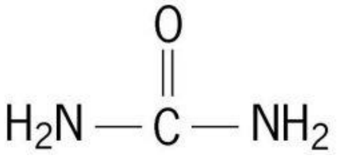
.... [1]

(iii) Suggest why non-woven polypropene is still not considered environmentally friendly.

.... [1]

[Turn over

(c) Two of the following molecules can form condensation polymers by itself.

		
molecule A	**molecule B**	**molecule C**
		
molecule D	**molecule E**	**molecule F**

Identify the two molecules (**A**, **B**, **C**, **D**, **E** and/or **F**) and draw the structure of the repeating unit of each polymer in the boxes provided.

molecule that can form a condensation polymer by itself:	molecule: ________
structure of repeating unit:	

molecule that can form a condensation polymer by itself:	molecule: ________
structure of repeating unit:	

[4]

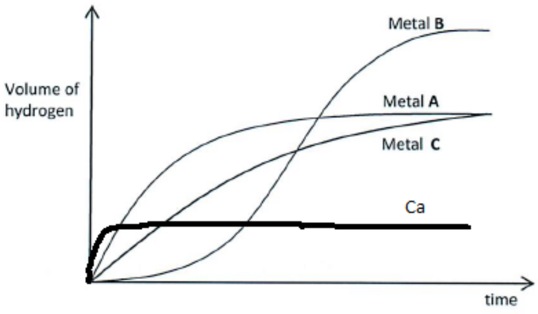
[Total: 10 marks]

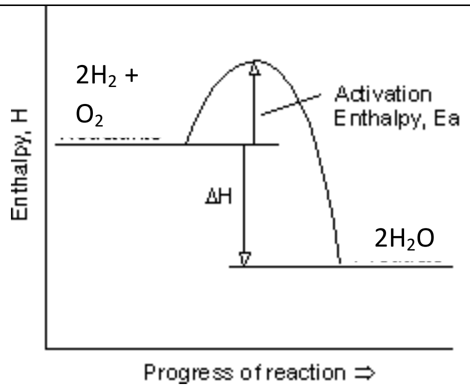
End of Paper

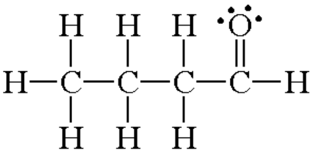
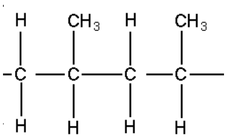
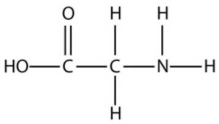
[Turn over

2017 Chemistry SPA
Preliminary 2
OTAS ANSWERS

Qn	Ans	Qn	Ans
1	**B**	21	**D**
2	**B**	22	**A**
3	**B**	23	**D**
4	**A**	24	**D**
5	**A**	25	**A**
6	**A**	26	**B**
7	**B**	27	**A**
8	**D**	28	**A**
9	**C**	29	**B**
10	**D**	30	**C**
11	**A**	31	**D**
12	**C**	32	**D**
13	**C**	33	**D**
14	**A**	34	**D**
15	**D**	35	**B**
16	**A**	36	**D**
17	**B**	37	**A**
18	**C**	38	**D**
19	**A**	39	**C**
20	**B**	40	**C**

A1(a)	$Pb(NO_3)_2$ / Al_2O_3	**1**
(b)	KBr	**1**
(c)	Fe_2O_3	**1**
(d)	Al_2O_3	**1**
(e)	Lead(II) nitrate and sodium iodide.	**1**
A2(a)	B is aluminium. Reaction is slow at start, because of the oxide layer reacting with acid. Reaction is fast when the oxide layer is removed, exposing the aluminium which reacts with the acid.	**1** **1** **1**
(b)	Metal A – magnesium Metal C – Zinc	½ ½
(c)	$2Al + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 3H_2$ $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$ $Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$ For both magnesium and zince, 1 mol of metal produces 1 mol of H_2, therefore same volume of hydrogen produced. For aluminium, 1 mol of metal produces 1.5 mol of H_2, therefore higher volume of hydrogen produced.	**1** **1**
(d)	 Graph must show that initial reaction is fast. Initial reaction is fast as Ca is very reactive. However, reaction stops due to the formation of a **layer of insoluble calcium sulfate**. This **prevents further reaction** between calcium and acid, therefore no more hydrogen is produced.	**1** **1**
A3(a)	The photograph is unlikely to show deposits of pure rubidium / hoax. Rubidium is a highly reactive metal which will react violently when exposed to air / water	**1**
(b)	Beryllium is less reactive than magnesium. It has no reaction with cold water / reacts very much slower than magnesium with water. It will react with steam to form beryllium oxide and hydrogen gas.	**1** **1** **1**
(c)	Reduction by carbon / carbon monoxide	**1**

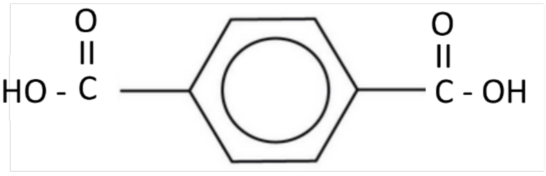
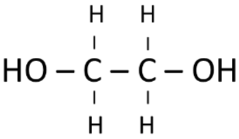
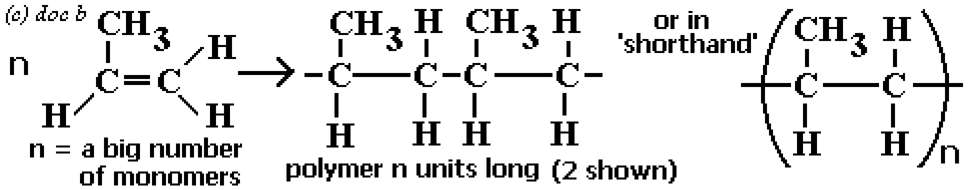
(d)(i)	Magnesium is more reactive than iron. It will undergo sacrificial protection/ corrode in its place/ lose electrons to iron.	**1** **1**
(ii)	**Simplest mole ratio of Fe, K, C, N** $= \frac{0.195}{56} : \frac{0.547}{39} : \frac{0.252}{12} : \frac{0.294}{14}$ **= 0.003482: 0.01403: 0.021: 0.021** $= \frac{0.003482}{0.003482} : \frac{0.01403}{0.003482} : \frac{0.021}{0.003482} : \frac{0.021}{0.003482}$ **= 1: 4: 6: 6** **Empirical formula is $FeK_4C_6N_6$.** **[1] for working, [1] for giving empirical formula.**	**2**
A4(a)	Anode: electrode 1 / on the left Cathode: electrode 2 / on the right	½ ½
(b)	Hydrogen gas is **oxidised** and releases electrons and water. These electrons flow from the anode to the cathode. Oxygen is then **reduced** to form hydroxide ions. The **movement of electron flow** from hydrogen to oxygen in the cell generates electricity.	½ ½ **1**
(c)	**High temperature** is required to maintain sodium hydroxide in the **molten state**. **Sodium metal deposited at the positive electrode would react with the oxygen** supplied, reducing the efficiency of the fuel cell.	**1** **1**
(d)(i)	The overall reaction for the hydrogen fuel cell is a redox reaction. The hydrogen is oxidised as the oxidation state of hydrogen increases from **0 in H_2 to +1 in H_2O** while oxygen is reduced as the oxidation state of oxygen decreases from **0 in O_2 to -2 in H_2O.**	**1** **1**
(ii)	The amount of electrical energy **absorbed** to **break** 2 moles of H-H and 1 mole of O=O bonds in H_2 and O_2 is **lesser** than energy **released** when the 4 moles of H-O bonds in H_2O are **formed**. Thus, it is an exothermic reaction and there is a **net amount of electrical energy released.**	**2**
(iii)		**2**
(e)	Methanol is a liquid and is not required to be stored under highly pressurized vessels unlike hydrogen. Thus it is safer to transport as a fuel.	**1**

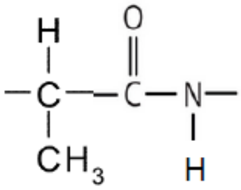
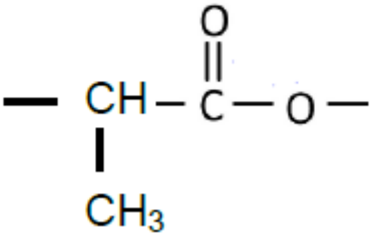
A5(a)	Step **2**. This is where the Cl atom breaks away from the compound as UV radiation is **absorbed** in order to **break** the C – Cl bond.	**2**
(b)	At the end of the reaction to convert ozone to oxygen, chlorine atom is **regenerated** and can be **used again to convert more ozone to oxygen** to repeat the depletion process.	**1** **1**
(c)	C – F bond is stronger. (As UV rays is only able to break C – Cl bond but not C – F bond.)	**1**
(d)	Ozone layer absorbs harmful UV rays from the sun. If ozone layer is depleted, the earth will be exposed to harmful UV rays which can cause skin cancer in human.	**1** **1**
A6 (a)	As the number of carbon atom increases/As the molecules get larger, the boiling point increases. They share the same general formula. OR The consecutive members of the group differ by $–CH_2$ OR They have the same functional group.	**1** **1**
(b)	$C_nH_{2n+1}CHO$ where n = 0 for first member / $C_nH_{2n}O$ where n= 1 $CH_3CH_2CH_2\ CH_2CH_2CH_2CH_2CHO$ OR $C_7H_{15}CHO$ OR $C_8H_{16}O$	**1** **1**
(c)		**1**
(d)	Product **A**: Propanoic acid [1] Polymer **B**: 	**1** **2**
(ii)		**2**

B1(a)	Decreases down the group.	
(b)	Atomic radius **increases** as the number of **electron shells increases** down the group. As the electron shells increase, the **distance** between the **nucleus** and the **incoming electron increases.** Therefore, the electrostatic forces of **attraction between the nucleus and the incoming electron decreases**, thus the amount of energy released decreases when the atom takes in an electron.	**1** **1** **1**
(c)	Fluorine has lower boiling point. Fluorine molecules are **smaller in size** than that of chlorine/ lower relative molecular mass than that of chlorine The **intermolecular forces of attraction** between fluorine molecules are weaker than that of chlorine. **Less energ**y is needed to overcome the weaker intermolecular forces of attraction.	**1** **1** **1**
(d)	Student 1 is **supported**. The **smaller** the halogen, the **stronger** the H – X bond. Student 2 is **not supported** as HX is a **covalent** compound and there are no halogen ions in HX. Therefore, the ionic radii is not relevant to the strength of the H – X bond.	**1** **1**
(e)	Acid strength **increases** down the group. The **smaller** the bond energy, the **easier** it is for the acid to **ionize** to form H^+ ions.	**1** **1**

B2 (a)	Expt 1- mass of cathode increases until 2.68g and stops increasing thereafter. Expt 2- mass of cathode kept increasing even after 2.68g.	**2**
(b)	$Ag^+(aq) + e^- \rightarrow Ag\,(s)$	**1**
(c)	Ag ions present in the solution discharges at the cathode. At the **anode, hydroxide ions are discharged** and **no new Ag ions are released into the solution**. Hence, once all the Ag ions in the solution are discharged, no more Ag can be formed.	**2**
(d)	$4OH^-\,(aq) \rightarrow 2H_2O\,(l) + O_2\,(g) + 4e^-$	**1**
(e)	**Silver electrodes** are used in experiment 2. The silver anode dissolves into the solution, **replenishing the silver ions** that have been discharged at the cathode, hence the increasing mass of silver deposited.	**2**
(f)	No of moles of Cu = 12.8g ÷ 64 = 0.2 mol No of moles of Cerium = 14.0g ÷ 140 = 0.1mol Amt of electrons to discharge Cu= 0.2 x 2 = 0.4 mole Charge of Cerium = +4 OR No of moles of Cu = 12.8g ÷ 64 = 0.2 mol No of moles of Cerium = 14.0g ÷ 140 = 0.1mol Amt of electrons to discharge Cu= 0.2 x 1 = 0.2 mole Charge of Cerium = +2	**1** **1**

B3	**Either**	
(a)	The linkage present in nylon is amide linkage. The one in terylene is ester linkage. Nylon is made up of dicarboxylic acid monomers and diamine monomers while terylene is made up of dicarboxylic acid monomers and diols monomers The side products from formation of both polymers are water molecules.	**1** **1** **1**
(b)	Condensation polymers are **macromolecule** made from combining many **monomers**, with an **elimination of a small molecule like water**.	**1**
(c)	Being non-biodegradable will allow the polymer to be durable and resistant to corrosion. However, being non-biodegradable will also create more landfills when the polymer is disposed off and thus, causing land pollution.	**1** **1**
(d)	The polymer has **much higher carbon content** than its monomers thus are **less flammable** and would **undergo incomplete combustion** with oxygen to form carbon monomers and soot. In contrast, its monomers have lower carbon content and is more flammable and undergoes complete combustion to form carbon dioxide.	**1** **1**
(e)	It is biodegradable and thus does not take up landfill space and reduce land pollution. It is carbon neutral as the same amount of carbon dioxide that is used to grow the corn plant is released upon decomposition/combustion of PLA.	**1** **1**

B3	**OR**	
(a)(i)	  $HO-CH_2-CH_2-OH$	1 1
(ii)	Condensation polymerisation as a small molecule of water is eliminated when 2 monomers polymerised.	1
(b)(i)		1
(ii)	Addition polymerisation	1
(iii)	Since is not biodegradable, it remains as a waste material in the environment and takes up landfill space. Or when burnt, it produces carbon dioxide and other harmful pollutants	1

(c)		molecule that can form a condensation polymer by itself:	**A**		
		structure of repeating unit:			
		molecule that can form a condensation polymer by itself:	**E**		4
		structure of repeating unit:			

Name: ___________________________(   )   Class:______

CHIJ KATONG CONVENT
PRELIMINARY EXAMINATIONS 2017
Secondary Four Express

CHEMISTRY (WITH SPA) 5073/01

Duration: 1 hour

Classes: 406

Candidates answer on the Optical Answer Sheet.

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid/ tape.
Write your name, class and index number in the spaces provided at the top of this page and on the Optical Answer Sheet.

There are **forty** questions on this paper. Answer **all** questions. For each question, there are four possible answers, **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done on the question paper.
A copy of the Data Sheet is printed on page 13.
A copy of the Periodic Table is printed on page 14.

At the end of the examination, hand in:
1. Optical Answer Sheet; and
2. Question paper **separately**.

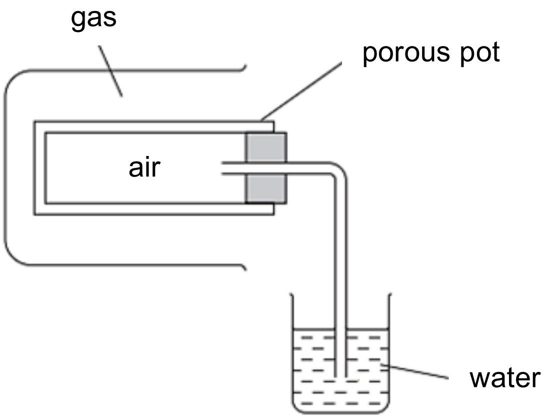
This question paper consists of **14** printed pages.

1 The sun-lit side of planet Venus has a temperature of 355 ºC. The night side of the same planet has a temperature of -130 ºC.

Which substance exists on one side of planet Venus as a liquid and the other side as a gas?

	melting point/ ºC	boiling point/ ºC
A	-210	-196
B	-183	-87
C	44	280
D	328	1744

2 The apparatus shown in the diagram was used to compare the rate of diffusion between a gas and air.

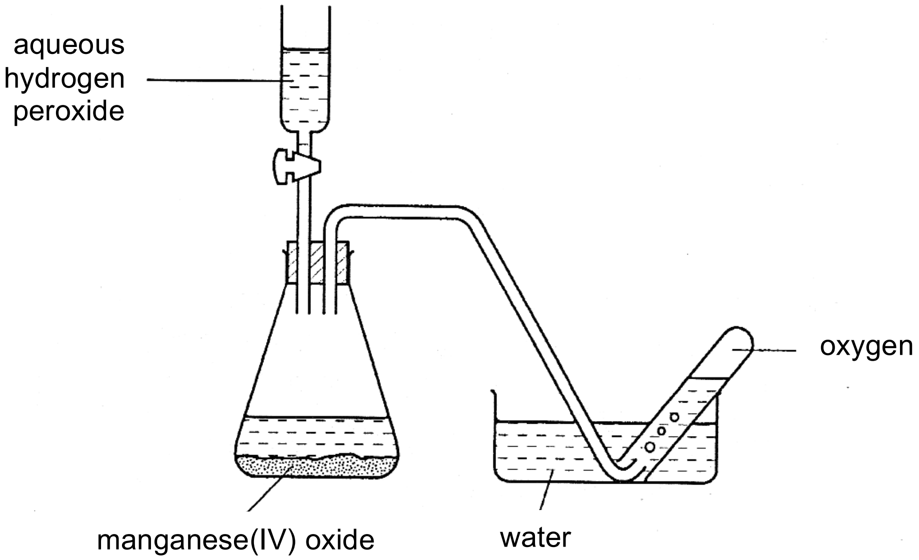


A beaker containing the gas was placed over the porous pot.

Which gas would cause bubbles to be observed in the beaker of water?

A carbon dioxide
B hydrogen
C oxygen
D sulfur dioxide

3 Aqueous hydrogen peroxide decomposes readily to form oxygen in the presence of manganese(IV) oxide as a catalyst. This reaction was used to produce and collect oxygen as shown in the diagram.



Which substance could have contaminated the first few test tubes of collected gas?

A chlorine
B hydrogen peroxide
C manganese(IV) oxide
D nitrogen

4 An organic solvent (hexane) and aqueous sodium chloride were accidentally mixed together.

Which methods of separation are needed to obtain pure samples of hexane and solid sodium chloride?

A filtration followed by crystallisation
B fractional distillation followed by evaporation to dryness
C simple distillation followed by crystallisation
D using a separating funnel followed by evaporation to dryness

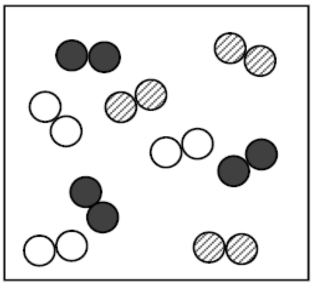
5 Which is the best method of obtaining pure water from ink?

A chromatography
B distillation
C filtration
D freezing

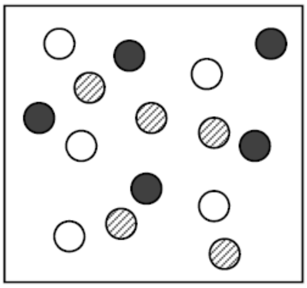
6 A gaseous mixture is made up of nitrogen, oxygen and chlorine.

Which diagram could show a pure sample of this mixture?

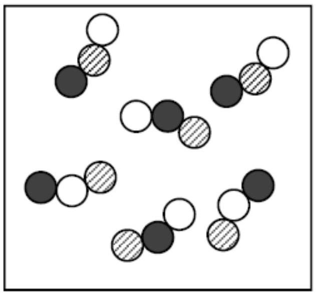
A



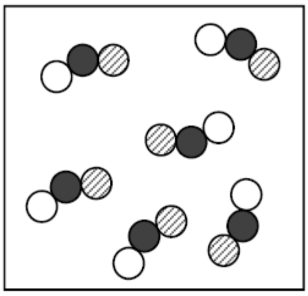
B



C



D



7 An ion, L^{2-}, has 18 neutrons and 18 electrons.

What does its nucleus contain?

A 16 protons and 16 neutrons
B 16 protons and 18 neutrons
C 18 protons and 16 neutrons
D 20 protons and 18 neutrons

8 The table shows the isotopic composition of iron.

isotope	percentage abundance/ %
^{54}Fe	5.8
^{56}Fe	91.6
^{57}Fe	2.2
^{58}Fe	0.4

What is the relative atomic mass of iron?

A 55.9
B 56.0
C 56.1
D 56.2

9 Talc is a mineral and has the formula $Mg_3Si_4O_{10}(OH)_2$.

What is the charge of the Si_4O_{10} ion?

A -2
B -4
C +1
D +2

[Turn over

10 The table shows the number of protons, neutrons and electrons in particles S, T, U and V.

particle	proton	neutron	electron
S	17	20	17
T	17	18	18
U	20	20	18
V	20	21	20

Which pair of particles would combine to form an ionic compound?

A S and T
B S and U
C T and U
D T and V

11 Element X has n protons and forms ions with a charge of -2. Element Y has (n+1) protons.

Which compound is formed when element X reacts with element Y?

A a covalent compound XY_2
B a covalent compound X_2Y
C an ionic compound XY_2
D an ionic compound X_2Y

12 Metals have positive ions in a 'sea of electrons'.

Which metal atom contributes the least number of electrons to this 'sea of electrons'?

A aluminium
B magnesium
C sodium
D zinc

13 Given they all have the same mass of 1 g, which substance has the smallest number of atoms?

A argon
B hydrogen
C iodine
D lead

14 Aerials in portable radios are made of a mixture of the oxides of calcium and iron known as 'ferrite'. It contains 18.5% calcium and 51.9% iron by mass.

Which is the empirical formula of 'ferrite'?

A $CaFe_2O$
B $CaFe_2O_4$
C Ca_2FeO_2
D Ca_4Fe_2O

15 In a combustion reaction, 4 cm^3 of methane burned completely in 10 cm^3 of oxygen according to the equation:

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$$

What is the final volume of gas left behind at room temperature and pressure?

A 4 cm^3
B 6 cm^3
C 12 cm^3
D 14 cm^3

16 Which statement about an alkaline solution is correct?

A It contains equal number of hydrogen and hydroxide ions.
B It contains more hydrogen ions than hydroxide ions.
C It contains more hydroxide ions than hydrogen ions.
D It contains only hydroxide ions.

17 In an experiment, five students each titrated 25.0 cm^3 of aqueous sodium hydroxide with dilute hydrochloric acid, using the same indicator.

The volume of hydrochloric acid used by each student is shown in the table.

student	I	II	III	IV	V
volume of dilute hydrochloric acid/ cm^3	19.4	19.5	19.4	19.5	21.0

Which statement explains the anomalous result obtained by student V?

A The burette was washed out with hydrochloric acid.
B The conical flask was washed out with aqueous sodium hydroxide.
C The pipette was washed out with aqueous sodium hydroxide.
D Too much indicator was added to the conical flask.

18 Nitrogenous fertiliser such as ammonium nitrate is used to increase crop yield.

Which substance can be added to increase the pH of acidic soil containing ammonium nitrate without causing a loss of nitrogen?

A calcium carbonate
B calcium hydroxide
C magnesium hydroxide
D potassium hydroxide

19 Which is not a redox reaction?

A $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$
B $Cu^{2+} + Zn \rightarrow Cu + Zn^{2+}$
C $CuO + H_2SO_4 \rightarrow CuSO_4 + H_2O$
D $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

20 Peroxodisulfuric acid, $H_2S_2O_8$, reacts with potassium iodide, KI, according to the equation:

$$H_2S_2O_8(aq) + 2KI(aq) \rightarrow K_2SO_4(aq) + H_2SO_4(aq) + I_2(aq)$$

What does the reaction show about the nature of peroxodisulfuric acid?

A It is acidic.
B It is basic.
C It is an oxidising agent.
D It is a reducing agent.

21 Water is formed when hydrogen is passed over the oxides of P and Q, but not when hydrogen is passed over the oxide of R. Furthermore, Q reduces the oxide of P.

Which is the order of reactivity for metals P, Q and R in increasing order?

A P, Q, R
B Q, P, R
C R, P, Q
D R, Q, P

22 Iron pipes corrode rapidly when exposed to seawater.

Which metal, when attached to the iron pipes, would not offer protection against corrosion?

A aluminium
B magnesium
C platinum
D zinc

23 Different types of steel differ in how much carbon they contain.

What are the properties of a high carbon steel?

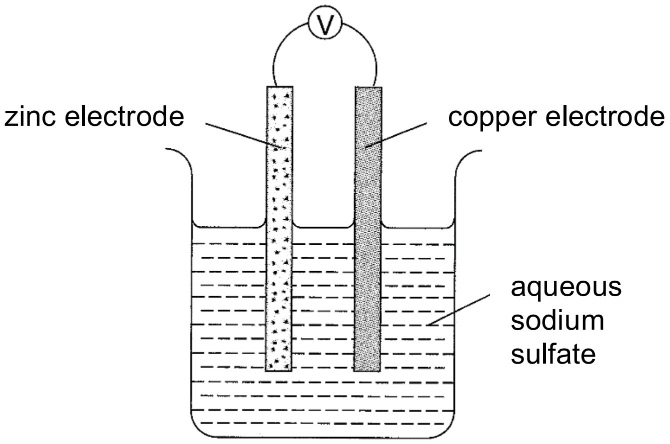
A soft and brittle
B soft and easily shaped
C strong and brittle
D strong and easily shaped

24 In an electrolysis experiment, the same amount of charge deposited 54.0 g of silver and 8.5 g of vanadium.

What is the charge on the vanadium ion?

A +1
B +2
C +3
D +4

25 The diagram shows a simple cell.



What happens when current flows through the circuit?

A Copper dissolves to form copper(II) ions.
B Electrons flow from the copper electrode to the zinc electrode.
C Hydrogen gas is liberated at the zinc electrode.
D Zinc dissolves to form zinc ions.

26 Which property cannot be predicted from the position of an element in the Periodic Table?

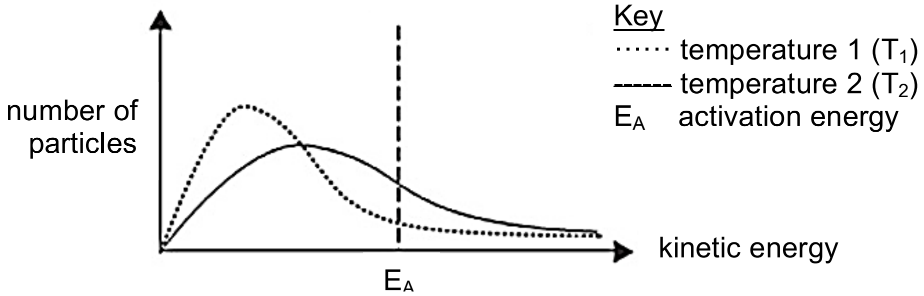
A the acidic or basic nature of its oxide
B the formula of its oxide
C the metallic or non-metallic character
D the number of isotopes it has

27 Excess bromine is shaken with a mixture of sodium chloride and sodium iodide solutions.

Which substances will the final mixture contain?

A bromine, iodine, sodium bromide
B bromine, iodine, sodium bromide, sodium chloride
C bromine, iodine, sodium bromide, sodium iodide
D Iodine, sodium bromide, sodium chloride

28 The diagram represents the distribution of kinetic energy of reactant particles at two different temperatures.



Given that the areas under the two curves are equal, which statement about the reaction is correct?

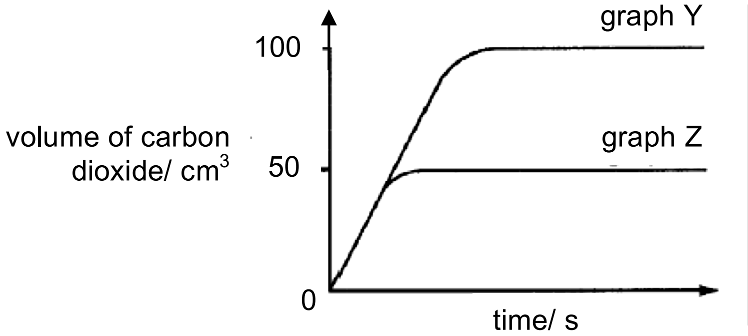
A At T_1, the activation energy is lower than at T_2.
B At T_1, the enthalpy change of the reaction is higher than at T_2.
C At T_2, a greater number of particles have sufficient energy to react.
D At T_2, the reaction takes a longer time to complete.

29 Two substances, X and Y, react to produce substance Z. The enthalpy change for the reaction is -120 kJ/mol, while the activation energy is +200 kJ/mol.

What is the activation energy for the decomposition of substance Z to substances X and Y?

A +80 kJ/mol
B +120 kJ/mol
C +200 kJ/mol
D +320 kJ/mol

30 Some sodium carbonate pellets were added to an excess of sulfuric acid at room temperature. The volume of carbon dioxide produced was measured over a period of time. Graph Y shows the results obtained.



Which change could have produced graph Z?

A Acid of half the original concentration was used.
B A lower temperature was used instead.
C Half the mass of sodium carbonate pellets was used.
D Powdered sodium carbonate of the same mass was used.

31 Which change would increase the speed of reaction between 1 mole of two gases?

A a decrease in surface area of the catalyst
B a decrease in temperature
C a decrease in the size of the reaction flask
D a decrease in the pressure of the gases

32 In the Haber process, nitrogen and hydrogen react to form ammonia.

Which is the main source of hydrogen?

A air
B crude oil
C ethanoic acid
D ethanol

33 Biodiesel, made from vegetable oil, can be used as a fuel for vehicles. Even though carbon dioxide is released when biodiesel is combusted, scientists still claim that biodiesel is a carbon neutral fuel.

Which is the basis for this claim?

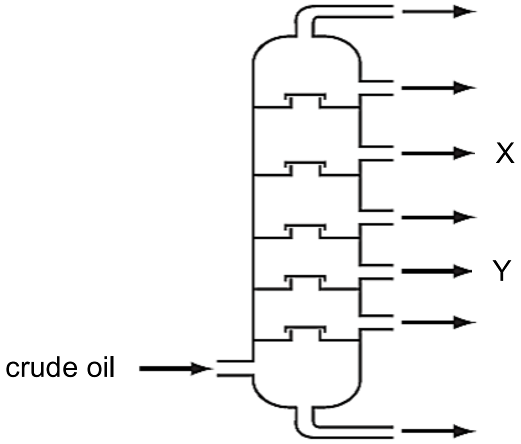
A Biodiesel is not a carbon compound.
B Biodiesel produces less carbon dioxide when it burns.
C Plants release carbon dioxide during respiration.
D Plants take up carbon dioxide during photosynthesis.

34 Which gas will not be removed from the exhaust gas of a petrol powered car by its catalytic converter?

A carbon dioxide
B carbon monoxide
C nitrogen dioxide
D unburnt hydrocarbons

[Turn over

35 Crude oil can be separated into different fractions using fractional distillation. The positions at which fractions X and Y are collected are shown in the diagram.



Which statement about the fractional distillation of crude oil is correct?

A The temperature increases up the column.
B X condenses at a lower temperature than Y.
C X has a higher boiling point than Y.
D X has longer chain molecules than Y.

36 A molecule of $C_{17}H_{36}$ undergoes catalytic cracking. The products of the reaction are one butane molecule, one propene molecule and some ethene molecules.

How many ethene molecules are produced during the reaction?

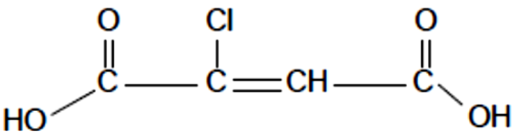
A 3
B 5
C 6
D 8

37 Adrenic acid is a naturally occurring polyunsaturated fatty acid with a molecular formula of $C_{22}H_{36}O_2$. It is one of the most abundant fatty acids in the early human brain.

What is the number of carbon-carbon double covalent bonds present in one molecule of the acid?

A 4
B 5
C 6
D 8

38 The diagram shows the structural formula of chloromaleic acid.



Which statement about chloromaleic acid is correct?

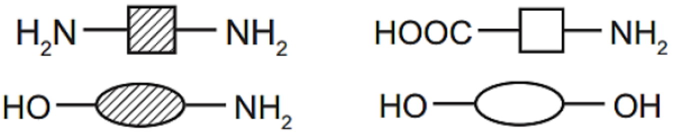
A It can undergo a substitution reaction with halogens.
B It decolourises bromine solution in the absence of sunlight.
C It will react with magnesium to produce a gas that relights a glowing splint.
D It will turn red litmus paper blue.

39 Alcohol X, was fully oxidised to organic compound Y. Reaction of Y with calcium carbonate produced a salt with the chemical formula $(C_2H_5CO_2)_2Ca$.

Which alcohol is used?

A C_2H_5OH
B $C_2H_5CH_2OH$
C $C_2H_5CH_2CH_2OH$
D $C_2H_5CH(OH)CH_2C_2H_5$

40 The diagrams show four monomers.

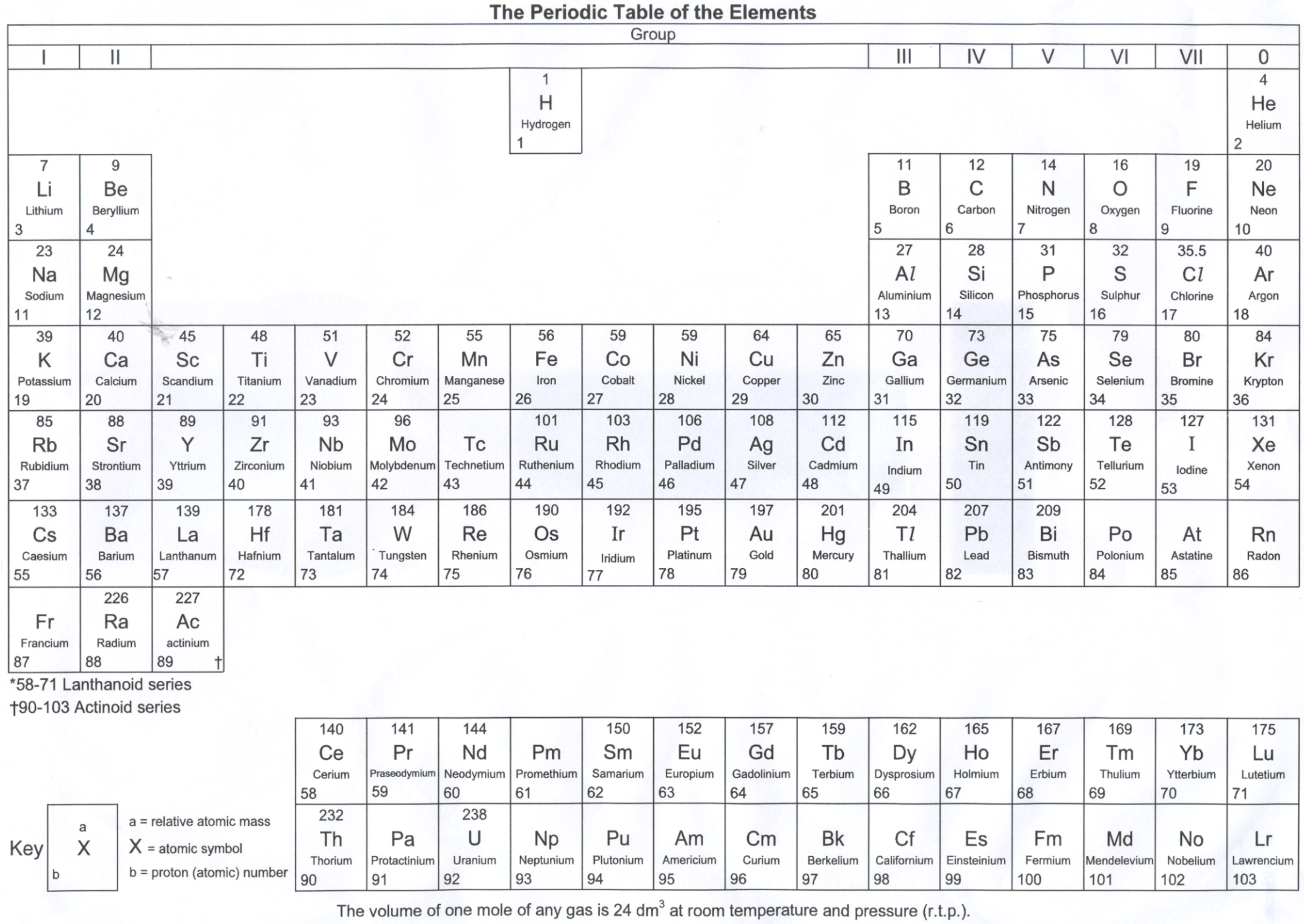


How many of these monomers could react with the molecule below to form a polymer?

A 1
B 2
C 3
D 4

Colours of Some Common Metal Hydroxides

aluminium hydroxide	white
calcium hydroxide	white
copper(II) hydroxide	light blue
iron(II) hydroxide	green
iron(III) hydroxide	red-brown
lead(II) hydroxide	white
zinc hydroxide	white



The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 H Hydrogen 1										4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulphur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radium 88	227 Ac actinium 89 †															

*58-71 Lanthanoid series
†90-103 Actinoid series

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

Key

a X b

a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

Name: _____________________________(   )   Class:______

CHIJ KATONG CONVENT
PRELIMINARY EXAMINATIONS 2017
Secondary Four Express

CHEMISTRY (WITH SPA) 5073

Duration: 1 hour 45 minutes

Class: 406

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your name, registration number and class on all the work you hand in.
You may use a soft pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid/ tape.
The use of an approved scientific calculator is expected, where appropriate.

Section A
Answer **all** questions.
Write your answers in the spaces provided on the Question Paper.

Section B
Answer **all** three questions, the last question is in the format of either/or.
Answer **all** questions in the spaces provided.

At the end of the examination fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Data Sheet is printed on page 21.
A copy of the Periodic Table is printed on page 22.

The use of an approved scientific calculator is expected, where appropriate.

FOR EXAMINER'S USE	
Paper 1	/ 40
Section A	/ 50
Section B	/ 30
TOTAL	/ 120

This question paper consists of **22** printed pages.

Section A [50 marks]

Answer **all** the questions in this section.
Write your answers in the spaces provided.

1 The head of a match stick contains potassium chlorate and antimony sulfide.

(a) Antimony sulfide are added to matches to help them burn more vigorously. Part of its chain structure is shown in Fig. 1.1.

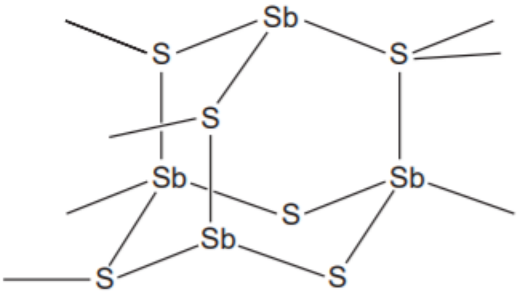


Fig. 1.1

With reference to its structure and bonding, explain why antimony sulfide has a high melting point.

………

………

………

…………………………………………………………………………………………………….....[2]

(b) When a match is struck on the side of the box, the friction produces enough heat to light the match. The equation for the reaction is:

$$5KClO_3 + 6P \rightarrow 5KCl + 3P_2O_5$$

(i) Explain, in terms of oxidation state, why potassium chlorate is the oxidising agent in the reaction.

……………………………………………………………………………………………………..

……………………………………………………………………………………………………[1]

1 **(b)** **(ii)** One of the products, phosphorus(V) oxide, P_2O_5, absorbs moisture from the air to form metaphosphoric acid, HPO_3. On addition of more water, phosphoric acid, H_3PO_4, is formed.

Predict and explain the electrical conductivity of the acids formed.

……

……

……

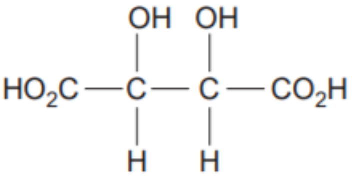
……………………………………………………………………………………………………[2]

(iii) Show by calculation, which of these acids, HPO_3 or H_3PO_4, contains the greater percentage of phosphorus by mass.

[2]

[Total: 7]

2 Tartaric acid is an organic acid extracted from grape juice. Its structure is shown in Fig. 2.1.



$HO_2C-C(OH)(H)-C(OH)(H)-CO_2H$

Fig. 2.1

(a) Tartaric acid is an example of a weak acid.

Explain what is meant by a *weak acid*.

……

……………………………………………………………………………………………………[1]

2 **(b)** Describe a simple test to show that tartaric acid is a weak acid.

………

………

………

……………………………………………………………………………………………………….....…[2]

(c) A solution of tartaric acid was titrated with 0.100 mol/dm^3 potassium hydroxide. Potassium tartrate and water are the products obtained.

$$C_2H_2(OH)_2(CO_2H)_2 + 2KOH \rightarrow C_2H_2(OH)_2(CO_2K)_2 + 2H_2O$$

(i) 6.00 cm^3 of aqueous potassium hydroxide was required to neutralise 20.0 cm^3 of tartaric acid.

Calculate the concentration, in mol/dm^3, of the tartaric acid solution.

[2]

(ii) Describe how a dry solid sample of the salt produced could be obtained from the products of the reaction.

……………………………………………………………………………………………………..

……………………………………………………………………………………………………..

……………………………………………………………………………………………………..

……………………………………………………………………………………………………[2]

[Total: 7]

3 Titanium (melting point of 1688 °C) can be extracted from its ore, rutile. Fig. 3.1 shows how titanium metal is extracted from rutile.

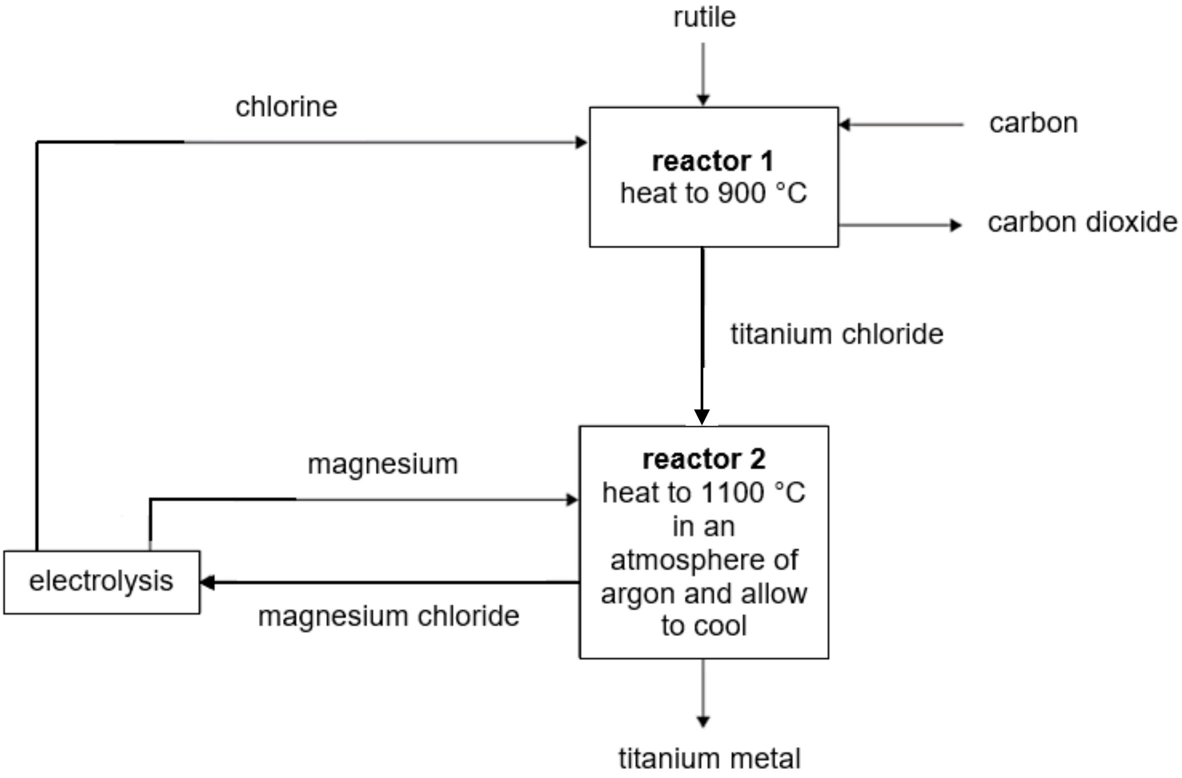


Fig. 3.1

(a) Using the information provided, arrange carbon, magnesium and titanium in increasing order of reactivity.

………

………[1]

(b) Describe an example of recycling in the extraction of titanium.

………

………[1]

(c) Explain why an atmosphere of argon must be used in reactor 2.

………

………

………

………[2]

3 **(d)** Fig. 3.2 shows how the mass of titanium metal produced changes with different mass of pure and impure rutile.

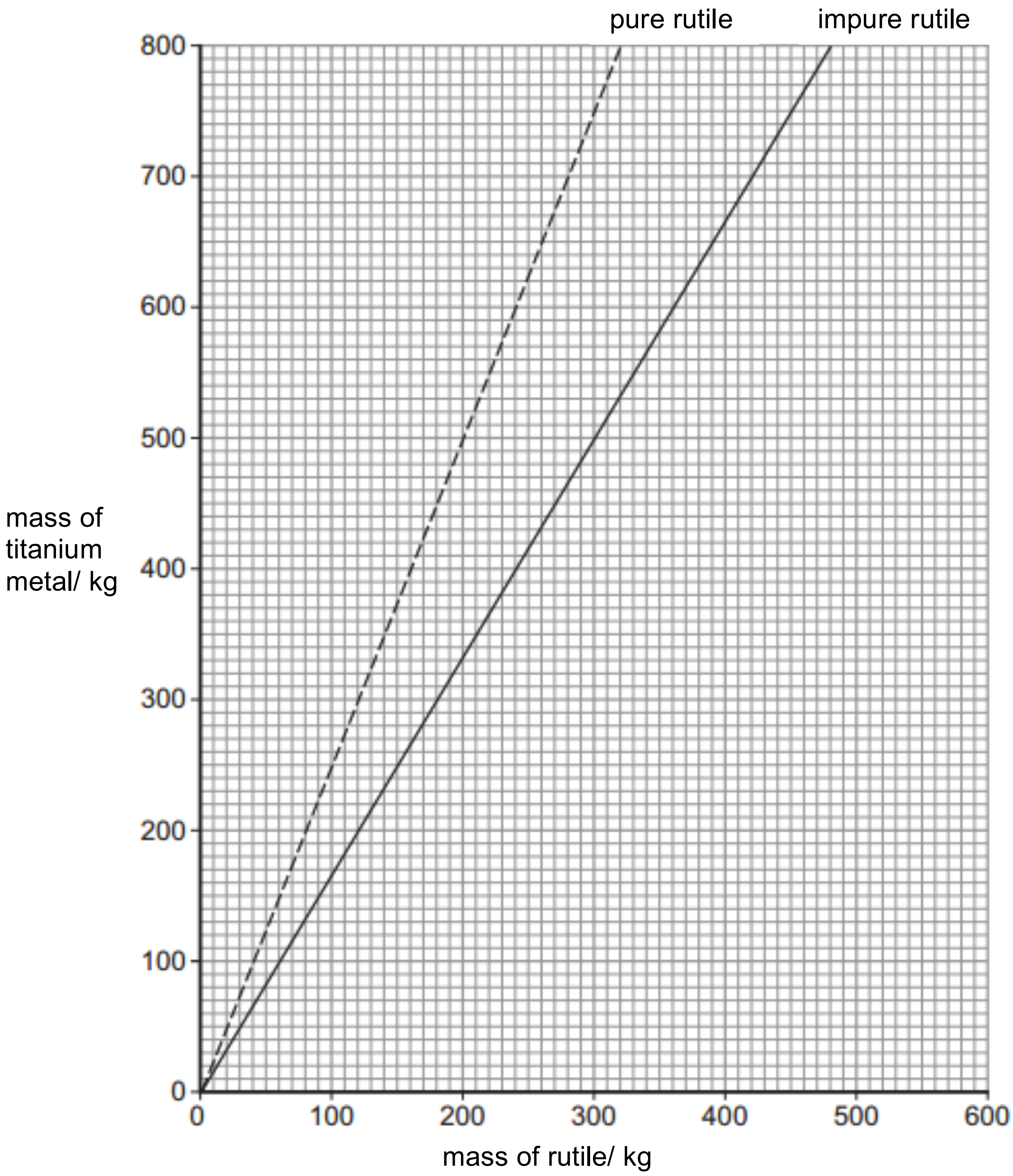


Fig. 3.2

(i) State the mass of titanium that can be obtained from 200 kg of pure rutile.

…………………………………………………………………………………….…......…….[1]

3 **(d)** **(ii)** Calculate the percentage purity of rutile in the impure ore for the same mass of titanium obtained.

[1]

(e) Describe how the titanium produced in reactor 2 can be separated from magnesium chloride.

………

………

………

……[2]

[Total: 8]

4 Heat packs are commonly used by walkers and climbers as hand or body warmers. One of the ingredients found in heat packs is powdered iron.

All the ingredients are contained in a plastic bag. When the bag is opened, air enters the pack and it slowly heats up and remains at a temperature of about 40 °C for several hours. The equation represents the chemical reaction taking place in the heat pack.

$$4Fe + 3O_2 + 5H_2O \rightarrow 2Fe_2O_3.5H_2O$$

(a) Identify the substance that is oxidised during the reaction. Explain your answer in terms of electrons transfer.

………

……[2]

(b) Sketch a labelled energy profile diagram for the reaction taking place in the heat pack, indicating clearly the reactants, products, activation energy (E_a), and enthalpy change (ΔH).

[2]

4 **(c)** In certain brands of the heat pack, a carbon catalyst is added to it.

Explain, in terms of the collision theory, why is the carbon catalyst added to the heat pack.

………

………

………

………..[3]

[Total: 7]

5 Some metal carbonates, when heated, decompose to produce carbon dioxide. Fig. 5.1 shows the results from an investigation on the rate of decomposition of four metal carbonates. In each experiment, 1.00 g of metal carbonate was heated to the same temperature using flame of the same intensity. The volume of carbon dioxide produced was measured at every minute interval.

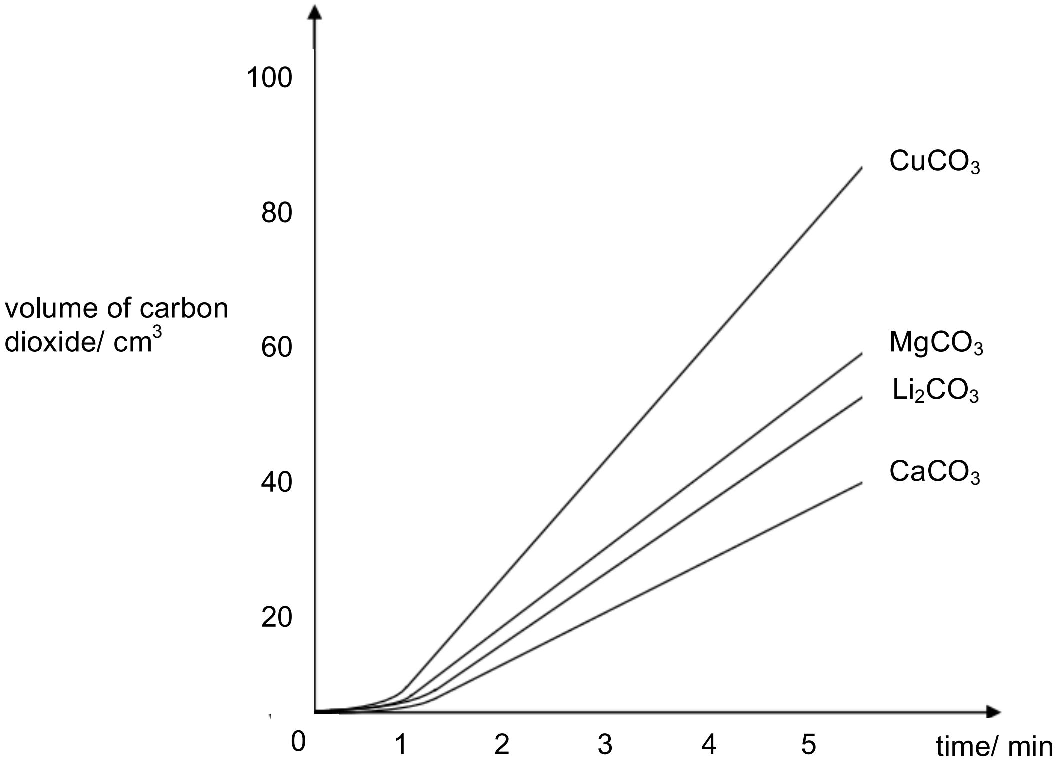


Fig. 5.1

(a) Explain why very little carbon dioxide was collected at the start of each experiment.

………

………..[1]

5 **(b)** Using Fig. 5.1, explain why the decomposition of metal carbonates was not complete at the end of the investigation.

………

………[1]

(c) Using only information from Fig. 5.1, state and explain which metal carbonate decomposed at the fastest rate.

………

………

………

………[2]

(d) Describe and explain how the volume of carbon dioxide will change with time if sodium carbonate was used for the experiment.

………

………

………

………[2]

[Total: 6]

6 The amount of carbon monoxide present in air can be detected and measured by the reaction with a white crystalline solid called iodine pentoxide, I_2O_5. The chemical equation for the reaction is given as:

$$5CO(g) + I_2O_5(s) \rightarrow I_2(s) + 5CO_2(g)$$

(a) Describe a change that can be observed for the reaction.

………[1]

(b) State a source of carbon monoxide and explain how it is produced.

………

………

………

………[2]

6 **(c)** Explain why it is important to have a reliable chemical test for carbon monoxide.

………

………

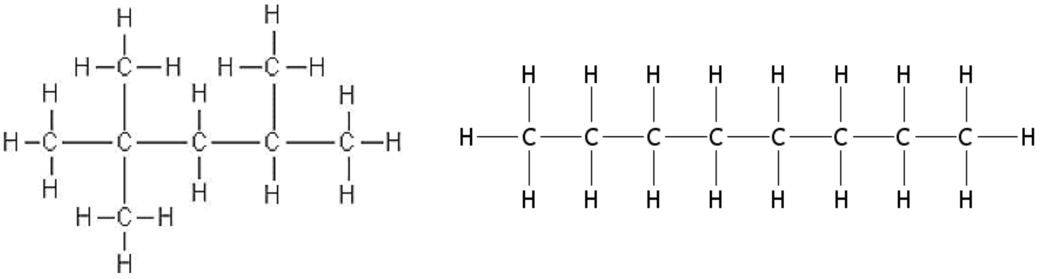
………

………[2]

[Total: 5]

7 **(a)** 2,2,4-trimethylpentane, also known as isooctane, is an isomer of octane C_8H_{18}.

The structures of isooctane and octane are shown in Fig. 7.1.



isooctane octane

Fig. 7.1

The enthalpy changes of combustion and boiling points for isooctane and octane are given in the Table 7.1.

Table 7.1

hydrocarbon	enthalpy change of combustion/ kJ mol^{-1}	boiling point/ °C
isooctane	- 5460	99.3
octane	- 5460	126.1

(i) Write a balanced equation for the complete combustion of isooctane.

……………………………………………………………………………………………[1]

(ii) Suggest why the enthalpy change of combustion for isooctane and octane are the same.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………[2]

7 **(a)** **(iii)** Suggest why the boiling points for isooctane and octane are different.

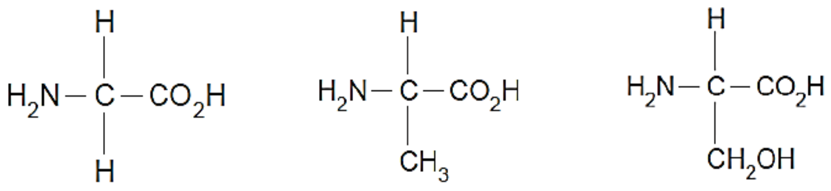
………

………

………

………[2]

(b) Spider silk is composed of polyamide chains mainly made from amino acids. Fig. 7.2 shows the structural formula of the three main amino acids, glycine, alanine and serine, found in spider silk.



glycine alanine serine

Fig. 7.2

(i) Assuming spider silk is made from repetitive sequences of –glycine–alanine–serine–, draw the structural formula of the repeat unit of the polyamide chain.

[2]

(ii) The M_r of each polyamide chain is about 600 000.

Assuming the polyamide chain is made from equal amounts of the above three amino acids, calculate the average number of amino acids monomers in each polyamide chain.

[3]

[Total: 10]

Name:______________________________ (   ) Class: _________

Section B [30 marks]

Answer **three** questions.
Question **10** is in the form of an **Either/Or** question. Only one part should be answered.
Write your answers in the spaces provided.

8 Dilute aqueous sodium chloride forms hydrogen and oxygen during electrolysis. Fig. 8.1 shows an electrolytic cell used for the process.

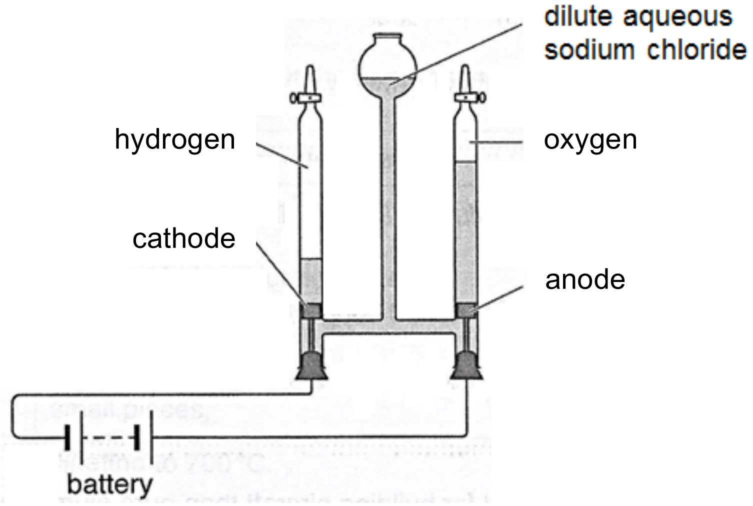


Fig. 8.1

(a) Write ionic equations for the reactions at the cathode and anode.

cathode: ……………………………………………………………………………………………………

anode: ……………………………………………………………………………………………………[2]

(b) The gases are collected and their volumes are measured. In theory, the ratio of hydrogen and oxygen should be 2:1.

Oxygen is more soluble than hydrogen in water. This changes the ratio of gases that are collected.

(i) Using the transfer of electrons, explain why the theoretical ratio of hydrogen to oxygen is 2:1.

……………………………………………………………………………………………………

……………………………………………………………………………………………………[1]

8 **(b)** **(ii)** Explain how and why the solubility of oxygen affects the ratio of hydrogen to oxygen that is collected.

……………………………………………………………………………………………………….

……………………………………………………………………………………………………….

……………………………………………………………………………………………………….

……………………………………………………………………………………………………[2]

(iii) The deviation from the expected ratio is more obvious at the start of electrolysis, but becomes less noticeable after the electrolysis has been running for some time.

Suggest a reason why this happens.

……………………………………………………………………………………………………….

……………………………………………………………………………………………………….

……………………………………………………………………………………………………….

……………………………………………………………………………………………………[2]

(c) Describe and explain the changes to the concentration of sodium chloride during the electrolysis.

……………………………………………………………………………………………………….

……………………………………………………………………………………………………[1]

(d) The same apparatus can be used to electrolyse concentrated aqueous sodium chloride.

State one difference between the products obtained from the electrolysis of concentrated and dilute aqueous sodium chloride.

……………………………………………………………………………………………………….

……………………………………………………………………………………………………[1]

(e) Suggest why inert electrodes are used for the electrolysis.

……………………………………………………………………………………………………….

……………………………………………………………………………………………………[1]

[Total: 10]

9 The first ionisation energy of elements is the energy required to remove one mole of electrons from one mole of gaseous atoms to form one mole of gaseous ions with a charge of +1.

This can be represented by the equation:

$$Na(g) \rightarrow Na^{+}(g) + e^{-} \qquad \Delta H = +494 \text{ kJ/mol}$$

The second ionisation energy of elements is the energy required to remove one mole of electrons from one mole of gaseous ions with a charge of +1 to form one mole of gaseous ions with a charge of +2.

This can be represented by the equation:

$$Na^{+}(g) \rightarrow Na^{2+}(g) + e^{-} \qquad \Delta H = +4562 \text{ kJ/mol}$$

Hence, the energy required to remove 2 moles of electrons from 1 mole of gaseous sodium atoms is 494 + 4562 = 5056 kJ/mol.

Table 9.1 shows the first and second ionisation energy for Group I elements, while Table 9.2 shows the first and second ionisation energy for Group II elements.

Table 9.1

element	first ionisation energy/ kJ mol^{-1}	second ionisation energy/ kJ mol^{-1}
lithium	520	7298
sodium	496	4562
potassium	419	3052
rubidium	403	2633
caesium	376	2234

Table 9.2

element	first ionisation energy/ kJ mol^{-1}	second ionisation energy/ kJ mol^{-1}
beryllium	900	1757
magnesium	737	1451
calcium	590	1145
strontium	550	1064
barium	503	965

9 **(a)** Describe and explain the trend in ionisation energy down Group I and II.

………

………

………

………

………

………[3]

(b) **(i)** Write the electronic configurations for sodium and magnesium atoms.

Na: ……………………………………………………………………………………………………

Mg: ……………………………………………………………………………………………………[1]

(ii) Using your answer in **(b)(i)**, suggest why the difference between the first and second ionisation energy is significantly higher for sodium than magnesium.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………[2]

(c) Write a balanced equation, including state symbols, for the third ionisation energy of sodium.

………[1]

(d) Calculate the energy required for 12 g of magnesium atoms to form Mg^{2+} ions.

[3]

[Total: 10]

10 Either

Ammonia can be manufactured using the Haber process. The percentage yield of ammonia using different temperatures and pressures are shown in the Table 10.1.

Table 10.1

pressure/ atm	ammonia yield/ %				
	100 °C	200 °C	300 °C	400 °C	500 °C
10	88.2	50.7	14.7	3.9	1.2
25	91.7	63.6	27.4	8.7	2.9
50	94.5	74.0	39.5	15.3	5.6
100	96.7	81.7	52.5	25.2	10.6
200	98.4	89.0	66.7	38.8	18.3
400	99.4	94.6	79.7	55.4	31.9
1000	99.9	98.3	92.6	79.8	57.5

(a) Describe how the percentage yield of ammonia is affected by

(i) increasing temperature,

……………………………………………………………………………………………………

……………………………………………………………………………………………………[1]

(ii) decreasing pressure.

……………………………………………………………………………………………………

……………………………………………………………………………………………………[1]

(b) **(i)** With reference to the information provided, state the optimum conditions for the Haber process.

……………………………………………………………………………………………………[1]

(ii) Explain why the conditions stated in **(b)(i)** are not used commercially.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………[2]

10 **(c)** The ammonia manufactured in Haber Process can be used to prepare nitric acid in another reaction called the Ostwald Process. This process converts ammonia into nitric acid in a three-step reaction.

Step 1: $4NH_3 (g) + 5O_2 (g) \rightleftharpoons 4NO (g) + 6H_2O (g)$

Step 2: $2NO (g) + O_2 (g) \rightleftharpoons 2NO_2 (g)$

Step 3: $3NO_2 (g) + H_2O (l) \rightarrow 2HNO_3 (aq) + NO (g)$

(i) Explain why the products of the Ostwald Process are not wasted.

………

………[1]

(ii) It is possible to monitor the progress of the Ostwald Process by measuring pH changes during the process.

State and explain the changes in pH before the start of step 1 and at the end of step 2.

………

………

………

………[2]

(iii) Calculate the maximum mass of nitric acid which can be made from 840 dm^3 of ammonia at room temperature and pressure.

[2]

[Total: 10]

10 OR

Perfumes usually contain three classes of compounds called top notes, middle notes and end notes.

(a) Top notes consist of small, light molecules that evaporate quickly. An example of a top note is styrallyl acetate as shown in Fig. 10.1.

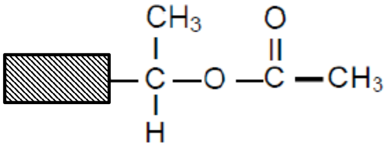


Fig. 10.1

(i) With reference to its structure, explain why the compound is likely to have a pleasant smell.

……………………………………………………………………………………………………

……………………………………………………………………………………………………[1]

(ii) Draw the structural formulae of the two compounds that are needed to form styrallyl acetate.

[2]

10 **(b)** Middle notes vapourise less readily than the top notes. A typical middle note is 2-phenylethanol. The structure of 2-phenylethanol is as shown in Fig. 10.2.

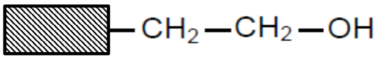


Fig. 10.2

Describe a chemical test to distinguish between styrallyl acetate and 2-phenylethanol.

……

……

……

……

……

……………………………………………………………………………………………………[3]

(c) End notes of a perfume are responsible for the long lasting odour which stays with the user. The structural formula of a typical end note is as shown in Fig. 10.3.

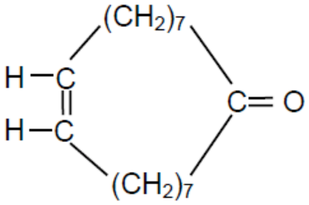


Fig. 10.3

(i) Explain why the end note is an unsaturated compound.

……

……………………………………………………………………………………………………[1]

(ii) Draw the structural formula of the product formed when the end note undergoes hydrogenation.

[1]

10 **(c)** **(iii)** Iodine value is a measure of how unsaturated a compound is. It is the mass, in grams, of iodine that reacts with 100 g of the compound.

Calculate the iodine value for the end note.

[2]

[Total: 10]

Colours of Some Common Metal Hydroxides

aluminium hydroxide	white
calcium hydroxide	white
copper(II) hydroxide	light blue
iron(II) hydroxide	green
iron(III) hydroxide	red-brown
lead(II) hydroxide	white
zinc hydroxide	white

The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
						1 H Hydrogen 1											4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulphur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radium 88	227 Ac actinium 89 †															

*58-71 Lanthanoid series
†90-103 Actinoid series

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

Key

a X b

a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

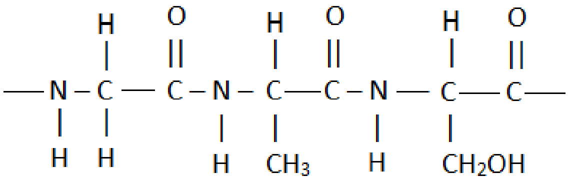
The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

4E Chemistry Preliminary 2017 answer scheme

1	B	**2**	B	**3**	D	**4**	D	**5**	B
6	A	**7**	B	**8**	A	**9**	B	**10**	C
11	A	**12**	C	**13**	D	**14**	B	**15**	D
16	C	**17**	B	**18**	A	**19**	C	**20**	C
21	A	**22**	C	**23**	C	**24**	C	**25**	D
26	D	**27**	B	**28**	C	**29**	D	**30**	C
31	C	**32**	B	**33**	D	**34**	A	**35**	B
36	B	**37**	A	**38**	B	**39**	B	**40**	C

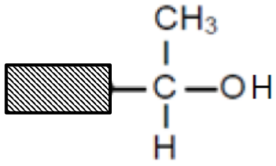
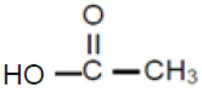
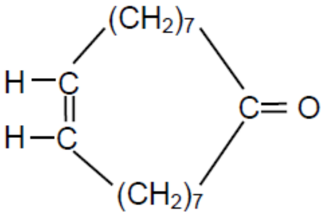
Section A (50 marks)		
Qn no	**Answer**	Marks/ Remarks
1(a)	Giant molecular structure with strong covalent bonds between antimony and sulfur atoms; A lot of energy needed to overcome the strong forces of attraction;	[1] [1]
1(b)(i)	Oxidation state of phosphorus increased from 0 in phosphorus to +5 in phosphorus(V) oxide;	[1]
1(b)(ii)	Electrical conductors/ can conduct electricity; They have mobile ions in the aqueous state/ when dissolved in water to serve as charge carriers; A: poor/low electrical conductivity A: if only mention mobile H^+ ions R: mobile electrons	[1] [1]
1(b)(iii)	% P in HPO_3 = 31/80 x 100% = 38.75% OR 38.8% (3 sf); % P in H_3PO_4 = 31/98 x 100% = 31.63% OR 31.6% (3 sf); Note: no working no mark R: fractions	[1] [1]
2(a)	An acid which dissociates/ionises partially in water to produce H^+ ions;	[1]
2(b)	Add a few drops of universal indicator to a sample of the acid; Green universal indicator/colourless solution will turn orange/yellow; A: use a pH meter to measure pH of tartaric acid, methyl orange (1m) R: red	[1] [1]
2(c)(i)	No. of mole of KOH = 0.100 x (6/1000) = 0.0006 mol; No. of mole of tartaric acid = 0.0006/2 = 0.0003 mol Conc. of tartaric acid = 0.0003 x (1000/20) = 0.015 mol/dm^3;	[1] [1]

2(c)(ii)	Heat the salt solution obtained to saturation; Cool and allow crystallisation to take place; Filter to obtain the crystals; Wash with distilled water, dry between pieces of filter paper;	[1] for 2 points in logical sequence
3(a)	Titanium, carbon, magnesium;	[1]
3(b)	The magnesium chloride produced in reactor 2 is collected and electrolysed to produce magnesium metal which is then used to react with titanium chloride again; OR Chlorine produced by electrolysis is used to react with rutile to produce titanium chloride in reactor 1;	[1]
3(c)	Argon is used to provide an unreactive/ inert atmosphere; To prevent the oxidation of/ reaction of oxygen with magnesium/ titanium/ titanium chloride; A: ensure that titanium chloride only reacts with magnesium in reactor 2	[1] [1]
3(d)(i)	500 kg;	[1]
3(d)(i)	% purity = 200/300 x 100%; = 66.7% (3 sf)	[1]
3(e)	Wash the mixture with water to dissolve the soluble magnesium chloride; <u>Filter</u> the mixture to obtain titanium as the residue and aqueous magnesium chloride as the filtrate; R: filtration	[1] [1]
4(a)	Iron/Fe; Each Fe atom loses 3 electrons to form Fe^{3+} ions/Fe_2O_3; A: loses electrons to form Fe^{3+}	[1] [1]
4(b)	R: -ΔH	[1] for exo energy profile diagram [1] for all correct labels unlabelled /incorrect axes -1m
4(c)	Catalyst allows the pack to heat up faster; More colliding particles possess energy equal to or greater than activation energy; Frequency of effective collisions increases, speed of reaction increases; R: more effective collisions, number of effective collisions increases	[1] [1] [1]

5(a)	Energy was still being absorbed to overcome the activation energy/ most reactant particles have insufficient activation energy to undergo decomposition; A: little or not enough energy for decomposition	[1]
5(b)	Volume of carbon dioxide has not reached a constant/ is still increasing at the end of 5 minutes; A: CO_2 was still being produced	[1]
5(c)	Copper(II) carbonate/ $CuCO_3$; Highest volume of carbon dioxide produced per unit time; A: copper carbonate A: most carbon dioxide produced throughout the experiment	[1] [1]
5(d)	No carbon dioxide will be collected as time pass; Sodium carbonate is stable to heat/ does not decompose upon heating; R: less/little carbon dioxide, no change in volume of carbon dioxide, volume of carbon dioxide collected will be a horizontal/straight line R: very hard/hard to decompose sodium carbonate, sodium is heat stable	[1] [1]
6(a)	White solid turns purplish-black/black/purple; A: solid turns purplish-black/black/purple R: a black solid is formed	[1]
6(b)	Incomplete combustion of fossil fuels; When there is insufficient oxygen; A: alkanes, alkenes, carbon containing substances/fuels, carbon R: air for oxygen	[1] [1]
6(c)	Carbon monoxide is a colourless and odourless gas; Can cause death at high levels within minutes/ breathing difficulties/ binds to haemoglobin to form carboxyhaemoglobin;	[1] [1]
7(a)(i)	$2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$;	[1]
7(a)(ii)	The number of C-H and C-C bonds broken, as well as the number of C=O and O-H bonds formed are the same for both hydrocarbons; Same amount of energy taken in/absorbed and given out/released; R: same number of bonds/same bonds are broken and formed	[1] [1]
7(a)(iii)	Less intermolecular forces of attraction between isooctane molecules; Less energy needed to overcome the intermolecular forces; R: weaker intermolecular forces of attraction	[1] [1]
7(b)(i)	 [1]: 2 proper amide linkages [1]: consists of 1 glycine, 1 alanine, 1 serine	if polymer -1m
7(b)(ii)	Mr of repeat unit = 215; Number of repeat units = 600 000/215; Number of amino acids = 2790.7 x 3 = 8372.1 = 8372; R: 8373	[1] [1] [1] allow ECF

Section B (30 marks)		
Qn no	Answer	Marks/ Remarks
8(a)	cathode: $2H^+(aq) + 2e^- \rightarrow H_2(g)$; anode: $4OH^-(aq) \rightarrow O_2(g) + 2H_2O(l) + 4e^-$; A: if all state symbols missing R: wrong state symbol(s), partial state symbols	[1] [1]
8(b)(i)	For every mole of water electrolysed, 4 mole of electrons are transferred from hydroxide ions to hydrogen ions to form 2 mole of hydrogen gas and 1 mole of oxygen gas;	[1]
8(b)(ii)	The hydrogen to oxygen ratio increases/ oxygen to hydrogen ratio decreases; Less oxygen collected/ more oxygen dissolves in solution compared to hydrogen;	[1] [1]
8(b)(iii)	Solution becomes saturated with oxygen; Oxygen no longer dissolves in solution and is collected as gas; A: oxygen cannot dissolve into the solution anymore	[1] [1]
8(c)	Concentration of sodium chloride increases as water is being used up; A: water is being removed from solution, OH^- and H^+ ions are removed/used up/discharged from the solution	[1]
8(d)	Chlorine gas produced at the anode for concentrated sodium chloride compared to oxygen gas and water for dilute sodium chloride; A: chloride gas produced at anode instead of oxygen gas, aqueous NaOH produced in the electrolysis of concentrated $NaCl$ but not for dilute $NaCl$	[1]
8(e)	To prevent the electrodes from reacting with the electrolytes or the products formed/ prevent the electrodes from dissolving into the solution; A: prevent reaction with solution/ions of solution, so they do not take part in reactions A: if students assume electrolysis of conc. $NaCl$ then accept prevention of reaction with chlorine only (R: chloride)	[1]
9(a)	Ionisation energy decreases down Group I and II; Down the group, electron to be removed/valence electron is found further away from the nucleus; Less energy is needed to overcome electrostatic forces of attraction between nucleus and electron to be removed/ electrostatic forces of attraction between nucleus and electron is weakened; A: forces of attraction R: bonds for forces of attraction, break for overcome, less electrostatic forces of attraction, electrostatic forces of attraction decreases, nucleon for nucleus, neutron for nucleus	[1] [1] [1]
9(b)(i)	Sodium: 2,8,1; Magnesium: 2,8,2;	[1]
9(b)(ii)	The two electrons to be removed for sodium are third and second electron shells; Those of magnesium are from the third electron shell; OR Removing the second electron will disrupt the stable electronic configuration of sodium ion Removing the second electron will give magnesium ion the stable electronic configuration;	[1] [1] [1] [1]

	OR More energy needed to remove second electron from sodium once stable/full/octet configuration is attained; Less energy needed to remove second electron of magnesium as it will achieve the stable/full/octet configuration;	[1] [1]
9(c)	$Na^{2+}(g) \rightarrow Na^{3+}(g) + e^-$; R: missing/wrong state symbol(s)	[1]
9(d)	Number of moles in 12 g of Mg = 12/24 = 0.5 mol Energy required to remove 2 electrons from 1 mol of Mg = 737 + 1451 = 2188 kJ; Energy required to form 12 g of Mg^{2+} ions = 2188 x 0.5 = 1094 kJ; R: wrong unit	[1] [1] [1]
10Either		
(a)(i)	Percentage yield of ammonia drops as temperature increases;	[1]
(a)(ii)	Percentage yield of ammonia decreases as pressure decreases;	[1]
(b)(i)	100 °C, 1000 atm;	[1]
(b)(ii)	Extremely high pressure of 1000 atm is operationally dangerous/ may cause explosion of the reaction vessel/ incurs high maintenance cost; Speed of reaction is too slow at 100 °C; A: costly to maintain pressure at 1000 atm and 100 °C(1m)	[1] [1]
(c)(i)	Nitrogen monoxide produced in step 3 can be used for step 2; R: water produced in step 1 can be used for step 3 R: products from each step can be used for the next step R: products can be reused for other steps	[1]
(c)(ii)	pH is above 7 before the start of step 1 while pH is below 7 at the end of step 2; Ammonia gas present at the start is alkaline while nitrogen dioxide produced at the end is acidic;	[1] [1]
(c)(iii)	No. of moles of ammonia = 840/24 = 35 mol; No. of moles of nitric acid = 35 x (2/3) = 23.33 mol Mass of nitric acid = 23.33 x (1+14+16x3) = 1470 g;	[1] [1]

10Or		
(ai)	It has the ester functional group; A: ester linkage	[1]
(aii)	Alcohol  Carboxylic acid  $\mathrm{HO-\overset{\overset{O}{\|}}{C}-CH_3}$	[1] [1]
(b)	Add acidified potassium manganate(VII) to both solutions; If purple solution turns colourless, the sample is middle note/2-phenylethanol; If purple solution remains purple, the sample is top note/styrallyl acetate; OR Add acidified potassium dichromate(VI) solution to each sample, if the solution turned from orange to green, the sample is middle note or if the solution remained orange, the sample is top note.	[1] [1] [1]
(ci)	It has a carbon-carbon double bond;	[1]
(cii)		[1]
(ciii)	1 mol of end note reacts with 1 mol of iodine. No. of mole of end note = 100/250 = 0.4 mol; No of mole of iodine = 0.4 mol Mass of iodine =0.4 x 2 x 127 =101.6 g; R: missing unit	[1] [1]

CHIJ ST. THERESA'S CONVENT
PRELIMINARY EXAMINATION 2017
SECONDARY FOUR EXPRESS

CANDIDATE NAME			
CLASS		INDEX NUMBER	

CHEMISTRY 5073/01

Paper 1 Multiple Choice

18 September 2017

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, class and index number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **forty** questions on this paper. Answer **all** questions. For each question, there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

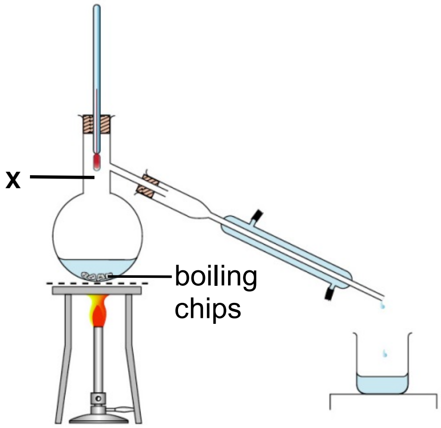
Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 16.
The use of an approved scientific calculator is expected, where appropriate.

This question paper consists of **16** printed pages.

1 The diagram below shows the distillation of a mixture of two liquids A and B.

The liquid A has a boiling point of 80°C and the liquid B has a boiling point of 110°C.



Which statement about the experiment is correct?

A The boiling chips are added to increase the rate of reaction.

B The liquid left in the flask contains more A than B.

C The thermometer records a constant temperature as each liquid is collected.

D The vapour at point X always contains more B than A.

2 The solubilities of three solids in water and tetrachloromethane are given in the table below.

solid	**solubility in water**	**solubility in tetrachloromethane**
sand	nil	nil
sodium chloride	good	nil
sulfur	nil	good

Which method would be suitable for obtaining **pure sand** from a mixture of sand, sodium chloride and sulfur?

A Add tetrachloromethane and stir; then filter.

B Add tetrachloromethane and stir; then filter, then add the residue to water and stir; and then filter this mixture and collect the residue.

C Add water and stir; then filter; then evaporate the filtrate to dryness.

D Add water and stir; then filter; then add tetrachloromethane to the filtrate and stir; then evaporate the solvent.

3 When a few drops of nitric acid and aqueous barium nitrate were added to a solution of substance C, a white precipitate was seen. When aqueous sodium hydroxide was added to solution of substance C, a white precipitate that was insoluble in excess sodium hydroxide was seen.

What could C be?

A aluminium carbonate
B calcium sulfate
C lead(II) sulfate
D zinc chloride

4 An experiment was carried out on three gases, D, E and F, which have relative molecular masses of 17, 28 and 71 (not necessarily in the correct order).

gas	effect on damp litmus paper
D	no effect on blue and red litmus paper
E	turns damp blue litmus paper red, then white
F	turns damp red litmus paper blue

Which row correctly shows the order of the rates of diffusion of the three gases?

	slowest	→	fastest
A	D	E	F
B	E	D	F
C	E	F	D
D	F	D	E

5 Manganese sulfide, MnS is a pink solid that contains ${}^{55}_{25}\text{Mn}^{2+}$ and ${}^{32}_{16}\text{S}^{2-}$ ions.

How many **more** protons, neutrons and electrons are there in the ${}^{55}_{25}\text{Mn}^{2+}$ ion as compared to the ${}^{32}_{16}\text{S}^{2-}$ ion?

	protons	**neutrons**	**electrons**
A	9	14	5
B	9	14	9
C	9	23	9
D	11	23	9

6 Which statements correctly describe the properties of the compound copper(II) sulfide, CuS, and mixtures of copper and sulfur?

	compound copper(II) sulfide	mixtures of copper and sulfur
1	copper and sulfur react when heated to form copper(II) sulfide	copper and sulfur mix together without any heat energy absorbed or released
2	the ratio of copper to sulfur is always 1 : 1	the ratio of copper to sulfur in mixtures can vary
3	copper(II) sulfide has the same properties as copper and sulfur	the mixtures do not have the same properties as copper and sulfur

A 1 only **B** 1 and 2 **C** 2 and 3 **D** 1, 2, and 3

7 Which compound contains both ionic and covalent bonds?

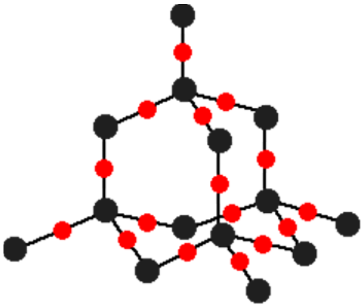
A ammonia

B ethyl ethanoate

C potassium nitrate

D sodium chloride

8 The diagram below shows part of the structure of silicon carbide.



Which row correctly shows the properties of silicon carbide?

	electrical conductivity	**when heated strongly in oxygen**
A	good	burns, giving a solid residue only
B	good	burns, leaving no solid residue
C	poor	burns, giving a solid residue only
D	poor	burns, giving a solid residue and a colourless gas

9 Aluminium carbonate is an unstable compound, which decomposes readily to aluminium hydroxide and carbon dioxide.

$$Al_2(CO_3)_3\,(s) + 3H_2O\,(l) \rightarrow 2Al(OH)_3\,(s) + 3CO_2\,(g)$$

What is the percentage purity of a sample of impure aluminium carbonate if 351 g of the sample produces 36 dm^3 of carbon dioxide?

(M_r of $Al_2(CO_3)_3$ = 234, M_r of CO_2 = 44)

A 13.6%

B 33.3%

C 54.5%

D 100.0%

10 Which of the information below is required to determine the empirical formula and molecular formula of a compound?

1 density of the compound
2 percentage composition of the compound
3 relative molecular mass of the compound

A 1 only **B** 1 and 2 **C** 2 and 3 **D** 1, 2, and 3

11 Which substance has the highest percentage by mass of nitrogen?

A	$CO(NH_2)_2$	M_r = 60
B	NH_4NO_3	M_r = 80
C	$(NH_4)_2SO_4$	M_r = 132
D	$(NH_4)_3PO_4$	M_r = 149

12 The diagram shows the results of an electrolysis experiment using graphite electrodes. Tubes A and B were filled with water at the start of the experiment.

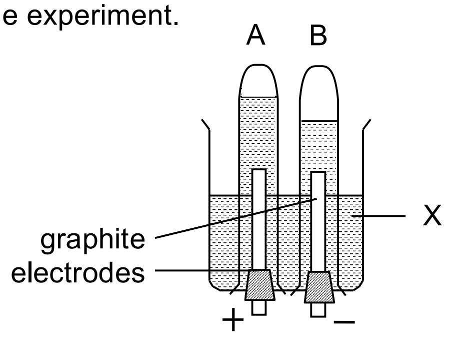
Which could be substance X?

A aqueous silver nitrate

B concentrated sodium chloride solution

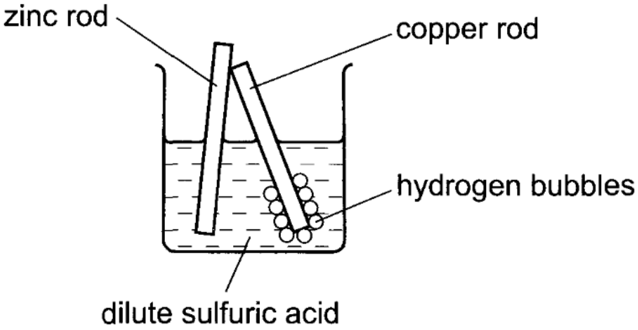
C deionised water

D dilute sulfuric acid



13 In an experiment, rods of copper and zinc are dipped into dilute sulfuric acid, with their top ends touching.

Hydrogen bubbles collect around the copper rod.



Which statement about the experiment is correct?

A Copper reacts with the acid.

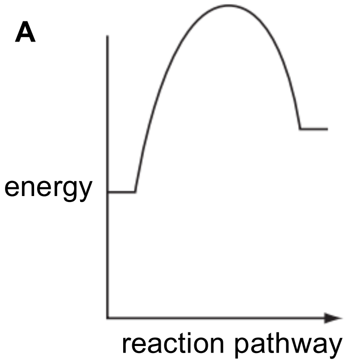
B Electrons flow from zinc to copper.

C The zinc becomes coated with copper.

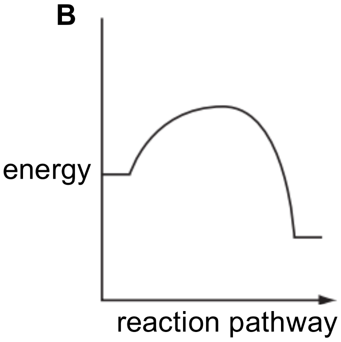
D The zinc is less reactive than copper.

14 Which reaction profile shows the **fastest** exothermic reaction?

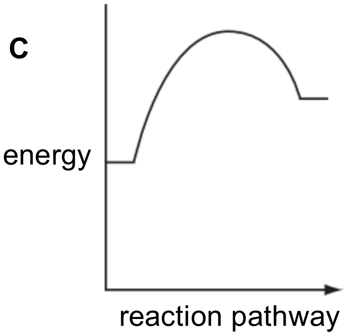
A



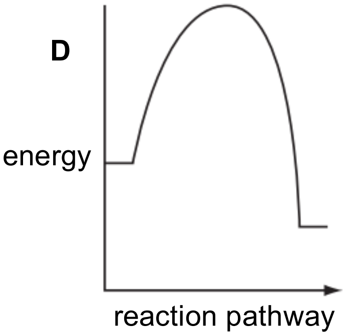
B



C



D



15 Which statement describes what happens when hydrogen and oxygen are used in a fuel cell?

A Hydrogen is reduced.
B Electricity is generated directly.
C Hydrogen is burned to form steam.
D Hydrogen and oxygen react to produce hydrogen peroxide.

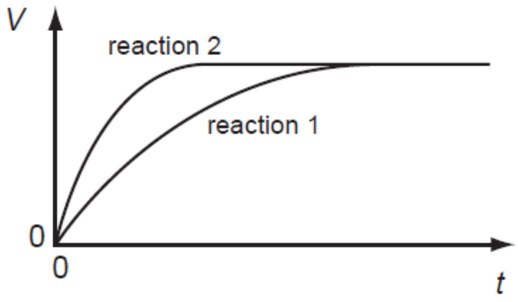
16 A student performs two reactions.

Reaction 1: 10 g of magnesium ribbon with excess 2.0 mol/dm^3 dilute hydrochloric acid
Reaction 2: 5 g of magnesium powder with excess 2.0 mol/dm^3 dilute hydrochloric acid

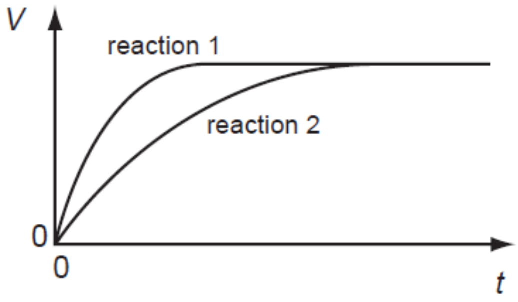
In both experiments, the volume of hydrogen produced, ***V***, is measured against time, ***t***.

Which set of graphs correctly shows the results obtained for the two experiments?

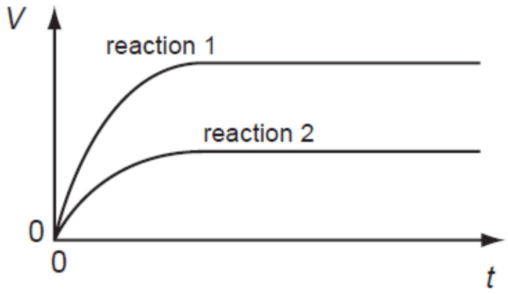
A



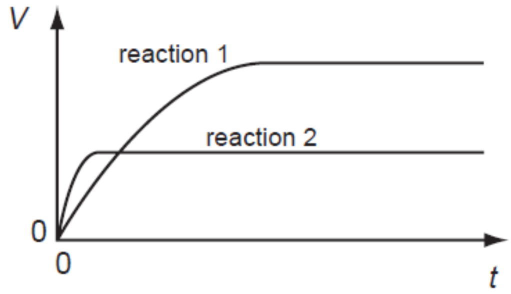
B



C



D



17 Which apparatus should the student use for the two experiments in **Q16**?

P an electronic balance
Q a stopwatch
R a measuring cylinder
S a gas syringe

A P, Q and R **B** P, Q and S **C** Q, R and S **D** P, Q, R and S

18 Which reaction does not involve either oxidation or reduction?

A $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$

B $Cu^{2+}(aq) + Zn(s) \rightarrow Cu(s) + Zn^{2+}(aq)$

C $CuO(s) + H_2SO_4(aq) \rightarrow CuSO_4(aq) + H_2O(l)$

D $Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$

19 Which statement correctly describes an acidic solution?

A It contains hydrogen ions only.

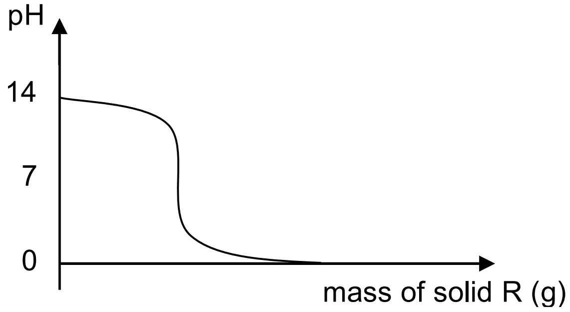
B It contains more hydrogen ions than hydroxide ions.

C It turns blue cobalt chloride paper pink.

D It turns universal indicator blue.

20 Solid R is gradually added to aqueous solution S.

The changes in pH are shown on the graph below.



What are substances R and S?

	substance R	substance S
A	insoluble non-metal oxide	sodium hydroxide
B	soluble metal oxide	aqueous ammonia
C	soluble non-metal oxide	aqueous ammonia
D	soluble non-metal oxide	sodium hydroxide

21 Ammonia may be obtained from ammonium chloride by heating with

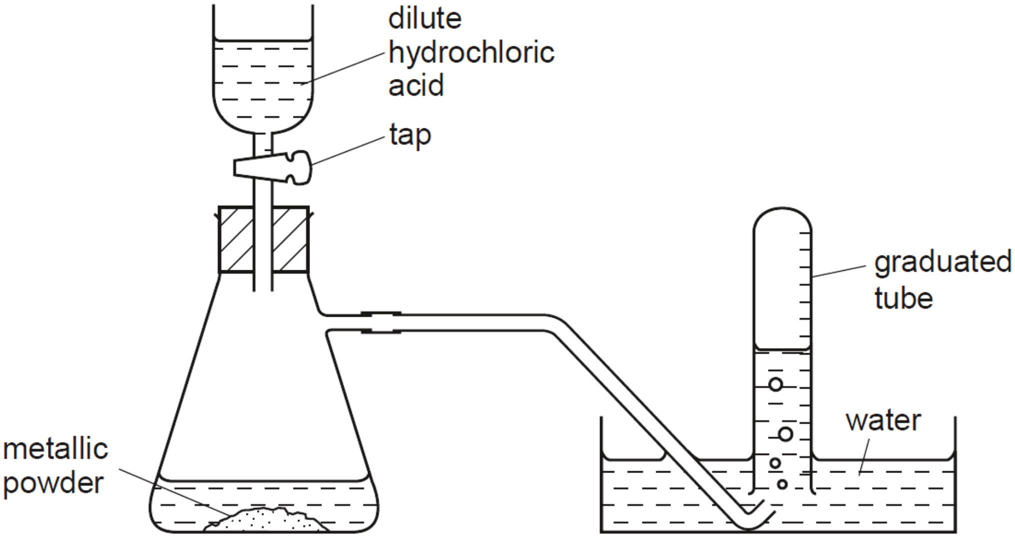
A aqueous barium hydroxide.

B aqueous calcium chloride.

C dilute hydrochloric acid.

D water.

22 The diagram below shows apparatus used to measure the volume of hydrogen given off when an excess of dilute hydrochloric acid is added to powdered metal. The volume of gas is measured at room temperature and pressure.



The experiment is carried out three times, using the same mass of powder each time but with different powders:

- pure calcium
- pure magnesium
- a mixture of calcium and magnesium

Which powder gives the greatest volume of hydrogen and which the least volume?

	greatest volume of H_2	least volume of H_2
A	pure calcium	pure magnesium
B	pure calcium	the mixture of calcium and magnesium
C	pure magnesium	pure calcium
D	pure magnesium	the mixture of calcium and magnesium

23 To reduce atmospheric pollution, the waste gases from a coal-burning power station are 'scrubbed' by passing them through a calcium compound.

Which calcium compound cannot be used?

A calcium carbonate

B calcium hydroxide

C calcium oxide

D calcium sulfate

24 Which element is likely to be sodium?

	melting point in °C	electrical conductivity	density in g / cm^3
A	98	good	0.97
B	113	poor	2.07
C	1083	good	8.92
D	1535	good	7.86

25 The following report appeared in a newspaper.

> Drums of bromine broke open after a vehicle crash on the motorway. Traffic was diverted as purple gaseous bromine drifted over the road (it is denser than air), causing irritation to drivers' eyes. Firemen sprayed water over the scene of the accident, dissolving the bromine and washing it away.

What is wrong with the report?

A Bromine does not dissolve in water.

B Bromine does not vaporise easily.

C Bromine is less dense than air.

D Bromine is not purple in colour.

26 Which oxide is unlikely to dissolve in aqueous sodium hydroxide?

A Al_2O_3 **B** MgO **C** P_4O_{10} **D** SO_2

27 The exhaust systems of most cars are fitted with catalytic converters that contain transition metals as catalysts to decrease the emission of atmospheric pollutants. Platinum and palladium are the two most common elements used. They are found below nickel in the Periodic Table.

Which properties are nickel, palladium and platinum likely to have in common?

1 variable oxidation states

2 high melting points

3 high density

A 1 only **B** 1 and 2 **C** 2 and 3 **D** 1, 2, and 3

28 Which statement correctly describes the elements in Group 0 of the Periodic Table?

A All of their atoms have eight electrons in the outer shell.

B They are colourful gases.

C They are inert and unreactive.

D They exist as diatomic molecules.

29 Some metals can be obtained by the reduction of their oxides with hydrogen.

Which line of the table is correct?

	aluminium	**silver**	**copper**	**sodium**
A	√	√	X	X
B	X	√	√	X
C	X	X	√	√
D	√	X	√	X

√ can be obtained by reduction of oxide with hydrogen

X cannot be obtained by reduction of oxide with hydrogen

30 In the extraction of iron, the role of carbon monoxide is

A a catalyst.

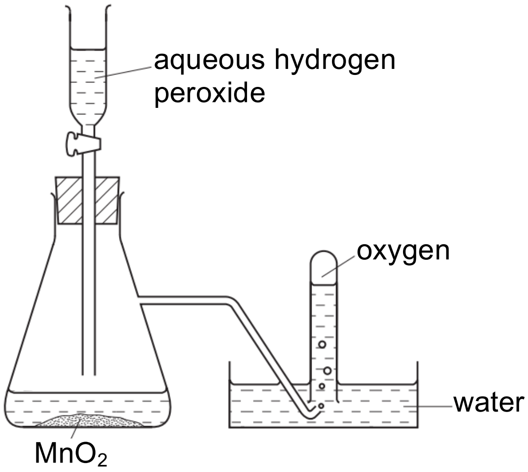
B a reducing agent.

C an oxidising agent.

D to remove impurities.

31 Oxygen was prepared from hydrogen peroxide and collected as shown in the diagram.

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$



The first few tubes of gas were rejected because the gas was contaminated by

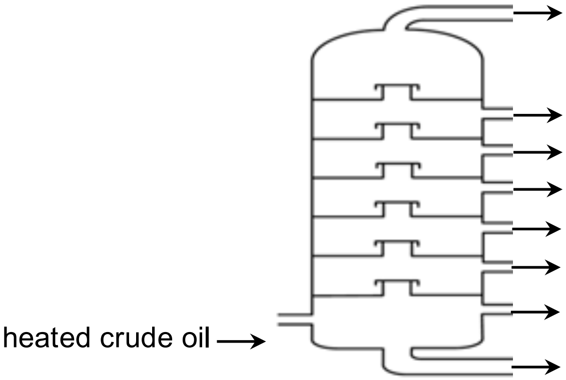
A hydrogen.

B hydrogen peroxide.

C nitrogen.

D water vapour.

32 The diagram shows the apparatus used for the fractional distillation of petroleum.



Which statement about the fractional distillation of petroleum is correct?

A At each level, only one compound is collected.

B The higher up the column, the greater the temperature.

C The molecules collected at the bottom of the column are the least flammable.

D The molecules reaching the top of the column have the highest viscosity.

33 Linoleic acid, $C_{17}H_{31}COOH$, is the main fatty acid found in vegetable oils such as soybean oil and corn oil.

Which statement about linoleic acid is correct?

A It burns in air with a non-smoky flame.

B It is polyunsaturated as it contains many double bonds between carbon and hydrogen atoms.

C It forms a solid compound on hydrogenation.

D It produces margarine when it reacts with steam in the presence of nickel catalyst.

34 How many different alkenes have the molecular formula C_5H_{10}?

A 2 **B** 3 **C** 4 **D** 5

35 The reaction between the hydrocarbon C_xH_6 and hydrogen chloride can be represented by the equation below.

$$C_xH_6\,(g) \quad + \quad HCl\,(g) \quad \rightarrow \quad C_xH_7Cl\,(g)$$

Which statement about the above reaction is true?

A It is a substitution reaction.

B UV light is required for the reaction to take place.

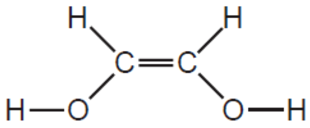
C The molecular formula of the hydrocarbon is C_2H_6.

D The molecular formula of the hydrocarbon is C_3H_6.

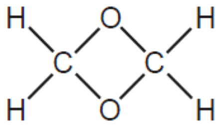
36 An aqueous solution of a compound of formula, $C_2H_4O_2$, reacts with sodium carbonate liberating carbon dioxide.

What is the structural formula of the compound?

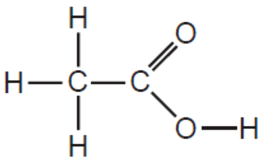
A



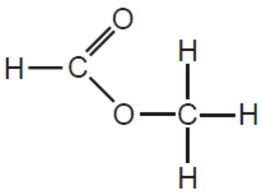
B



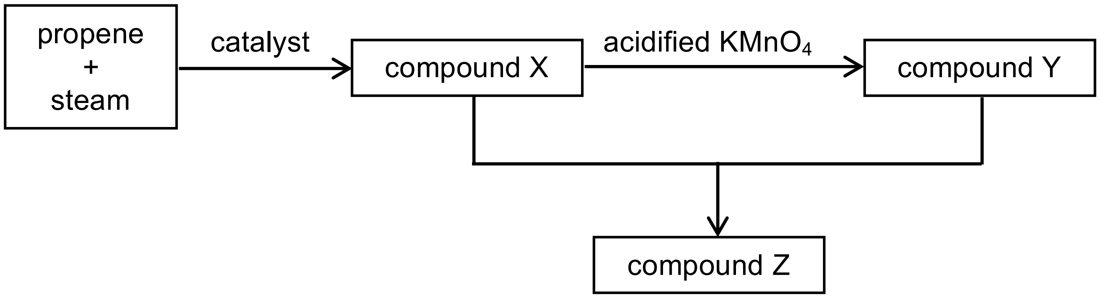
C



D



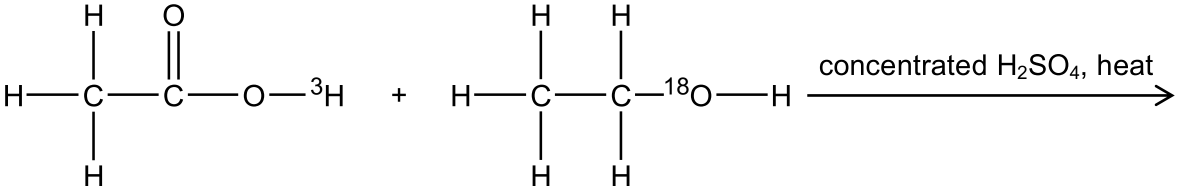
37 The following reaction scheme is carried out for the synthesis of a compound **Z**.



Which row correctly identifies compounds X, Y and Z?

	X	Y	Z
A	propanol	butanoic acid	propyl butanoate
B	propane	propanol	propanoic acid
C	propanoic acid	propanol	propyl propanoate
D	propanol	propanoic acid	propyl propanoate

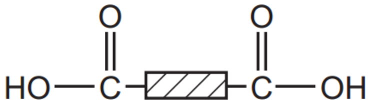
38 Ethanoic acid containing a radioactive hydrogen atom (^{3}H) was reacted with ethanol that contains a radioactive oxygen atom (^{18}O) in the presence of concentrated sulfuric acid and heat.



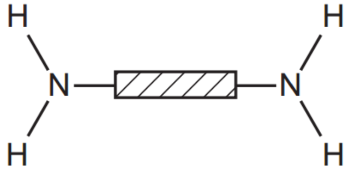
Which row correctly shows where the radioactive atoms will be found in the products?

	^{3}H	^{18}O
A	ester	ester
B	ester	water
C	water	ester
D	water	water

39 A polymer **X** is hydrolysed and the two products are



and



What can be deduced about **X**?

A It is held by weak van der Waals forces of attraction.

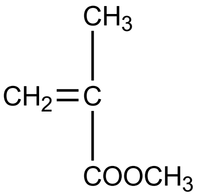
B It is made by addition polymerisation.

C It is made by condensation polymerisation.

D It is *Terylene*.

40 In an artificial hip joint, bone cement is used to attach the poly(ethene) cup for the joint to the pelvic girdle.

Bone cement is formed by the polymerisation of 2-methylpropenoate and the process is highly exothermic.

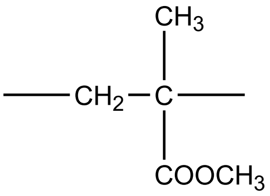


$CH_2{=}C(CH_3)COOCH_3$

2-methylpropenoate

Which statements correctly describe this polymerisation?

I The repeat unit of the polymer is



$-CH_2-C(CH_3)(COOCH_3)-$

II The formation of the cement occurs by addition polymerisation.

III The amount of energy released during bond making is less than the amount of energy absorbed during bond breaking.

A I and II only

B I and III only

C II and III only

D I, II and III

CHIJ ST. THERESA'S CONVENT
PRELIMINARY EXAMINATION 2017
SECONDARY FOUR EXPRESS

CANDIDATE NAME	

CLASS		INDEX NUMBER	

CHEMISTRY 5073/02

Paper 2 **13 September 2017**

1 hour 45 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions in the spaces provided.

Section B
Answer **all** three questions, the last question is in the form either/or.
Answer **all** questions in the spaces provided.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page 20.

The use of an approved scientific calculator is expected, where appropriate.

For Examiner's Use	
Section A	
Section B	
Total	

This question paper consists of **20** printed pages.

SECTION A

Answer **all** the questions in this paper in the spaces provided.
The total mark for this section is 50.

A1 The Periodic Table shows trends down each group and across each period.

(a) Which trends are only true down a group, which trends are only true across a period, which trends are true for both, and which trends are not true for both?

Put a tick (✓) in **one** box in each row.

trend	**only true down a group**	**only true across a period**	**true for both**	**not true for both**
The mass number increases.				
The atomic radius increases.				
The melting point increases.				
There is a change in the character of the oxides from basic to amphoteric to acidic.				

[2]

(b) Group I and Group VII show different trends in their properties.

Group I
Li
Na
K
Rb

Group VII
F
C*l*
Br
I

(i) Explain the trend in reactivity down each group.

……………………………………………………………………………………………..

……………………………………………………………………………………………..

……………………………………………………………………………………………..

…………………………………………………………………………………………… [3]

(ii) Hydrogen is not placed in any group of the Periodic Table though it shares some similar properties with the elements in Group I and the elements in Group VII.

Give reasons to explain why hydrogen can be placed in either Group I or Group VII of the Periodic Table.

Group I ……………………………………………………………………………………

……………………………………………………………………………………………..

Group VII …………………………………………………………………………………

……………………………………………………………………………………………..

[2]

(c) Persulfate ions, $S_2O_8^{2-}$ oxidise iodide ions according to the following equation.

$$S_2O_8^{2-}\ (aq) + 2I^-\ (aq) \rightarrow\ 2SO_4^{2-}\ (aq) + I_2(aq)$$

The reaction occurs very slowly at room temperature, so a catalyst of Fe^{2+} ions is used.

The reaction involving the Fe^{2+} catalyst takes place in two steps:

$$2Fe^{2+}\ (aq) + S_2O_8^{2-}\ (aq) \rightarrow\ 2Fe^{3+}\ (aq) + 2SO_4^{2-}\ (aq)$$

$$2Fe^{3+}\ (aq) + 2I^-\ (aq) \rightarrow\ 2Fe^{2+}\ (aq) + I_2(aq)$$

(i) With reference to the collision of particles, suggest why the reaction between persulfate ions and iodide ions is very slow at room temperature.

……………………………………………………………………………………………..

…………………………………………………………………………………………… [1]

(ii) Using the above equations, explain how the Fe^{2+} ion displays one of the characteristics of a catalyst.

……………………………………………………………………………………………..

…………………………………………………………………………………………… [1]

(iii) Using information from the above equations, suggest the property of transition metals that allow Fe^{2+} to act as a catalyst in this reaction.

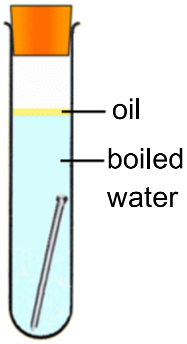
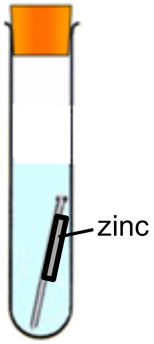
……………………………………………………………………………………………..

…………………………………………………………………………………………… [1]

[Total: 10]

A2 **(a)** Iron is probably the most widely used and most important metal in the world today. One problem with using iron is that it rusts.

The diagram below shows an experiment carried out to investigate different rust prevention methods. An iron nail is placed in each of the four test tubes, A, B, C, and D. A ferroxyl indicator is used to indicate when rusting has taken place. When the colour of the ferroxyl indicator changes from yellow to blue, this indicates that rusting has taken place.

				
test tube	A	B	C	D
observation	indicator turns blue	indicator remains yellow	indicator remains yellow	

(i) Explain the observations seen in test tubes A, B and C.

……………………………………………………………………………………………..

……………………………………………………………………………………………..

……………………………………………………………………………………………..

…………………………………………………………………………………………. [3]

(ii) In test tube D, a piece of zinc metal is attached to the iron nail.

Suggest with a reason, the observation that would be made in the test tube after some time.

……………………………………………………………………………………………..

……………………………………………………………………………………………..

……………………………………………………………………………………………..

…………………………………………………………………………………………. [3]

(b) Iron alloys are widely used in the industry.

(i) Using a named example of an iron alloy, explain what is meant by the term *alloy*.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

………………………………………………………………………………………… [2]

(ii) Using your example named in **(i)**, state and explain one advantage of the alloy over the pure metal(s).

…………………………………………………………………………………………………

…………………………………………………………………………………………………

………………………………………………………………………………………… [2]

[Total: 10]

A3 Figure 1 shows the composition of elements in the Earth's crust.
Table 1 shows the year of discovery and cost per tonne of some metals.

Figure 1: Elemental composition of the Earth's crust by mass

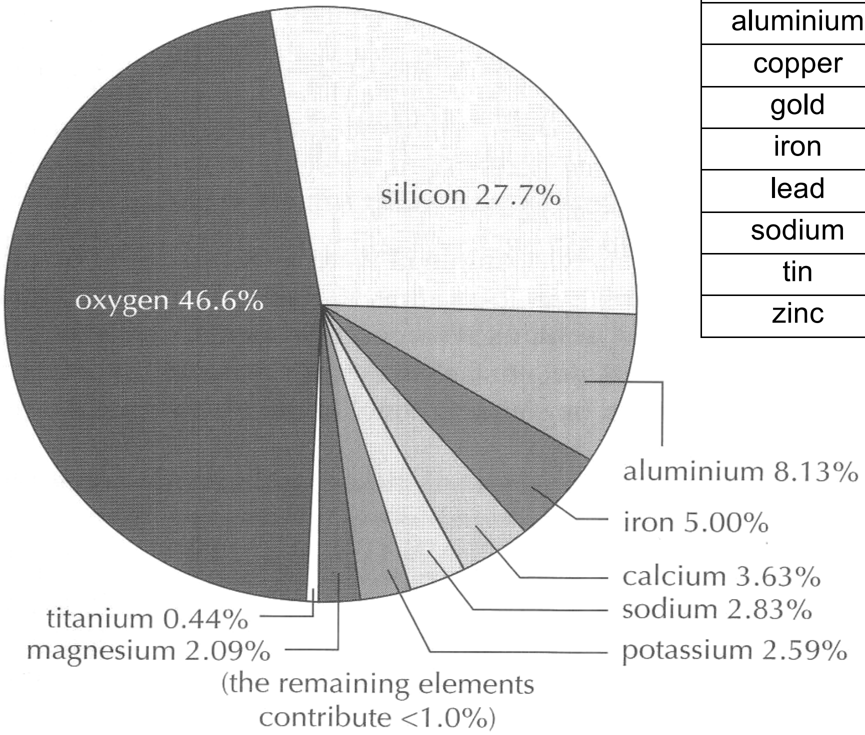


Table 1

Metal	Year of discovery	Cost per tonne / S$
aluminium	1827	2,500
copper	4200 BC	10,000
gold	6000 BC	50,000,000
iron	1500 BC	5,500
lead	3500 BC	2,500
sodium	1807	3,500
tin	1750 BC	25,000
zinc	1400	2,400

(a) Most metals are commonly found as ores. Using the information in Figure 1, which element is most likely to be found combined with metals?

……………………………………………………………………………………………….. [1]

(b) Using the information in Figure 1, suggest the most common compound found in the Earth's crust.

……………………………………………………………………………………………….. [1]

(c) Using your knowledge of the reactivity series, suggest the relationship between the year of discovery of the metals and the reactivity of the metals in Table 1.

……………………………………………………………………………………………….. [1]

(d) Using the information in Figure 1, suggest why it is costly to produce copper and tin.

……………………………………………………………………………………………….. [1]

(e) Which metals found in Table 1 were most likely isolated and discovered by electrolysis? Give a reason for your answer.

…………………………………………………………………………………………………

……………………………………………………………………………………………….. [2]

(f) Suggest with a reason, why aluminium is discovered later than sodium despite sodium being more reactive than aluminium.

…………………………………………………………………………………………………

……………………………………………………………………………………………….. [1]

[Total: 7]

A4 PotashCorp is the world's largest producer of fertilisers, most of which are made from salts.

(a) The company reacts acids with other compounds to make the salts.

The table below shows the names of some salts used in fertilisers.

Salts can be prepared by either of the following methods:

(i) titration
(ii) reaction of acid with excess metal, base or metal carbonate
(iii) precipitation

Complete the table by filling in the missing information.

name of salt	formula of salt	name of acid used to make salt	name of other compound used to make salt	method of preparation (i), (ii) or (iii)
potassium nitrate				
calcium phosphate *(insoluble in water)*				
ammonium chloride				

[6]

(b) Using your answers in **(a)**, describe briefly how a pure dry sample of potassium nitrate can be obtained.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

…………………………………………………………………………………………………. [4]

(c) State one physical property of potassium nitrate.

Explain this property in terms of the structure and bonding of potassium nitrate.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

………………………………………………………………………………………………….. [2]

(d) Each bag of fertiliser has a label which gives the N : P : K ratio.

The N : P : K ratio shows the ratio by mass of nitrogen, phosphorus and potassium in the fertiliser, and is always quoted as whole numbers.

Determine the N : P : K ratio for each of the salts in the table below.

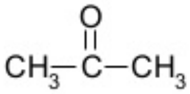
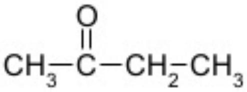
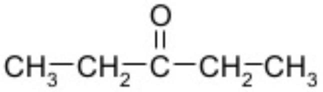
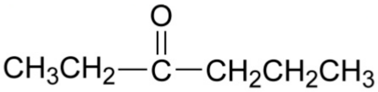
name of salt	N : P : K ratio
potassium nitrate	
calcium phosphate	
ammonium chloride	

[2]

[Total: 12]

A5 **(a)** Ketones are a homologous series of organic compounds.

The table shows the names, formulae and boiling points of some ketones.

name	structural formula	boiling point / °C
2-propanone	 $CH_3-\overset{\overset{O}{\|}}{C}-CH_3$	56
2-butanone	 $CH_3-\overset{\overset{O}{\|}}{C}-CH_2-CH_3$	80
3-pentanone	 $CH_3-CH_2-\overset{\overset{O}{\|}}{C}-CH_2-CH_3$	
3-hexanone	 $CH_3CH_2-\overset{\overset{O}{\|}}{C}-CH_2CH_2CH_3$	123

(i) Deduce the general formula and functional group of the ketone homologous series

general formula ….…………………… functional group ….…………………… [2]

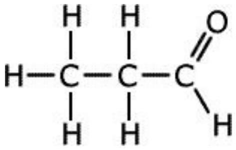
(ii) Predict the boiling point of 3-pentanone.

………………………………………………………………………………………… [1]

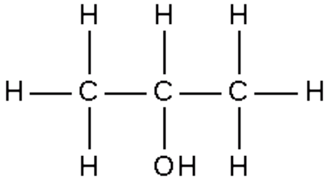
(iii) Using the information above, deduce the significance of the number "3" in the name "3-hexanone".

………………………………………………………………………………………… [1]

(iv) 2-propanone, propanal (an aldehyde) and 2-propanol are all compounds of carbon, hydrogen and oxygen.



propanal



2-propanol

State with reasons, which of these three compounds are isomers of each other.

…………………………………………………………………………………………

…………………………………………………………………………………………

………………………………………………………………………………………… [2]

(b) Ketones can be made by the oxidation of some alcohols.
For example, 2-propanone can be formed from the oxidation of 2-propanol.

(i) State a suitable oxidising agent that can be used for the oxidation of 2-propanol to 2-propanone, and the observation that would be made during this reaction.

…………………………………………………………………………………………

………………………………………………………………………………………… [2]

(ii) Write an equation for the oxidation of 2-propanol to 2-propanone. Show the organic compounds as displayed formulae.

[1]

[Total: 9]

SECTION B (30 marks)

Answer all **three** questions from this section.

The last question is in the form of an either/or and only one of the alternatives should be attempted.

B6 Chemical Kinetics

Chemical kinetics is the study of the rate (or speed) of reactions and the factors that affect them.

In general, when the concentration of a reactant increases, the rate of the reaction increases. However, the rate of the reaction may not always be directly proportional to the concentration of each of the reactants in the reaction.

The rate of a reaction can be defined as the rate of increase in concentration of a product with time or the rate of decrease in concentration of a reactant with time.

Rate Law

The rate law or rate equation provides information on how the rate of a reaction depends on the concentration of all the reactants.

Consider the reaction: $a A + b B \rightarrow$ products

where ***a*** and ***b*** are the stoichiometric coefficients and ***A*** and ***B*** are the reactants.

The rate equation or rate law can be expressed as:

$$\textbf{Rate} = \textbf{k} [\textbf{A}]^m [\textbf{B}]^n$$

where **k** is a constant of proportionality in the rate equation.
m is the order of reaction with respect to reactant A
n is order of reaction with respect to reactant B

Order of reaction

The order of reaction with respect to a given reactant is defined as the power to which the concentration of that reactant is raised to in the rate equation.

A reaction is said to be zero order with respect to a particular reactant, e.g. A, if the rate of reaction does not depend on the concentration of A.

rate $\propto [A]^0$ where [A] represents the concentration of A

Hence, rate = k $[A]^0$ = k where k is the proportionality constant

A reaction is said to be first order with respect to a particular reactant, e.g. B, if the rate of reaction is directly proportional to the concentration of B.

rate $\propto [B]^1$ where [B] represents the concentration of B

Hence, rate = k $[B]^1$ = k [B] where k is the proportionality constant

A reaction is said to be second order with respect to a particular reactant, e.g. C, if the rate of reaction is directly proportional to the square of the concentration of C.

rate $\propto [C]^2$ where [C] represents the concentration of C

Hence, rate = k $[C]^2$ = k $[C]^2$ where k is the proportionality constant

Overall Order of a Reaction

The overall order of a reaction is the sum of the orders of reaction of all the reactants.

For example, if the rate equation for a reaction is

$$\textbf{Rate} = \mathbf{k\,[A]^m\,[B]^n}$$

The overall order of the reaction is (**m** + **n**).

Hydrolysis of halogenoalkanes

Halogenoalkanes can react with aqueous sodium hydroxide upon warming to produce alcohols and the respective hydrogen halides. This is known as a hydrolysis reaction.

For example, $CH_3Br\ (aq) + NaOH\ (aq) \rightarrow CH_3OH\ (aq) + HBr\ (aq)$

The results of an investigation into the kinetics of this reaction are given below:

experiment number	$[CH_3Br]$ / mol dm^{-3}	[NaOH] / mol dm^{-3}	initial rate of reaction / mol dm^{-3} s^{-1}
1	0.10	0.20	0.001
2	0.20	0.10	0.001
3	0.20	0.20	0.002
4	0.30	0.20	0.003
5	0.60	0.40	0.012

The data collected in the table can then be analysed and processed to give information about the kinetics of the hydrolysis reaction between bromomethane and aqueous sodium hydroxide.

(a) Use the information in the table to deduce the order of reaction with respect to CH_3Br. Explain your reasoning.

[1]

(b) Use the information in the table to deduce the order of reaction with respect to NaOH. Explain your reasoning.

[1]

(c) What is the overall order of the reaction between bromomethane and aqueous sodium hydroxide?

…………………………………………………………………………………………………...[1]

(d) Write an overall rate equation for the reaction between bromomethane and aqueous sodium hydroxide.

…………………………………………………………………………………………………...[1]

(e) Determine the value and unit for the rate constant, k, in your rate equation in **(d)**.

……………………………………………………………………………………………………

…………………………………………………………………………………………………...[1]

(f) The reactants and products for the reaction between bromomethane and aqueous sodium hydroxide are all colourless.

Describe a chemical test that can be carried out on the product(s) to confirm that the reaction has occurred. Include the observation(s) that would be made for a positive test.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

…………………………………………………………………………………………………...[2]

(g) A dibromoalkane W (M_r = 188), is warmed with excess aqueous sodium hydroxide to produce a diol X. The diol is then oxidised fully to a dicarboxylic acid Y. Under suitable conditions, diol X and dicarboxylic acid Y can react to form a polymer Z.

Deduce the identities of W, X, Y and Z.

[4]

[Total: 11]

B7 Hydrazine is a compound often used in rocket fuels as it can be stored conveniently in liquid form, reacts exothermically with oxygen, and produces only gaseous products in the process.

The reaction of hydrazine with oxygen (Reaction **I**) can be expressed as follows:

$$N_2H_4(g) + O_2(g) \rightarrow N_2(g) + 2H_2O(g) \qquad \Delta H = -622\text{kJ/mol}$$

It has been suggested that the reaction between hydrazine and fluorine (Reaction **II**) is more exothermic than that between hydrazine and oxygen.

Reaction II

$$N_2H_4(g) + 2F_2(g) \rightarrow N_2(g) + 4HF(g)$$

Bond energy is the energy released when a bond is formed between two atoms or the energy required to break a bond between two atoms.

The following table shows the bond energies of selected covalent bonds, measured in kilojoules per mole.

bond	bond energy in kJ/mol
F – F	158
N – N	160
N – H	390
H – F	565
N = N	418
N ≡ N	945

(a) Draw a dot-and-cross diagram to show the covalent bonding in hydrazine.
Show outer shell electrons only.

[2]

(b) Using the bond energies given above,

(i) calculate the amount of energy (kJ) required to break all the bonds in the reactants in Reaction II;

[1]

(ii) calculate the amount of energy (kJ) released when all the bonds are formed in the products in Reaction II;

[1]

(iii) calculate ΔH for Reaction II.

[1]

(c) Which gas, oxygen or fluorine, would be a better oxidant for the hydrazine in rocket fuel? Give a reason for your answer.

……………………………………………………………………………………………………

…………………………………………………………………………………………………... [1]

(d) Draw an energy profile diagram for the reaction between hydrazine and oxygen. On your diagram label the product(s), activation energy, E_a, and enthalpy change for the reaction, ΔH.

[2]

(e) Dinitrogen tetroxide (N_2O_4) is sometimes added to hydrazine in rocket fuels. Oxides of nitrogen are obtained as waste products.

Explain why this can be harmful to the environment.

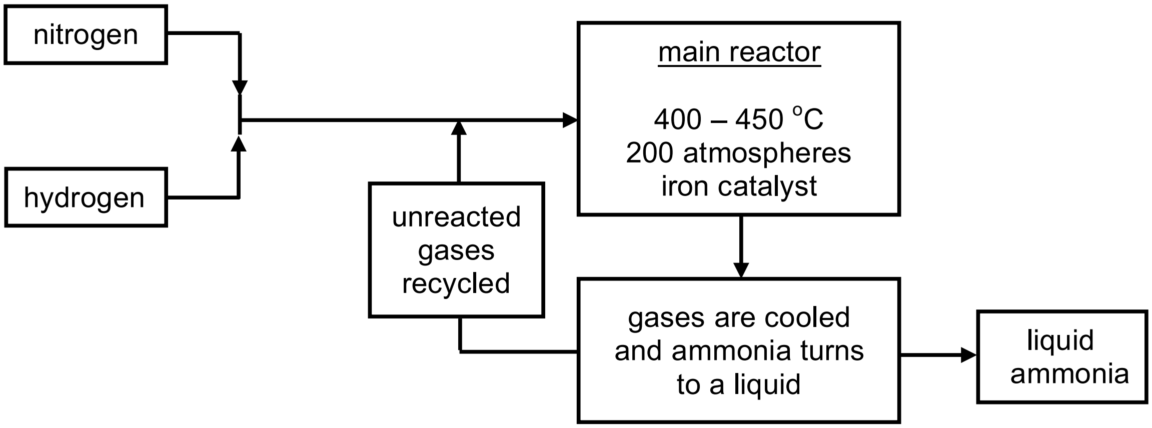
……………………………………………………………………………………………………

…………………………………………………………………………………………………...[1]

[Total: 9]

EITHER

B8 The Haber process for making ammonia can be represented by the flow diagram below.



(a) State how nitrogen and hydrogen can be obtained for the making of ammonia.

nitrogen ……………………………………… hydrogen ………………………………………

[2]

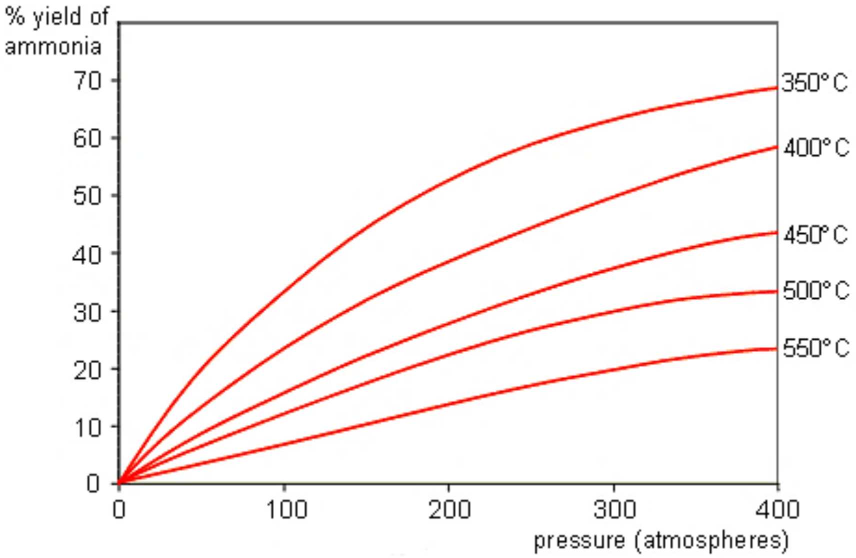
(b) Which element is reduced in the reaction?

Use ideas about changes in oxidation state to explain your answer.

…………………………………………………………………………………………………

…………………………………………………………………………………………………[1]

(c) The graph shows the yield of ammonia that is made under different conditions.



(i) Explain, in terms of collisions between (reacting) particles, how a higher temperature affects the rate of reaction in the reactor.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………[2]

(ii) Using the information in the graph, state the conditions that would produce the highest yield of ammonia.

…………………………………………………………………………………………[1]

(iii) What effect does the iron catalyst have on the yield of ammonia obtained?

Explain your reasoning.

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………[2]

(iv) Explain why the unreacted gases obtained from the main reactor are recycled.

……………………………………………………………………………………………

…………………………………………………………………………………………[1]

(v) In practice, it is not possible to obtain 100% yield of ammonia in the Haber process.

Explain why this is so.

……………………………………………………………………………………………

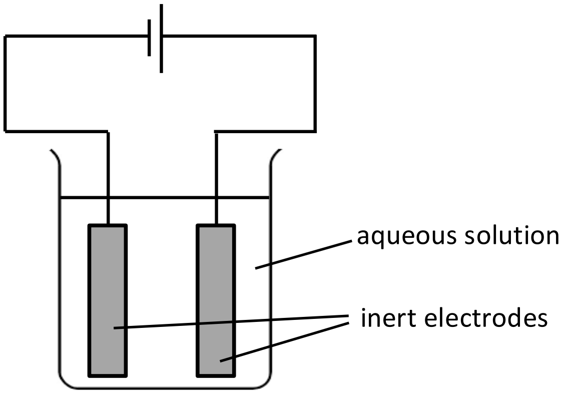
…………………………………………………………………………………………[1]

[Total: 10]

OR

B8 Lead(II) nitrate and copper(II) chloride are both soluble salts.

The diagram shows the apparatus that a student used to electrolyse aqueous solutions of the salts.



(a) Complete the table of information about the electrolysis.

solution	**name of products of electrolysis**		**ionic equation for reaction at each electrode**
dilute aqueous lead(II) nitrate	at negative electrode		
	at positive electrode		
concentrated aqueous copper(II) chloride	at negative electrode		
	at positive electrode		

[4]

(b) Complete the table below to show the observations that would be made during the electrolysis.

solution	**observations**	
dilute aqueous lead(II) nitrate	at negative electrode	
	at positive electrode	
	in electrolyte	
concentrated aqueous copper(II) chloride	at negative electrode	
	at positive electrode	
	in electrolyte	

[3]

(c) 20 cm^3 of 0.5 mol dm^{-3} aqueous lead(II) nitrate was mixed with 15 cm^3 of 0.8 mol dm^{-3} aqueous copper(II) chloride.

Calculate the maximum mass of precipitate that can be obtained.

[3]

[Total: 10]

Mark Scheme for 2017 Chemistry Preliminary Examination Paper 1

Qn	Answer	LO	Type A/B
1	C	Methods of purification and analysis 1.2(a)	A
2	B	Methods of purification and analysis 1.2(b)	B
3	B	Identification of ions and gases 1.3(a), (b)	A
4	B	Identification of ions and gases 1.3(c), Kinetic particle theory 2.1(d)	B
5	A	Atomic structure 2.2(d), (f)	B
6	B	Structure and properties of materials 2.3(a)	A
7	C	Ionic bonding 2.4; Covalent Bonding 2.5	A
8	D	Covalent bonding 2.5(d)	B
9	B	Formulae, Stoichiometry and the Mole Concept 3(j), (l)	B
10	C	Formulae, Stoichiometry and the Mole Concept 3(i)	A
11	A	Formulae, Stoichiometry and the Mole Concept 3(h)	B
12	D	Electrolysis 4(f)	B
13	B	Electrolysis 4(j)	B
14	B	Energy from Chemicals 5(a), (b); Speed of reaction 6.1(c)	A
15	B	Energy from Chemicals 5(e)	A
16	D	Speed of reaction 6.1(a)	B
17	D	Experimental design 1.1(b)	B
18	C	Redox 6.2(c)	A
19	B	Acids and bases 7.1(a), (b)	A
20	D	Acids and bases 7.1(d), (h)	B
21	A	Ammonia 7.3(d)	A
22	C	Formulae, Stoichiometry and the Mole Concept 3(f), (j)	B
23	D	Acids and bases 7.1(g), (h); Air 10(d)(ii)	A
24	A	Group properties 8.2(a)	B
25	D	Group properties 8.2(b)	B
26	B	Acids and bases 7.1(i)	A
27	D	Transition elements 8.3(a)	A
28	C	Group properties 8.2(c)	A
29	B	Metals 9.2(a)(ii)	B
30	B	Iron 9.5(a)	A
31	C	Air 10(a)	A
32	C	Fuels & Crude Oil 11.1(b); Alkanes 11.2(a)	B
33	C	Alkenes 11.3(e), (f), (g)	B
34	D	Alkanes 11.2(d)	B
35	D	Alkenes 11.3(e)	B
36	C	Carboxylic acids 11.5(c)	A
37	D	Alkenes 11.3(e), Alcohols 11.4(c), Carboxylic acids 11.5(e)	B
38	C	Carboxylic acids 11.5(e)	B
39	C	Macromolecules 11.6(e)	A
40	A	Macromolecules 11.6(b), (d); Energy from Chemicals 5(c), (d)	B

Overview for Paper 1 & Paper 2

	Paper 1		**Paper 2**		**Overall**
Topic	**Type A**	**Type B**	**Type A**	**Type B**	**Total marks**
Experimental Chemistry	2	2	0	2	6
The Particulate Nature of Matter	2	3	2	2	9
Formulae, Stoichiometry and the Mole Concept	1	3	0	3	7
Electrolysis	0	2	7	0	9
Energy from Chemicals	2	0	5	0	7
Chemical Reactions	1	1	4	11	17
Acids, Bases and Salts	4	1	12	0	17
The Periodic Table	2	2	7	1	12
Metals	1	1	4	10	16
Air	1	0	1	0	2
Organic Chemistry	2	7	2	8	19
Data-based Questions	-	-	0	9	9
Total	**18**	**22**	**44**	**46**	**130**

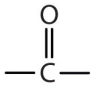
% type A = (18 + 44) / 130 = **47.7%** (recommended 45%)

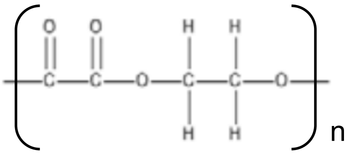
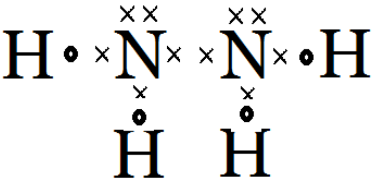
% type B = (22 + 46) / 130 = **52.3%** (recommended 55%)

<table>
<tr><th>Qn.</th><th>Part</th><th>Answer</th><th>LO</th><th>Type A/ B</th><th>Marks</th></tr>
<tr><td rowspan="3">A1</td><td>(a)</td><td>
<table>
<tr><th>trend</th><th>only true down a group</th><th>only true across a period</th><th>true for both</th><th>not true for both</th></tr>
<tr><td>The mass number increases.</td><td></td><td></td><td>✓</td><td></td></tr>
<tr><td>The atomic radius increases.</td><td>✓</td><td></td><td></td><td></td></tr>
<tr><td>The melting point increases.</td><td></td><td></td><td></td><td>✓</td></tr>
<tr><td>There is a change in the character of the oxides from basic to amphoteric to acidic.</td><td></td><td>✓</td><td></td><td></td></tr>
</table>
</td><td>Periodic Table
8.1</td><td>A</td><td>[2]</td></tr>
<tr><td>(b)</td><td>(i) Reactivity increases down Group I and decreases down Group VII [1]
For Group I: easier to remove valence electrons as they are further away from the nucleus/there are more electron shells [1]
For Group VII: more difficult to accept/attract one electron as incoming electron is further away from the nucleus/there are more electron shells [1]
(ii) Group I: H atom has one valence electron / able to form singly positively charged ion (H^+) [1]
Group VII: H atom able to gain one electron to form a singly negatively charged ion (H^-) / forms diatomic molecules (H_2) [1]</td><td>Group Properties
8.2(a), (b)</td><td>A</td><td>[5]</td></tr>
<tr><td>(c)</td><td>(i) The two ions are of the same charge and repel, hence they are not able to collide with each other (frequently) [1]
(ii) It is not (chemically) used up in the reaction / It is regenerated during the reaction [1]
(iii) It exhibits variable oxidation states. [1]</td><td>Speed of Reaction
6.1(b)
Transition Elements
8.3(a)</td><td>B</td><td>[3]</td></tr>
<tr><td>A2</td><td>(a)</td><td>(i) test tube A – rusting takes place due to presence of oxygen (air) and water [1]
test tube B – rusting does not take place due to absence of water (absorbed by calcium chloride) [1]
test tube C – rusting does not take place due to absence of oxygen (air) in boiled water [1]
(ii) indicator remains yellow [1]
Zinc is more reactive than iron [1]
and corrodes / reacts with oxygen (air) and water instead of iron [1]</td><td>Iron
9.5(d), (e)</td><td>B</td><td>[6]</td></tr>
</table>

<table>
<tr><td></td><td>(b)</td><td>(i) steel / stainless steel [1]
mixture of iron with one or more other elements (carbon / carbon and chromium) [1]
(ii) for steel: harder/stronger [1] than (pure) iron as the presence of atoms of different sizes make it more difficult for the layers of atoms to slide over one another [1]
for stainless steel: more resistant to corrosion [1] than (pure) iron [1] due to the presence of more reactive metals (e.g. chromium) that react with oxygen and water instead of iron to form a protective layer [1]</td><td>Properties of Metals
9.1(b), (d)</td><td>A</td><td>[4]</td></tr>
<tr><td rowspan="6">A3</td><td>(a)</td><td>oxygen [1]</td><td rowspan="2">Data-based questions</td><td>B</td><td>[1]</td></tr>
<tr><td>(b)</td><td>Silicon dioxide / silica / SiO_2</td><td>B</td><td>[1]</td></tr>
<tr><td>(c)</td><td>The more reactive the metal is, the later the year of discovery. [1]</td><td>Metals
9.2(a), 9.3(a)</td><td>B</td><td>[1]</td></tr>
<tr><td>(d)</td><td>Both copper and tin are scarce (less than 1%) so the cost of production is higher.</td><td>Data-based questions</td><td>B</td><td>[1]</td></tr>
<tr><td>(e)</td><td>Aluminium and sodium [1]
Isolation of metals by electrolysis was only possible after 1800 when the voltaic cell was invented/ the two metals are too high in the reactivity series to be isolated by reduction with carbon or hydrogen. [1]</td><td>Metals
9.2(a), 9.3(a)</td><td>B</td><td>[2]</td></tr>
<tr><td>(f)</td><td>Aluminium requires a higher temperature to be melted / aluminium ores have a higher lattice energy due to the higher ionic charge, hence it is harder to be isolated.</td><td>Periodic Table, Metals
8, 9</td><td>B</td><td>[1]</td></tr>
<tr><td rowspan="2">A4</td><td>(a)</td><td>
<table>
<tr><th>name of salt</th><th>formula of salt</th><th>name of acid used to make salt</th><th>name of other compound used to make salt</th><th>method of preparation (i), (ii) or (iii)</th></tr>
<tr><td>potassium nitrate</td><td>KNO_3</td><td>nitric acid</td><td>potassium hydroxide / potassium carbonate</td><td>(i)</td></tr>
<tr><td>calcium phosphate</td><td>$Ca_3(PO_4)_2$</td><td>phosphoric acid</td><td>calcium hydroxide / nitrate / chloride</td><td>(iii)</td></tr>
<tr><td>ammonium chloride</td><td>NH_4Cl</td><td>hydrochloric acid</td><td>aqueous ammonia / ammonium carbonate</td><td>(i)</td></tr>
</table>
1 mark for any 2 correct answers (max. 6)</td><td>Acids & Bases
7.1(d), (e), (h)
Salts
7.2(c)</td><td>A</td><td>[6]</td></tr>
<tr><td>(b)</td><td>Titrate nitric acid (in burette) with potassium hydroxide / potassium carbonate (in pipette) using a suitable indicator (e.g. methyl orange). [1]
Repeat titration using the same volume of nitric acid obtained earlier but without adding the indicator. [1]
Heat the salt solution obtained to obtain a saturated solution (using evaporating dish). Leave the solution to cool for crystallisation to take place. [1]
Filter the solution, and collect the crystals from the filter paper onto a paper towel, and allow to dry. [1]</td><td>Salts
7.2(a), (c)</td><td>A</td><td>[4]</td></tr>
</table>

<table>
<tr>
<td rowspan="2"></td>
<td>(c)</td>
<td>High m.p/b.p / hard [1]
due to giant ionic lattice structure with strong electrostatic forces of attraction between oppositely charged K^+ and NO_3^- ions that require a lot of energy to break/overcome [1]
OR
Good conductor of electricity in molten or aqueous state [1]
due to presence of mobile K^+ and NO_3^- ions that can move to conduct electricity when a potential difference is applied [1]
OR
Brittle [1]
ions of the same charge are brought close together and repel each other when a stress/force is applied to the ionic lattice [1]
OR
Soluble in water [1]
K^+ and NO_3^- ions are able to form strong ion-solvent interactions with water that releases sufficient energy to cause the detachment of ions from the giant ionic lattice</td>
<td>Structure and properties of materials 2.3(d)

Ionic Bonding 2.4(e)</td>
<td>A</td>
<td>[2]</td>
</tr>
<tr>
<td>(d)</td>
<td>
<table>
<tr><th>name of salt</th><th>N : P : K ratio</th></tr>
<tr><td>potassium nitrate</td><td>14 : 0 : 39</td></tr>
<tr><td>calcium phosphate</td><td>0 : 31 : 0 or 0 : 62 : 0</td></tr>
<tr><td>ammonium chloride</td><td>14 : 0 : 0</td></tr>
</table>
1 mark for 2 correct answers
2 marks for 3 correct answers</td>
<td>Data-based questions</td>
<td>B</td>
<td>[2]</td>
</tr>
<tr>
<td rowspan="2">A5</td>
<td rowspan="2">(a)</td>
<td rowspan="2">(i) general formula: $C_nH_{2n}O$ [1]
functional group:  $-\overset{\overset{O}{\|}}{C}-$ [1]
(ii) accept 101 – 104 °C [1]
(iii) indicates position of C=O functional group (on the main hydrocarbon chain / backbone) [1]
(iv) 2-propanone and propanal are isomers [1]
They have the same molecular formula (of C_3H_6O) but different structural formula [1]</td>
<td rowspan="2">Alkanes 11.2(a), (d)</td>
<td>B</td>
<td>[4]</td>
</tr>
<tr>
<td>A</td>
<td>[2]</td>
</tr>
</table>

	(b)	(i) potassium manganate (VII) or potassium permanganate / $KMnO_4$ [1] colour change from purple to colourless [1] OR potassium dichromate (VI) / $K_2Cr_2O_7$ [1] colour change from orange to green [1]	Redox 6.2 (d)	A	[2]
		(ii) $C_3H_7OH + [O] \rightarrow C_3H_6O + H_2O$ [1] All bonds must be shown.		B	[1]
B6	**(a)**	Comparing experiments 1 and 3, when the concentration of CH_3Br is doubled, the rate of reaction is also doubled, hence the rate of reaction is directly proportional to $[CH_3Br]$. OR Comparing experiments 1 and 4, when the concentration of CH_3Br is triped, the rate of reaction is also tripled, hence the rate of reaction is directly proportional to $[CH_3Br]$. Order of reaction w.r.t CH_3Br = 1 [1] *reject order of reaction without logical reasoning.*	Speed of Reaction 6.1(f)	B	[1]
	(b)	Comparing experiments 2 and 3, when the concentration of NaOH is doubled, the rate of reaction is also doubled, hence the rate of reaction is directly proportional to [NaOH]. Order of reaction w.r.t NaOH = 1 [1] *reject order of reaction without logical reasoning.*	Speed of Reaction 6.1(f)	B	[1]
	(c)	Overall order = 1 + 1 = 2 [1]	Data-based questions	B	[1]
	(d)	Rate = k $[CH_3Br][NaOH]$ [1]	Data-based questions	B	[1]
	(e)	$k = 0.05\ mol^{-1}dm^{3}s^{-1}$ 1 mark for both correct value and unit	Data-based questions	B	[1]
	(f)	Add a few drops of acidified aqueous silver nitrate [1] to the test solution. White precipitate formed [1]	Identification of ions and gases 1.3(b)	B	[2]
	(g)	W: dibromoethane / $Br(CH_2)_2Br$ [1] X: 1,2-ethane-diol / $OH(CH_2)_2OH$ [1] Y: ethanedioic acid / $(COOH)_2$ [1] Z:  [1]	Alcohols 11.4(c) Macromolecules 11.6(d)	B	[4]
B7	**(a)**	 correct number of electrons for each atom [1] correct number of electrons shared for each bond [1]	Covalent Bonding 2.5(c)	B	[2]

<table>
<tr><td rowspan="4"></td><td>(b)</td><td>(i) Amount of energy required
= 163 + 4(390) + 2(158) = 2036 kJ [1]
(ii) Amount of energy released
= 945 + 4(565) = 3205 kJ [1]
(iii) ΔH for Reaction II = 2039 – 3205 = –1169 kJ [1]</td><td>Energy from Chemicals
5(c), (d)</td><td>A</td><td>[3]</td></tr>
<tr><td>(c)</td><td>Fluorine, because the reaction is more exothermic / more energy is released. [1]
OR
Oxygen, because no pollutants are produced/released [1]</td><td>Data-based Questions</td><td>B</td><td>[1]</td></tr>
<tr><td>(d)</td><td>Correct shape of graph and labelled reactants and products [1]
Correct labelled activation energy for the forward reaction + Correct labelled enthalpy change [1]
Do not allow double headed arrow head / arrow in wrong direction
Note – arrows do not have to start exactly at reactant level and finish exactly at product or maximum of curve
Maximum of one mark for an error carried forward for a reaction that is endothermic i.e. enthalpy change mark and activation energy</td><td>Energy from Chemicals
5(b)</td><td>A</td><td>[2]</td></tr>
<tr><td>(e)</td><td>Oxides of nitrogen dissolve in rainwater forming acid rain that corrodes limestone structures and building and causes harm to aquatic plants/animals [1]</td><td>Air
10(e)(ii)</td><td>A</td><td>[1]</td></tr>
<tr><td rowspan="7">EITHER
B8</td><td>(a)</td><td>nitrogen – fractional distillation of liquid air [1]
hydrogen – cracking of petroleum / crude oil [1]</td><td>Ammonia
7.3(a)</td><td>A</td><td>[2]</td></tr>
<tr><td>(b)</td><td>Nitrogen as the oxidation state decreases from 0 in N_2 to –3 in NH_3. [1]</td><td>Redox</td><td>B</td><td>[1]</td></tr>
<tr><td rowspan="5">(c)</td><td>(i) Higher temperature
⇒ increase in kinetic energy & speed of particles [1]
⇒ increase in frequency of effective collisions [1]
⇒ increase in rate of reaction</td><td rowspan="5">Speed of Reaction
6.1(a), 6.1(b)
Ammonia
7.3(b), (c)</td><td>A</td><td>[2]</td></tr>
<tr><td>(ii) 350 °C and 400 atmospheres [1]</td><td>B</td><td>[1]</td></tr>
<tr><td>(iii) no effect on yield of ammonia [1]
increases the speed of both the forward and reverse reactions to the same extent [1]</td><td>B</td><td>[2]</td></tr>
<tr><td>(iv) to increase yield of ammonia / reduce cost/ reduce waste / save materials or resources [1]</td><td>B</td><td>[1]</td></tr>
<tr><td>(v) reversible reaction [1]</td><td>B</td><td>[1]</td></tr>
<tr><td>OR
B8</td><td>(a)</td><td>
<table>
<tr><th>solution</th><th colspan="2">name of products of electrolysis</th><th>ionic equation for reaction at each electrode</th></tr>
<tr><td rowspan="2">dilute aqueous lead(II) nitrate</td><td>at negative electrode</td><td>hydrogen (gas)</td><td>$2H^+ + 2e^- \rightarrow H_2$ (g)</td></tr>
<tr><td>at positive electrode</td><td>oxygen (gas) and water</td><td>$4OH^-$ (aq) $\rightarrow 2H_2O$ (aq) + O_2 (g) + 4 e^-</td></tr>
<tr><td rowspan="2">concentrated aqueous copper(II) chloride</td><td>at negative electrode</td><td>copper (solid)</td><td>Cu^{2+} (aq) + $2e^- \rightarrow$ Cu (s)</td></tr>
<tr><td>at positive electrode</td><td>chlorine (gas)</td><td>$2Cl^-$ (aq) $\rightarrow Cl_2$ (g) + $2e^-$</td></tr>
</table>
1 mark for each correct row</td><td>Electrolysis
4(e), (f), (g)</td><td>A</td><td>[4]</td></tr>
</table>

<table>
<tr>
<td></td>
<td>(b)</td>
<td>
<table>
<tr><th>solution</th><th colspan="2">observations</th></tr>
<tr><td rowspan="3">dilute aqueous lead(II) nitrate</td><td>at negative electrode</td><td>Effervescence / bubbles</td></tr>
<tr><td>at positive electrode</td><td>Effervescence / bubbles</td></tr>
<tr><td>in electrolyte</td><td>No change observed</td></tr>
<tr><td rowspan="3">concentrated aqueous copper(II) chloride</td><td>at negative electrode</td><td>Pink / reddish brown deposit</td></tr>
<tr><td>at positive electrode</td><td>Effervescence / bubbles</td></tr>
<tr><td>in electrolyte</td><td>Blue colour fades/ becomes lighter lighter</td></tr>
</table>
1 mark for every 2 correct answers
</td>
<td>Electrolysis
4(e), (f), (g)</td>
<td>A</td>
<td>[3]</td>
</tr>
<tr>
<td></td>
<td>(c)</td>
<td>n[$Pb(NO_3)_2$] = 0.5 x (20/1000) = 0.01 mol
n[$CuCl_2$] = 0.8 x (15/1000) = 0.012 mol [1]

Mole ratio of $Pb(NO_3)_2$: $CuCl_2$ = 1 : 1
n($PbCl_2$) = 0.01 mol [1]

m($PbCl_2$) = 0.01 x (207 + 71) = 2.78 g [1]</td>
<td>Formulae, Stoichiometry and the Mole Concept
3(g), (k)</td>
<td>B</td>
<td>[3]</td>
</tr>
</table>

Candidate Name: ______________________

Class	Index No.

FUHUA SECONDARY SCHOOL

Secondary Four Express

Preliminary Examinations 2017

4E

CHEMISTRY

5073/01

Paper 1 Multiple Choice

28 August 2017
0750 – 0850
1 hour

READ THESE INSTRUCTIONS FIRST

INSTRUCTIONS TO CANDIDATES

Write in soft pencil.

Write your name and index number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet provided.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

A copy of the Periodic Table is printed on page 14.

The use of an approved scientific calculator is expected, where appropriate.

PARENT'S SIGNATURE	FOR EXAMINER'S USE
	/40

Setter: *Mdm Hia Soo Ching*

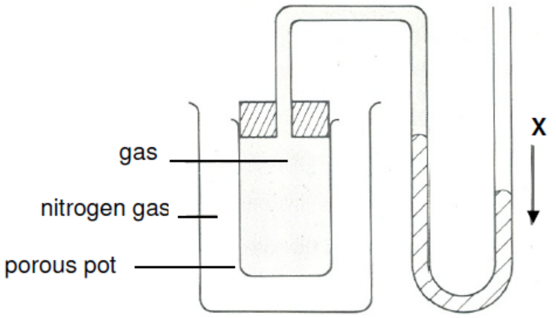
Vetter: *Mr Elton Tan*

This question paper consists of 14 printed pages including this page.

Multiple Choice Questions [40 marks]

Answer **all** questions and shade your answers on the OMR sheet provided.

1 The following apparatus can be used to show the diffusion of gases.



Which of the following gases will cause the liquid level in column X to fall as shown above?

A ammonia
B chlorine
C hydrogen chloride
D sulfur dioxide

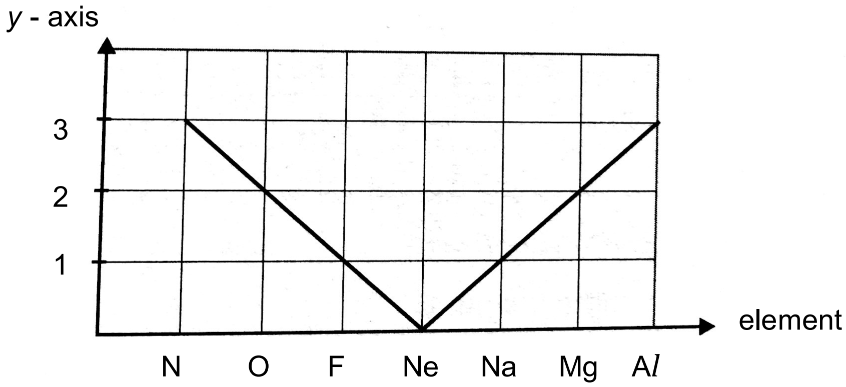
2 Some information on three solids is given below.

solid	solubility in water	solubility in ethanol	action of heat
X	soluble	insoluble	no effect
Y	insoluble	soluble	no effect
Z	soluble	soluble	sublimes

Which of the following procedures could be carried out to obtain a pure sample of Z from a mixture of the three solids?

A Add ethanol to the mixture, filter and collect the residue.
B Add water to the mixture and filter to collect the residue.
C Add ethanol to the mixture, filter and evaporate the filtrate.
D Heat the mixture and condense the gases.

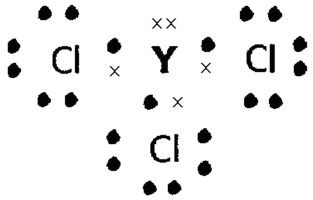
3 The graph below shows information of seven elements in the Periodic Table.



What could the *y*-axis represent?

A atomic number
B number of electron shells
C number of valence electrons
D valency of element

4 The electronic structure of a compound formed between an element Y and chlorine is shown below (only valence electrons are shown).



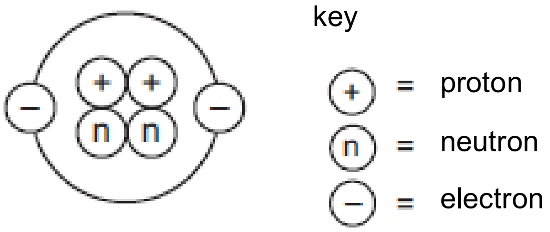
What is the chemical formula when sodium combines with element Y?

A Na_2Y
B NaY_2
C Na_3Y
D Na_5Y

5 An element Z has the electronic structure 2,4.
Z combines with chlorine to form a compound that is most likely a

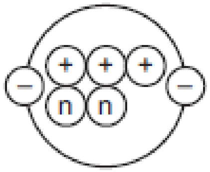
A good conductor of electricity in liquid.
B liquid with a simple molecular structure.
C solid that dissolves in water.
D solid with a giant ionic crystal lattice structure.

6 The diagram shows the structure of an atom.



Which diagram shows the structure of an isotope of this atom?

A



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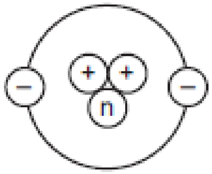

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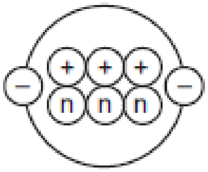
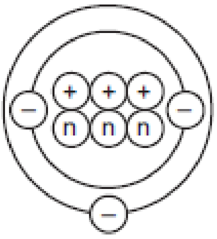


D



7 Which substance has metallic bonding?

substance	electrical conductivity		nature of product formed by reaction between substance and oxygen
	when solid	when liquid	
A	×	√	no reaction
B	×	×	reacts with alkali
C	√	√	reacts with both alkali and acid
D	√	√	does not react with alkali nor acid

8 The compound S_2O_7 reacts with water to produce sulfuric acid and oxygen only.
What volume of oxygen, measured at room temperature and pressure, is evolved when 0.704 g of S_2O_7 is reacted?

A 48 cm^3 **B** 96 cm^3 **C** 192 cm^3 **D** 384 cm^3

9 When solid potassium hydrogen sulfate ($KHSO_4$) is heated strongly, the following reaction occurs:

$$2KHSO_4\ (s) \rightarrow K_2SO_4\ (s) + H_2O\ (g) + SO_3\ (g)$$

What is the loss in mass when 20.4 g of solid potassium hydrogen sulfate is heated?

A 1.35 g **B** 6.00 g **C** 7.35 g **D** 13.10 g

10 Farmers and gardeners often treat soil with ammonium sulfate to increase the nitrogen content in soil. Calcium hydroxide is also often added to soil.
Given that a farmer added both chemicals to soil together, which of the statements below is true?

A Ammonium sulfate increases the pH of soil.
B The calcium hydroxide decreases the pH of the soil.
C Sulfur dioxide is produced in the reaction between ammonium sulfate and calcium hydroxide.
D Ammonium sulfate can react with calcium hydroxide and the nitrogen content of soil does not improve.

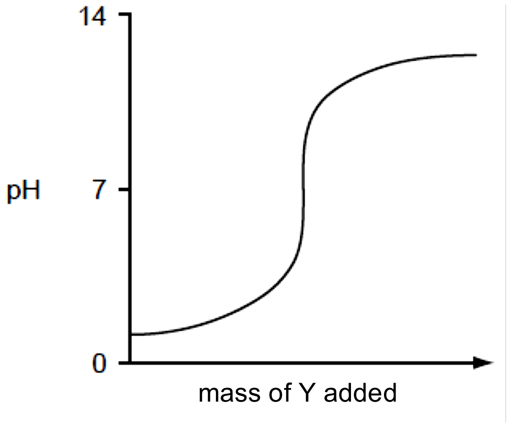
11 The following are some statements on hydroxide, OH^- ions.

- It reacts with hydrogen ions to form water.
- It reacts with aqueous iron(III) sulfate to form a green precipitate.
- It migrates to the cathode in electrolysis of an aqueous solution.
- Its solution gives an alkaline gas when warmed with aqueous ammonium chloride.

How many statements are correct?

A 1 **B** 2 **C** 3 **D** 4

12 Solid Y was added bit by bit with stirring to an aqueous solution of Z.
The changes in pH of the mixture are shown in the graph.



Identify Y and Z.

	Y	Z
A	soluble metal oxide	hydrochloric acid
B	soluble metal oxide	sodium hydroxide
C	insoluble metal oxide	nitric acid
D	insoluble metal oxide	aqueous ammonia

13 What will be the best method for making a sample of lead(II) chloride?

A Add lead(II) sulfate to dilute hydrochloric acid, and filter.
B Add dilute hydrochloric acid to aqueous lead(II) nitrate, and filter.
C Heat powdered lead with aqueous sodium chloride, cool, and filter.
D Pass hot chlorine gas over a heated lump of lead, and cool.

14 The table shows the results of tests carried out to examine the air in an industrial area.

tests carried out with	observations
aqueous calcium hydroxide	white precipitate formed
anhydrous copper(II) sulfate	white solid turned blue
acidified potassium manganate(VII)	purple solution decolourised

Which of the following sets of gases was present in the sample of air?

A CO_2, H_2O, SO_2
B CO_2, H_2O, NO_2
C CO_2, H_2, SO_2
D CO_2, H_2, NO_2

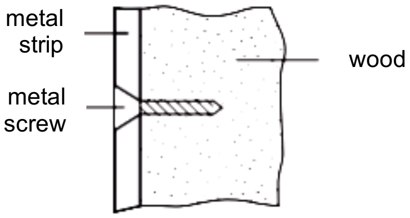
15 Which of the following reactions is neither a reduction nor oxidation reaction?

A Aqueous silver nitrate is added to hydrochloric acid.
B Discharge of hydrogen ions at the cathode.
C Silver chloride is exposed to light.
D Wine turns sour.

16 Alloys are usually harder than the metals from which they are made.
Which difference between the metals explains the greater hardness of alloys?

A densities
B atomic radii
C electrical conductivities
D relative atomic masses

17 An old railway carriage is being restored by having metal strips secured to the outside of the wooden carriage by means of screws.
After a few weeks of being exposed to the wind and rain, the screws are heavily corroded but the metal strips are not.



Which two metals would give this result?

	screw	strip
A	copper	steel
B	copper	zinc
C	steel	copper
D	steel	magnesium

18 When zinc foil is placed in an aqueous solution containing both magnesium chloride and copper(II) sulfate, which element is displaced?

A chlorine
B copper
C hydrogen
D magnesium

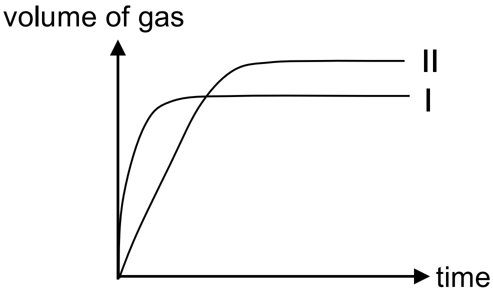
19 Chlorine and iodine are both in Group VII of the Periodic Table.
Which statement about these elements is correct?

A Chlorine is less reactive than iodine.
B Chlorine has a lower melting point than iodine.
C Chlorine and iodine are diatomic gases at room temperature.
D Iodine will react with a solution of sodium chloride.

20 Which statement about alkali metals is true?

A They form metal oxides with water.
B They form covalent bonds with halogens.
C Their reducing powers increase down the group.
D Their melting and boiling points increase down the group.

21 In the graph, curve I represents the result of a reaction between 1.0 g of calcium granules and excess water at 25 °C.



Which alteration to the conditions would produce curve II?

A 1.0 g of calcium powder with excess water at 25 °C.
B 1.0 g of calcium powder with excess water at 50 °C.
C 1.15 g of calcium granules with excess water at 15 °C.
D 1.15 g of calcium granules with excess water at 50 °C.

22 Excess magnesium was reacted with dilute hydrochloric acid at room temperature.

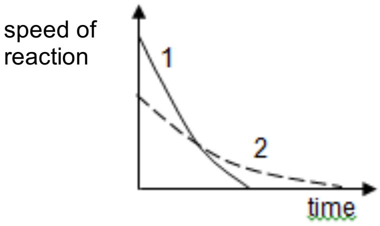
$$Mg\ (s) + 2HCl\ (aq) \rightarrow MgCl_2\ (aq) + H_2\ (g)$$

Two experiments were carried out.

Experiment 1: 40 cm^3 of 1 mol/dm^3 hydrochloric acid
Experiment 2: 15 cm^3 of 2 mol/dm^3 hydrochloric acid

Which graph shows how the speed of reaction varied with time in each experiment?

A



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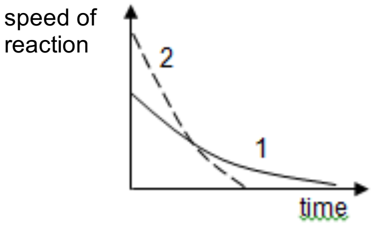
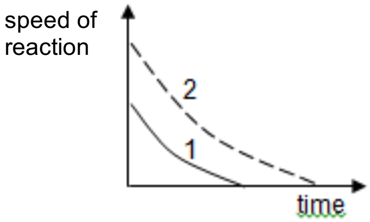
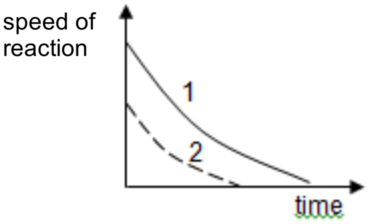


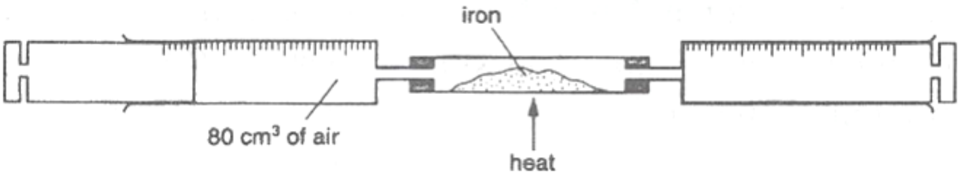
C



D



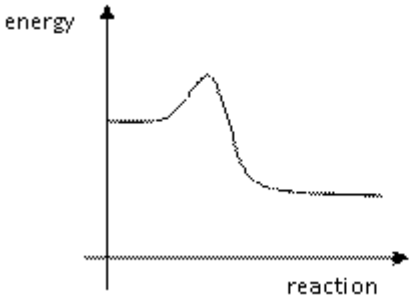
23 An 80 cm^3 sample of air is trapped in a syringe. The air is slowly passed over heated iron in a tube until there is no further decrease in volume.
When cooled to the original temperature, which volume of gas remains?



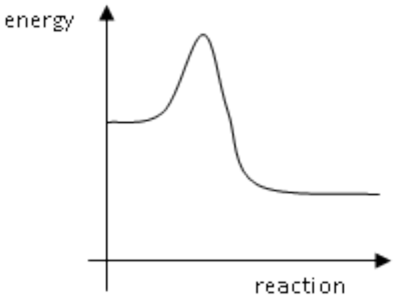
- **A** 16 cm^3
- **B** 24 cm^3
- **C** 63 cm^3
- **D** 80 cm^3

24 Four different chemical reactions are represented in the following energy profile diagrams.
Which diagram shows the slowest endothermic reaction?

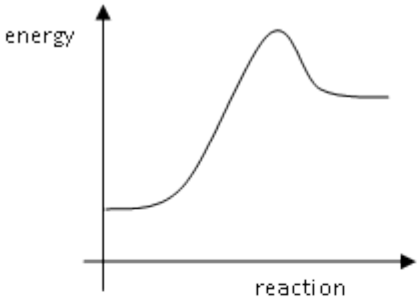
A



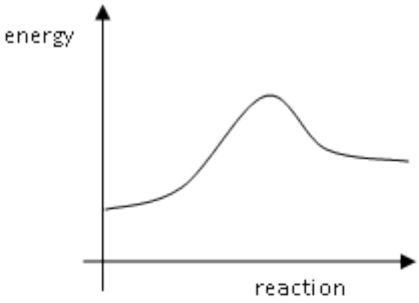
B



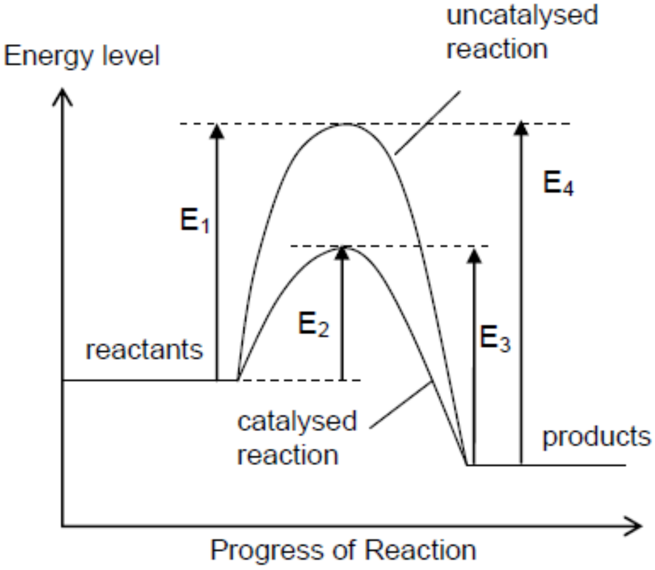
C



D



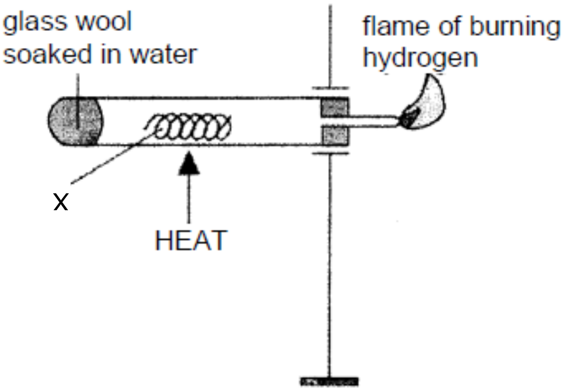
25 The energy profile diagram shows the same reaction that occurred in the absence, and in the presence, of a catalyst.



Which of the following statements is correct when describing the energy changes involved in the reaction?

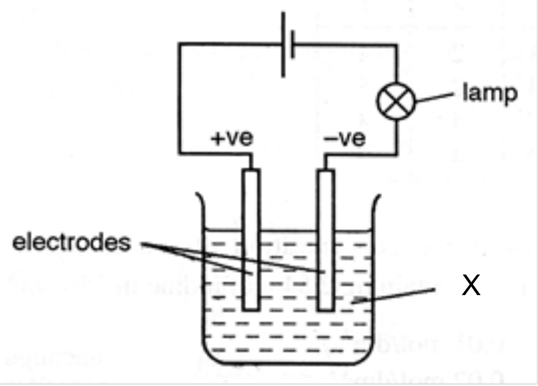
- **A** The forward catalysed reaction is endothermic.
- **B** $(E_4 – E_1)$ is the enthalpy change of the reverse reaction.
- **C** E_2 is the activation energy for the reverse catalysed reaction.
- **D** The enthalpy change of the reaction is decreased by using a catalyst.

26 Based on the setup as shown in the diagram below, what is substance X most likely to be?



- **A** X is a metal below hydrogen in the reactivity series.
- **B** X is a metal above hydrogen in the reactivity series.
- **C** X is an oxide of a metal that is below hydrogen in the reactivity series.
- **D** X is an oxide of a metal that is above hydrogen in the reactivity series.

27 When the circuit in the set-up below is closed, the bulb is lighted up, but X is not decomposed.



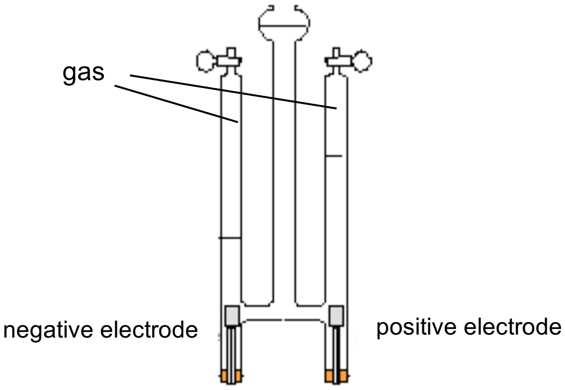
X is likely to be

A mercury
B lead(II) iodide
C aqueous silver nitrate
D concentrated potassium nitrate solution

28 An article to be gold plated is made the cathode (negative electrode) of a cell.
What would be suitable materials for the anode and the electrolyte?

	anode	electrolyte
A	carbon	aqueous gold(II) chloride
B	carbon	dilute hydrochloric acid
C	gold	aqueous gold(II) chloride
D	gold	dilute hydrochloric acid

29 The diagram below shows the electrolysis of a substance after a few hours.



The substance is

A copper(II) sulfate solution
B concentrated hydrochloric acid
C silver nitrate solution
D sodium chloride solution

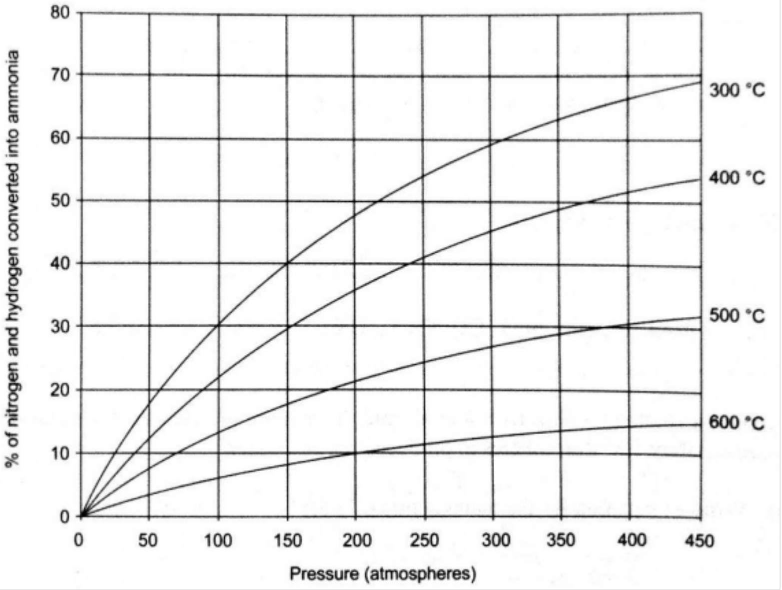
30 Which one of the following chemical equations shows the removal of one or more exhaust gases in a catalytic converter?

A $2CO + 2NO \rightarrow 2CO_2 + N_2$
B $2CO + SO_2 \rightarrow 2CO_2 + S$
C $2SO_2 + O_2 \rightarrow 2SO_3$
D $N_2 + 2O_2 \rightarrow 2NO_2$

31 In an experiment, 2 moles of aluminium ions, Al^{3+} were discharged in the electrolysis of molten aluminium oxide.
Which amount of metal ions would be discharged by an equal amount of electricity in the following experiments?

A 2 mol of Cu^{2+}, in the electrolysis of aqueous copper(II) nitrate
B 3 mol of Pb^{2+}, in the electrolysis of molten lead(II) bromide
C 3 mol of Ag^{+}, in the electrolysis of aqueous silver nitrate
D 6 mol of Zn^{2+}, in the electrolysis of aqueous zinc sulfate

32 The graph below gives the percentage conversion of nitrogen and hydrogen under different conditions.
The equation for the reaction is given as: $N_2 + 3H_2 \rightleftharpoons 2NH_3$ $\Delta H = -92kJ$



Which of the following statements is correct?

A The yield of ammonia increases with increasing pressure.
B Finely divided nickel is used to catalyse the reaction.
C The yield of ammonia increases with increasing temperature.
D The forward reaction for production of ammonia is an endothermic process.

33 Two compounds are thought to be isomers.
Possible similarities and differences are listed below. Which combination would confirm isomerism?

	similarity	difference
A	molecular mass	molecular structure
B	molecular structure	molecular mass
C	chemical properties	physical properties
D	physical properties	chemical properties

34 The following data gives the concentration in parts per billion parts of air, in four industralised cities.
In which city would limestone buildings be under the greatest threat from pollution?

city	carbon monoxide	nitrogen dioxides	ozone
A	0.01	45	21
B	0.03	17	23
C	0.20	38	11
D	3.00	32	30

35 5 g of vegetable oil (M_r = 800) reacted completely with 900 cm^3 of hydrogen gas (measured at room temperature and pressure) to form margarine which is a saturated fat. How many C=C bonds are there in one molecule of the oil?

A 3 **B** 4 **C** 5 **D** 6

36 An alcohol, X, was fully oxidised to a carboxylic acid. Neutralisation of the acid with aluminium oxide gives a salt with the formula $(CH_3CO_2)_3Al$.

What was alcohol X?

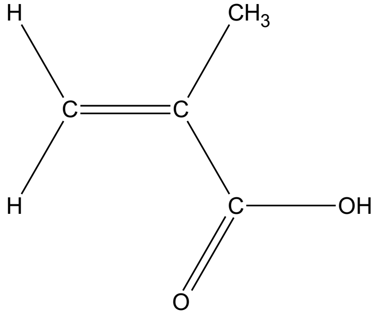
A CH_3OH
B CH_3CH_2OH
C $CH_3CH_2CH_2OH$
D $CH_3CH_2CH_2CH_2\ CH_2CH_2OH$

37 Ethanol can be manufactured from carbohydrates as well as ethene.
The table gives statements about the processes involved.

In which row are both statements **incorrect**?

	process using carbohydrates	process using ethene
A	conversion to ethanol gives a low yield	conversion to ethanol gives a high yield
B	conversion to ethanol uses yeast as a catalyst	conversion to ethanol carried out at less than 100 atm.
C	conversion carried out with the reactants in gaseous state	conversion carried out in aqueous state
D	conversion to ethanol carried out at less than 100 atm.	ethene obtained from fractional distillation of hydrocarbons

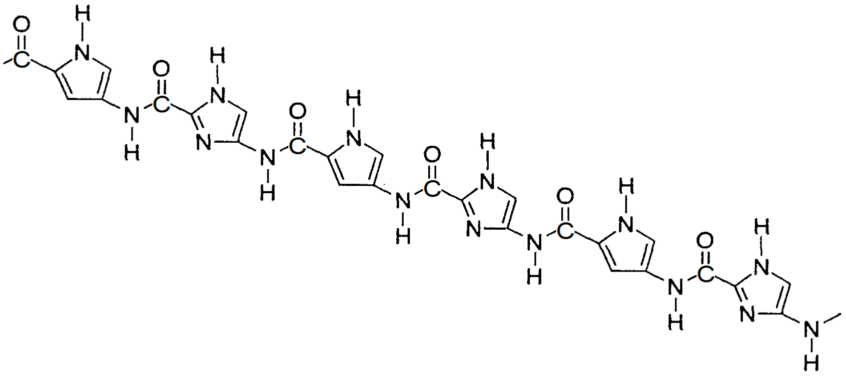
38 An organic compound E has the following structural formula:



Which of the following statements about compound E is true?

A Compound E cannot be polymerised.
B No change in the colour of aqueous bromine when it is added to compound E.
C An aqueous solution of compound E reacts with copper to give hydrogen gas.
D Compound E reacts with ethanol to give a compound with relative molecular mass of 114.

39 The structure below shows part of a polymer.



- It is a polyamide.
- It is formed in an addition polymerisation reaction.
- The partial structure is that of nylon.
- It is formed from two different types of monomers.
- Each monomer has two different functional groups.

How many statements are correct?

A 2 **B** 3 **C** 4 **D** 5

40 The following reactions are carried out.

reaction	result
ethanoic acid is added to magnesium	gas X given off
ammonium ethanoate is warmed with aqueous sodium hydroxide	salt Y formed
ethanoic acid is added to aqueous ammonia	salt Z formed

What are X, Y and Z?

	X	Y	Z
A	ammonia	ammonium hydroxide	water
B	ammonia	sodium ethanoate	ammonium ethanoate
C	hydrogen	ammonium hydroxide	water
D	hydrogen	sodium ethanoate	ammonium ethanoate

End of Paper

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 **H** Hydrogen 1										4 **He** Helium 2
7 **Li** Lithium 3	9 **Be** Beryllium 4											11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
23 **Na** Sodium 11	24 **Mg** Magnesium 12											27 **Al** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulfur 16	35.5 **Cl** Chlorine 17	40 **Ar** Argon 18
39 **K** Potassium 19	40 **Ca** Calcium 20	45 **Sc** Scandium 21	48 **Ti** Titanium 22	51 **V** Vanadium 23	52 **Cr** Chromium 24	55 **Mn** Manganese 25	56 **Fe** Iron 26	59 **Co** Cobalt 27	59 **Ni** Nickel 28	64 **Cu** Copper 29	65 **Zn** Zinc 30	70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **As** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
85 **Rb** Rubidium 37	88 **Sr** Strontium 38	89 **Y** Yttrium 39	91 **Zr** Zirconium 40	93 **Nb** Niobium 41	96 **Mo** Molybdenum 42	**Tc** Technetium 43	101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47	112 **Cd** Cadmium 48	115 **In** Indium 49	119 **Sn** Tin 50	122 **Sb** Antimony 51	128 **Te** Tellurium 52	127 **I** Iodine 53	131 **Xe** Xenon 54
133 **Cs** Caesium 55	137 **Ba** Barium 56	139 **La** Lanthanum 57 *	178 **Hf** Hafnium 72	181 **Ta** Tantalum 73	184 **W** Tungsten 74	186 **Re** Rhenium 75	190 **Os** Osmium 76	192 **Ir** Iridium 77	195 **Pt** Platinum 78	197 **Au** Gold 79	201 **Hg** Mercury 80	204 **Tl** Thallium 81	207 **Pb** Lead 82	209 **Bi** Bismuth 83	209 **Po** Polonium 84	210 **At** Astatine 85	222 **Rn** Radon 86
223 **Fr** Francium 87	226 **Ra** Radium 88	227 **Ac** Actinium 89 †															
				140 **Ce** Cerium 58	141 **Pr** Praseodymium 59	144 **Nd** Neodymium 60	147 **Pm** Promethium 61	150 **Sm** Samarium 62	152 **Eu** Europium 63	157 **Gd** Gadolinium 64	159 **Tb** Terbium 65	162 **Dy** Dysprosium 66	165 **Ho** Holmium 67	167 **Er** Erbium 68	169 **Tm** Thulium 69	173 **Yb** Ytterbium 70	175 **Lu** Lutetium 71
				232 **Th** Thorium 90	231 **Pa** Protactinium 91	238 **U** Uranium 92	237 **Np** Neptunium 93	244 **Pu** Plutonium 94	243 **Am** Americium 95	247 **Cm** Curium 96	247 **Bk** Berkelium 97	251 **Cf** Californium 98	252 **Es** Einsteinium 99	257 **Fm** Fermium 100	258 **Md** Mendelevium 101	259 **No** Nobelium 102	260 **Lr** Lawrencium 103

* 58–71 Lanthanoid series
† 90–103 Actinoid series

Key

a **X** b

a = relative atomic mass
X = atomic symbol
b = atomic (proton) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

	Class	Index No.
Candidate Name:		

FUHUA SECONDARY SCHOOL

Secondary Four Express

Preliminary Examinations 2017

4E

Fuhua Secondary Fuhua Secondary Fuhua Secondary Fuhua Secondary Fuhua Secondary Fuhua Secondary Fuhua Secondary Fuhua Secondary Fuhua Secondary
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CHEMISTRY 5073/02

Paper 2

18 August 2017
1045 – 1230
1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number in the spaces provided on top of this page.

Write in dark blue or black pen.

You may use a HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

Section A (50 marks)
Answer **all** questions.
Write your answers in the spaces provided.

Section B (30 marks)
Answer all **three** questions, the last question is in the form of either/or.
Write your answers in the spaces provided.

The number of marks is given in brackets [ ] at the end of each question or part question.

A copy of the Periodic Table is printed on page 19.

The use of an approved scientific calculator is expected, where appropriate.

PARENT'S SIGNATURE

FOR EXAMINER'S USE		
Section A	Section B	**Total**
/50	**/30**	**/80**

Setter: Mdm Hia Soo Ching

Vetter: Mr Elton Tan

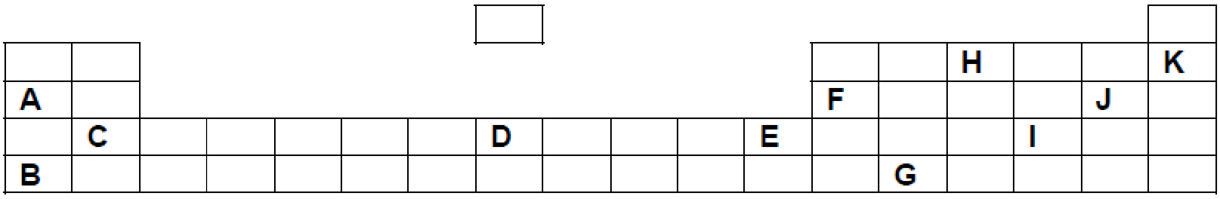
This question paper consists of 19 printed pages including this page.

Section A

Answer **all** the questions in the spaces provided.

The total mark for this section is 50.

A1 In the Periodic Table below, the letters **A** to **K** represent some elements but not the symbols of the respective elements.



Use the letter(s) to identify and answer the following questions.

(a) A metal that sinks in and reacts vigorously with water

____ [1]

(b) An oxidising gas.

____ [1]

(c) A monoatomic element.

____ [1]

(d) An element which forms an ion with charge +2 and +3.

____ [1]

(e) The formula of the compound formed between **H** and **J**.

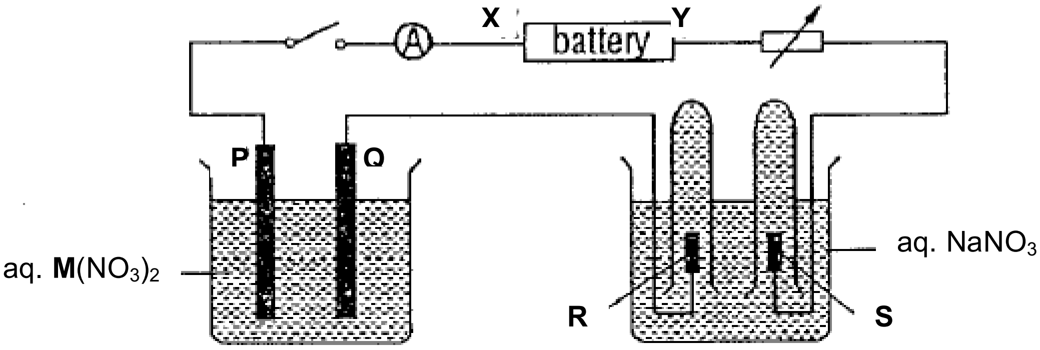
____ [1]

[Total: 5]

A2 The following experiment was set up for the electrolysis of aqueous **M**(NO_3)$_2$ and aqueous sodium nitrate. Electrode **Q** is made up of metal **M**.

Electrodes **P**, **R** and **S** are made of platinum.

X and **Y** are terminals of the battery.
When the switch was closed, metal **M** began to deposit at electrode **P**, and gas bubbles appeared above **R** and **S**.



(a) Deduce the polarity (positive or negative) of the terminals **X** and **Y** of the battery.

X: ______________________________

Y: ______________________________ [1]

(b) Write an ionic equation for the reaction occurring at electrode **P**. Include state symbols.

______________________________ [1]

(c) After the electrolysis has been carried out for 30 minutes, 200 cm^3 of gas, measured at room temperature and presure, was collected in the test tube at electrode **R**.

(i) Name the gas collected in the test tube at electrode **R**.

______________________________ [1]

(ii) Estimate the volume of gas collected in the test tube at electrode **S**.

______________________________ [1]

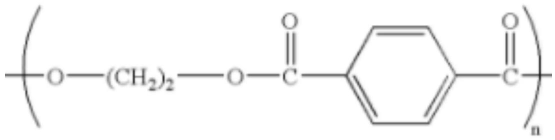
(iii) If the relative atomic mass of metal **M** is 64, calculate the gain in mass of electrode **P**.

[3]

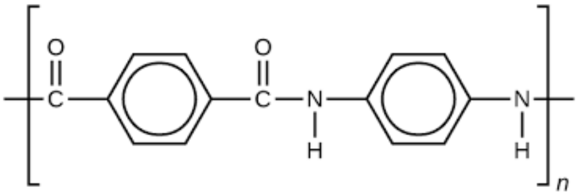
[Total: 7]

A3 The diagram below shows the structure of some polymers **A**, **B**, **C** and **D**.

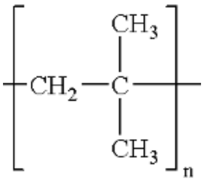
A



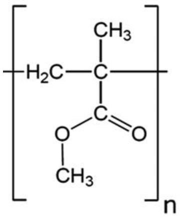
B



C



D



(a) A sample of **C** contain molecules with an average relative molecular mass of 14 000. How many carbon atoms are there in an average molecule of the polymer?

[1]

(b) Which of the statements would you predict to be true and which to be false? Put a tick (√) in one box in each row.

	true	false
D is a polyester.		
Water is formed as a by-product when monomers react to form **A** and **B**.		
The empirical formula of **C** is the same as its monomer.		
One of the monomers that react to form **B** is an alcohol.		

[2]

(c) Draw the displayed formulae of the monomers that react to form **A**.

[2]

(d) **(i)** Draw the structural formula of the monomer that react to form **D**.

[1]

(ii) The monomer in **(d)(i)** can be formed by reacting an acid and an alcohol under suitable conditions.
Draw the structural formulae of the acid and alcohol.

[2]

(iii) State the conditions required for the reaction in **(d)(ii)**.

____ [1]

(e) **A**, **B**, **C** and **D** are non-biodegradable.
Explain why being non-biodegradable is both an advantage and a disadvantage.

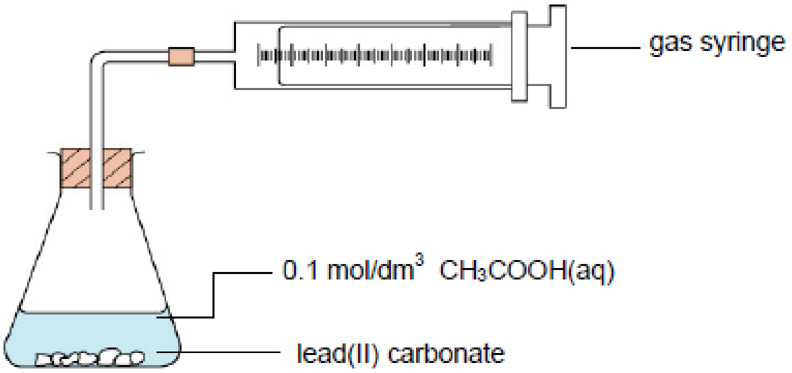
____

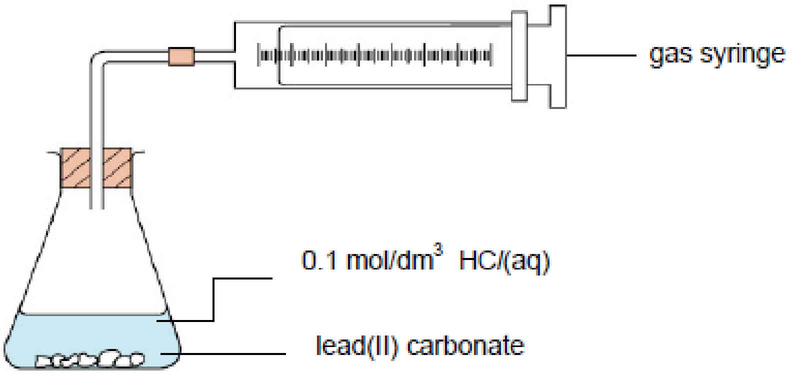
____

____ [2]

[Total: 11]

A4 A student conducted an experiment using hydrochloric acid and ethanoic acid to prepare two different salts. The experimental setup used is shown below.





(a) Hydrochloric acid is a strong acid, ethanoic acid is a weak acid.
Describe a **simple** test to show which is the strong acid and which is the weak acid.

.

[2]

(b) State the chemical formulae of the **two** salts formed from the above experiment

[2]

(c) The student recorded down the following observations.

> "*Slower effervescence is observed with ethanoic acid at the beginning of the experiment but the gas syringe is pushed further away from its initial position at the end of the experiment.*"

Explain the above observations made.

[4]

(d) An exothermic change occurred in both reactions mentioned above.
Define *exothermic change*.

____

. ____ [1]

[Total: 9]

A5 Copper can be extracted by two different extraction processes involving low grade ore, chalcopyrite, $CuFeS_2$. The ore is first crushed in huge cylindrical ball mills.

The following show information about these processes.

process	roasting & smelting	leaching
main process	The concentrated ore is then heated in the furnace to about 700 °C in the presence of oxygen according to the following equation: $2CuFeS_2(s) + 3O_2(g) \rightarrow 2FeO(s) + 2CuS(s) + 2SO_2(g)$ The iron(II) oxide impurities are then removed by heating to over 1200 °C silica.	The ore is treated with dilute sulfuric acid and converts insoluble chalcopyrite into a solution containing Cu^{2+}, Fe^{2+}, Fe^{3+} and SO^{2-} ions.
conversion	Copper(II) sulfide is reduced to copper by further heating with oxygen.	Copper can also be extracted from solutions of copper(II) salts using scrap iron.

(a) Suggest **two** environmental reasons and why the extraction of copper by leaching is preferable to the roasting and smelting process.

____

____

____ [2]

.

(b) The leaching process uses lesser energy than the roasting and smelting process. Use the information in the table to explain why.

____

____

____ [2]

.

(c) **(i)** Give the ionic equation for the reaction involved in the recovery of solid copper from an aqueous solution using scrap iron.

____ [1]

(ii) Can zinc or magnesium be used in place of iron?
Explain why.

[2]

(d) The copper obtained from these two processes is only 95% pure. This impure copper has to be further refined by electrolysis to obtain copper of 99% purity for use in electrical wiring.

Draw and label an electrolytic cell diagram to demonstrate the electrolytic refining of copper.

.

[2]

[Total: 9]

A6 When zinc is added to a solution of copper(II) sulfate, a displacement reaction takes place. The equation for this reaction is given below:

$$Zn + CuSO_4 \rightarrow Cu + ZnSO_4 \quad \Delta H = -220 \text{ kJ/mol}$$

(a) Complete the energy profile diagram.

Your diagram should include

- formulae of reactants and products
- enthalpy change of reaction
- activation energy

[2]

(b) In an experiment, 20 cm^3 of copper(II) sulfate solution is reacted with excess zinc powder. The amount of heat evolved is found to be 1.76 kJ.

Calculate the concentration, in mol/dm^3, of the copper(II) sulfate solution used.

[2]

[Total: 4]

A7 Some physical properties of chlorides of carbon and lead are shown in the table below.

chloride	melting point/°C	electrical conductivity
tetrachloromethane, CCl_4	-23	does not conduct in any state
lead(II) chloride, $PbCl_2$	498	good conductor in molten state but non-conductor in aqueous solution

(a) Draw a 'dot and cross' diagram to show the bonding in tetrachloromethane
Show outer electrons only.

[1]

(b) Explain why tetrachloromethane and lead(II) chloride have different properties.

____

____

____

____

____

____

____

____ [4]

[Total: 5]

Section B: Free Response Questions [30 marks]

Answer all **three** questions in this section.

The last question is in the form of an either/or and only one of the alternatives should be attempted.

B8 Read the information about the oxides of elements in Period 3 of the Periodic Table.

The formulae and the chemical properties of the oxides and chlorides of the elements change across Period 3.

element	metal/non-metal	formula of main oxide	bonding in oxide	formula in chloride	bonding in chloride
Na	metal	Na_2O	ionic	$NaCl$	ionic
Mg	metal	MgO	ionic	$MgCl_2$	ionic
Al	metal	Al_2O_3	ionic	$AlCl_3$	covalent
Si	non-metal	SiO_2	covalent	$SiCl_4$	covalent
P	non-metal	P_4O_{10}	covalent	PCl_3	covalent
S	non-metal	SO_3	covalent	S_2Cl_2	covalent
Cl	non-metal	Cl_2O_7	covalent	Cl_2	covalent

Electronegativity refers to the tendency of an atom to attract electrons to itself.
Metals tend to have low electronegativities while non-metals have high electronegativities.
The electronegativity values of Period 3 elements are shown in the table below.

element	electronegativity of each element
Na	0.9
Mg	1.2
Al	1.6
Si	1.8
P	2.1
S	2.5
Cl	3.0

Oxygen has electronegativity of 3.5.

The difference in the electronegativities between each element and oxygen can be calculated. Some examples are shown the table below.

formula of oxides	difference in electronegativities between each element and oxygen
Na_2O	2.6
MgO	2.3
Al_2O_3	2.1

(a) Describe the pattern for the difference in electronegativities between each element and oxygen across Period 3.

[2]

(b) With reference to atomic structure, give reason(s) why the electronegativity of oxygen is higher than that of any element in Period 3.

[2]

(c) A student wrote the following conclusion by studying the results.

> "The bonds in the oxides and chlorides are covalent when the difference in electronegativities is less than 2.0."

Do you agree with this conclusion?
Use the results to explain your reasoning.

[4]

(d) The electronegativity of beryllium is 1.57. Predict the bonding in beryllium chloride and beryllium oxide.
Explain your answer.

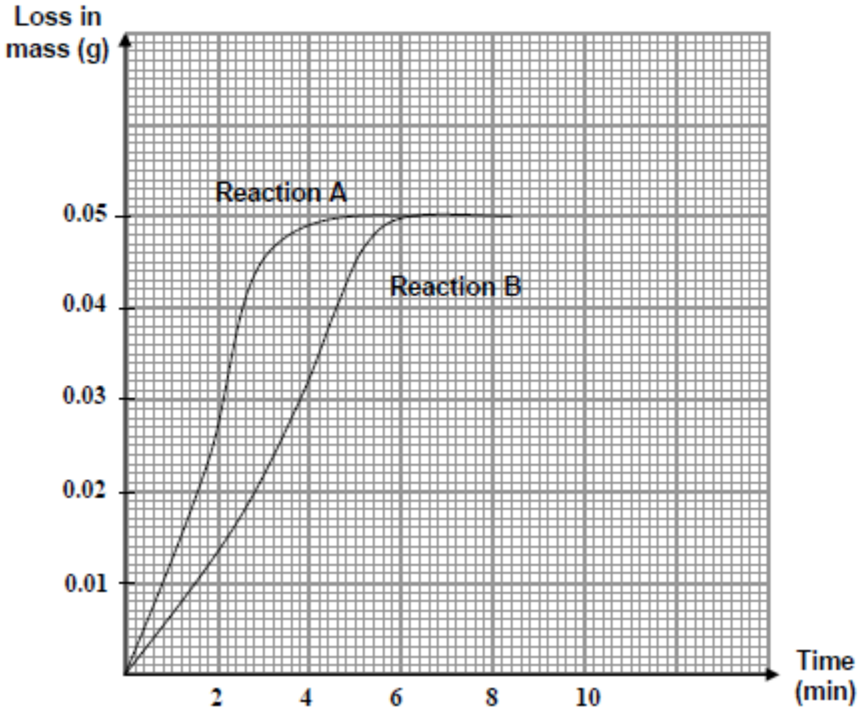
[2]

(e) Suggest, with reason(s), an electronegative value for argon.

[2]

[Total:12]

B9 The graphs below show the reaction of zinc with dilute nitric acid in two different reactions. The beaker and its contents were weighed every two minutes and the loss in mass was recorded.



(a) **(i)** In Reaction **A**, 1.625 g of large lumps of zinc was added to 250 cm^3 of dilute nitric acid of 0.500 mol/dm^3 in a beaker.
Explain the cause of the loss in mass.

____

____ [1]

(ii) Determine the limiting reactant.
Show your working clearly. [2]

(b) In Reaction **B**, the reaction was repeated using 1.625 g of large lumps of zinc added to 250 cm^3 of dilute nitric acid of 0.500 mol/dm^3 in a beaker at a lower temperature.
All other conditions of the reaction remained the same.

Explain the difference in initial speed of reaction for reaction **B**.

____

____

____

____ [2]

(c) A third reaction, Reaction **C**, is repeated with the addition of 50 cm^3 of aqueous copper(II) sulfate.

Two students predict the results of this experiment.

Student 1: 'The initial rate of reaction is **slower** as the aqueous copper(II) sulfate is an impurity.'

Student 2: 'The loss in mass is **lesser** as the aqueous copper(II) sulfate reacts with one of the reactants.'

Do you agree with the students?

Explain your reasoning.

____

____

____

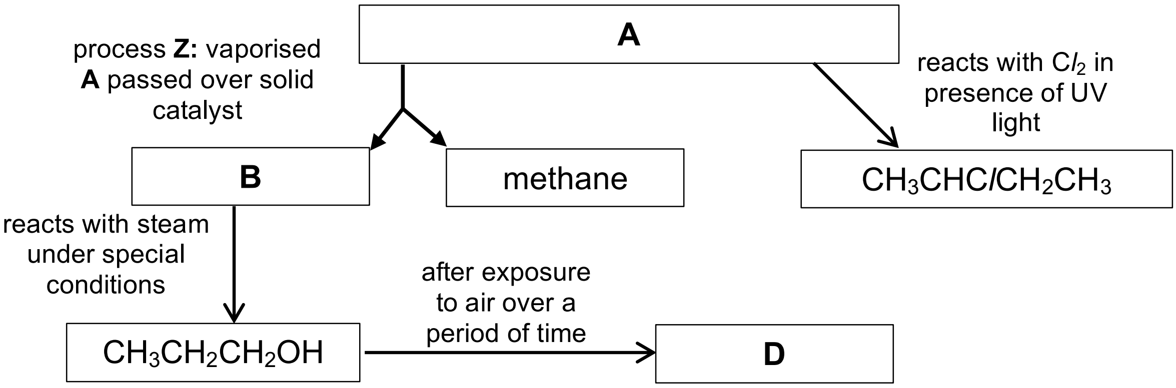
____

____ [3]

[Total: 8]

B10 ***Either***

The reaction scheme of organic compound **A** is shown below.



(a) **(i)** Name the process **Z** and state the solid catalyst used.

[2]

(ii) Describe a test to differentiate compound **A** from **B**.

[2]

(iii) Construct a balanced chemical equation for process **Z**.

[1]

(b) Describe a test to prove that $CH_3CH_2CH_2OH$ has been completely converted to **D**.

[2]

(c) **(i)** Molecules of **B** can undergo addition polymerisation to form a polymer with a relative molecular mass of 33600. How many monomers of **B** are required to form this polymer?

[1]

(ii) With reference to their structures, state one similarity and one difference between monomer B and its polymer,

____

____

____ [2]

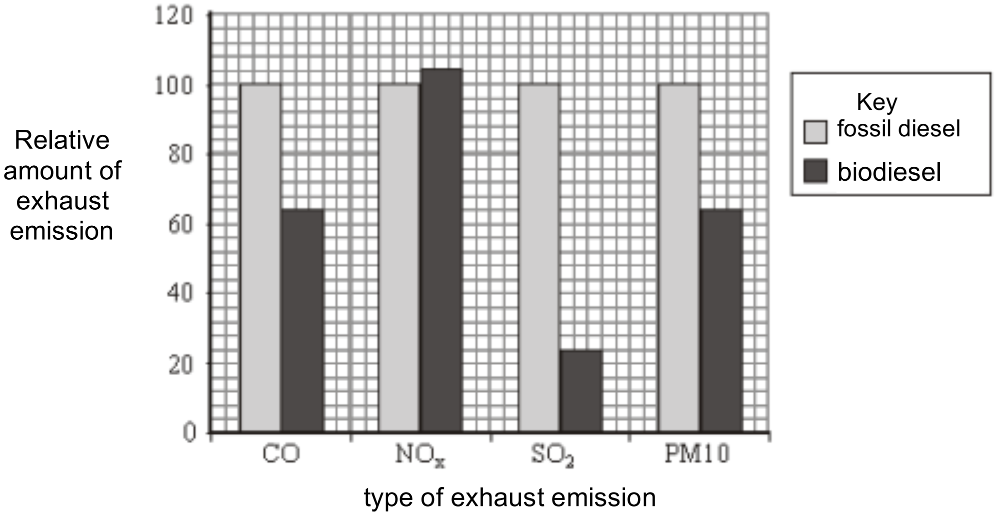
[Total: 10]

B10 ***OR***

Diesel obtained from crude oil is often called fossil diesel.
Biodiesel can be made from many vegetable oils.

Tiny particles of solids are produced when the fuel does not burn completely. This increases the level of particulates (PM10) in the atmosphere. These particles are small enough to pass through the throat and nose and enter the lungs.

One research project compared the exhaust emissions when fossil diesel or biodiesel were used as fuels. Some of the relative amounts of these exhaust emissions are shown in the bar chart.



(a) **(i)** Using the data given, compare the exhaust emission between fossil diesel and biodiesel.

____

____

____ [2]

(ii) Exhaust emissions from fossil diesel cause more harm to human health than those from biodiesel. Explain why.

____

____

____

____ [2]

(b) Some scientists suggest that biodiesel is ***carbon neutral***. Explain why.

____

____

____ [2]

(c) Refrigerants are substances used to cool refrigerators and freezers. Until recently, many of the compounds used as refrigerants were chlorofluorocarbons (CFCs), but these are now known to form chlorine radicals. One such compound is $CFCl_3$.

$$CFCl_3 \xrightarrow{\text{UV light}} CFCl_2 + Cl$$

The Cl atom reacts with ozone in a two-step reaction.

Step 1: $Cl + O_3 \rightarrow ClO + O_2$
Step 2: $ClO + O \rightarrow Cl + O_2$

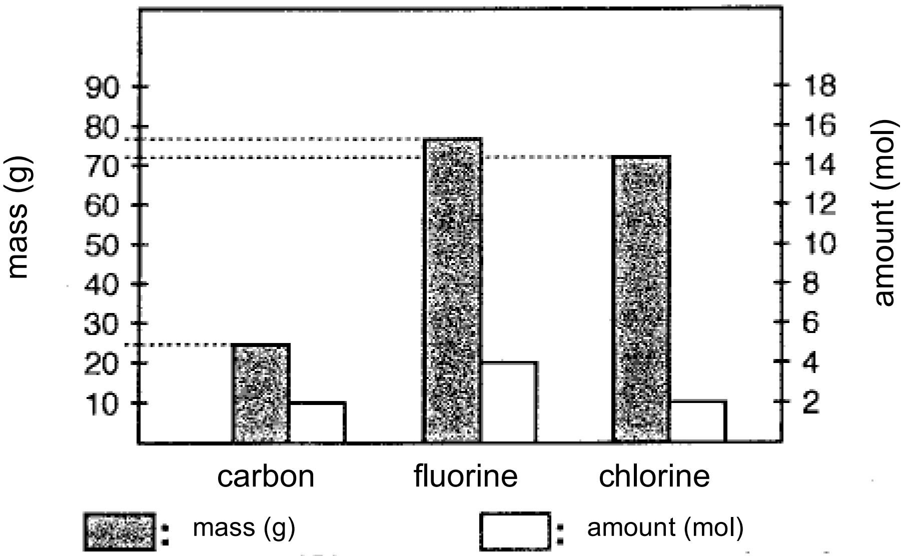
(i) One molecule of $CFCl_3$ can destroy thousands of ozone molecules. Explain why.

____

____

____ [2]

(ii) The graph below shows the mass and amount of carbon, fluorine and chlorine atoms in one mole of a certain compound of CFCs found in the aerosol can of hairspray.



Using the above information, determine the molecular formula of this CFCs compound.

[2]

[Total: 10]

End of Paper

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 **H** Hydrogen 1										4 **He** Helium 2
7 **Li** Lithium 3	9 **Be** Beryllium 4											11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
23 **Na** Sodium 11	24 **Mg** Magnesium 12											27 **Al** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulfur 16	35.5 **Cl** Chlorine 17	40 **Ar** Argon 18
39 **K** Potassium 19	40 **Ca** Calcium 20	45 **Sc** Scandium 21	48 **Ti** Titanium 22	51 **V** Vanadium 23	52 **Cr** Chromium 24	55 **Mn** Manganese 25	56 **Fe** Iron 26	59 **Co** Cobalt 27	59 **Ni** Nickel 28	64 **Cu** Copper 29	65 **Zn** Zinc 30	70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **As** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
85 **Rb** Rubidium 37	88 **Sr** Strontium 38	89 **Y** Yttrium 39	91 **Zr** Zirconium 40	93 **Nb** Niobium 41	96 **Mo** Molybdenum 42	**Tc** Technetium 43	101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47	112 **Cd** Cadmium 48	115 **In** Indium 49	119 **Sn** Tin 50	122 **Sb** Antimony 51	128 **Te** Tellurium 52	127 **I** Iodine 53	131 **Xe** Xenon 54
133 **Cs** Caesium 55	137 **Ba** Barium 56	139 **La** Lanthanum 57 *	178 **Hf** Hafnium 72	181 **Ta** Tantalum 73	184 **W** Tungsten 74	186 **Re** Rhenium 75	190 **Os** Osmium 76	192 **Ir** Iridium 77	195 **Pt** Platinum 78	197 **Au** Gold 79	201 **Hg** Mercury 80	204 **Tl** Thallium 81	207 **Pb** Lead 82	209 **Bi** Bismuth 83	209 **Po** Polonium 84	210 **At** Astatine 85	222 **Rn** Radon 86
223 **Fr** Francium 87	226 **Ra** Radium 88	227 **Ac** Actinium 89 †															
				140 **Ce** Cerium 58	141 **Pr** Praseodymium 59	144 **Nd** Neodymium 60	147 **Pm** Promethium 61	150 **Sm** Samarium 62	152 **Eu** Europium 63	157 **Gd** Gadolinium 64	159 **Tb** Terbium 65	162 **Dy** Dysprosium 66	165 **Ho** Holmium 67	167 **Er** Erbium 68	169 **Tm** Thulium 69	173 **Yb** Ytterbium 70	175 **Lu** Lutetium 71
				232 **Th** Thorium 90	231 **Pa** Protactinium 91	238 **U** Uranium 92	237 **Np** Neptunium 93	244 **Pu** Plutonium 94	243 **Am** Americium 95	247 **Cm** Curium 96	247 **Bk** Berkelium 97	251 **Cf** Californium 98	252 **Es** Einsteinium 99	257 **Fm** Fermium 100	258 **Md** Mendelevium 101	259 **No** Nobelium 102	260 **Lr** Lawrencium 103

* 58–71 Lanthanoid series
† 90–103 Actinoid series

Key

a **X** b	a = relative atomic mass **X** = atomic symbol b = atomic (proton) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

2017 Preliminary Examination **Fuhua Secondary School**
Marking scheme for Secondary 4
CHEMISTRY 5073

Paper 1 (Multiple choice questions)

Qn	Ans	Qn	Ans	Qn	Ans	Qn	Ans
1	A	11	B	21	C	31	B
2	D	12	A	22	B	32	A
3	D	13	B	23	C	33	A
4	C	14	A	24	C	34	A
5	B	15	A	25	B	35	D
6	B	16	B	26	B	36	B
7	C	17	C	27	A	37	C
8	A	18	B	28	C	38	D
9	C	19	B	29	D	39	B
10	D	20	C	30	A	40	D

Paper 2 (Structured and Free Response)

A1 **(a)** B [1]

(b) J [1]

(c) K [1]

(d) D [1]

(e) HJ_3 [1]

A2 **(a)** **X**: negative **Y:** positive [1]

(b) $M^{-2+}(aq) + 2e^- \rightarrow M(s)$ [1]

(c) **(i)** hydrogen [1]

(ii) 100 cm^3 [1]

(iii) $2H^+(aq) + 2e^- \rightarrow H_2(g)$ [3]
No. of moles of hydrogen gas = 200/24000 = 0.0083333 [1]
No. of moles of electrons = 0.01667 [1]
No. of moles of M = 0.01667 /2 = 0.0083333
Mass of M = 0.0083333 × 64 = 0.533 g [1]

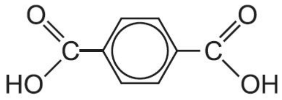
A3 **(a)** 1000 [1] [1]

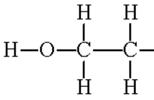
(b)

	true	false
D is a polyester.		√
Water is formed as a by-product when monomers react to form **A** and **B**.	√	
The empirical formula of **C** is the same as its monomer.	√	
One of the monomers that react to form **B** is an alcohol.		√

4 √ : [2]
1-3 √ : [1]
[2]

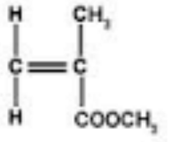
(c)


[1]

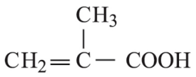

ethane-1,2-diol [1] [2]

need to show all bonds, including –O-H bond

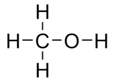
(d) **(i)**


[1]

(ii)


$CH_2=C(CH_3)-COOH$

[1] and


[1] [2]

(iii) Warming/heating with concentrated sulfuric acid [1] [1]

(e) Disadvantage: Polymer can only be disposed off by burying in landfills which will lead to land or air pollution.[1]

Advantage: Polymer is durable and resistant to corrosion. [1] [2]

A4 **(a)** Measure pH of the acid samples with a pH meter, [1] [2]
if the acid gives a lower pH reading such as 1 or 2, it is a strong acid while acid that gives a higher pH reading such as 3 or 4 is a weak acid. [1]

OR

Add two or three drops of Universal indicator into each acid sample separately. If the UI produced a red colour, the acid is a strong acid. If the UI produced a yellow or orange colour, the acid is a weak acid.

(b) $(CH_3COO)_2Pb$ [1]
$PbCl_2$ [1]

(c) Ethanoic acid dissociate partially in aqueous solution to produce H^+ ions [1]
Ethanoic acid produces a lower initial concentration of H^+ ions in aqueous solution than hydrochloric acid [1]
Hence produces a slower initial rate of reaction.
[Accept RA for hydrochloric acid]

Lead(II) carbonate reacts with hydrochloric acid to form **insoluble** lead(II) chloride [1]
which coats around lead(II) carbonate and prevents it from further reaction with acid. [1]
gives a low yield of carbon dioxide gas.
[Accept RA for ethanoic acid] [4]

(d) An exothermic change refers to a chemical reaction in which energy is given out to the surroundings [1]

A5 **(a)** Lesser fossil fuels burnt (reduced energy requirements in leaching process) hence reducing CO_2 produced, a greenhouse gas which leads to reduced effect on global warming OR
conserves resources/fossil fuels [1]

No SO_2 gas produced, an air pollutant which causes acid rain [1] [2]

(b) The roasting and smelting required high energy demands such as

heating to a high temperature of 700 °C during the roasting of the ores, 1200 °C for the removal of iron(II) oxide impurities and additional heating of copper(II) oxide and oxygen during conversion (list any two) [1]

as compared to leaching where no heating is required.[1] [2]

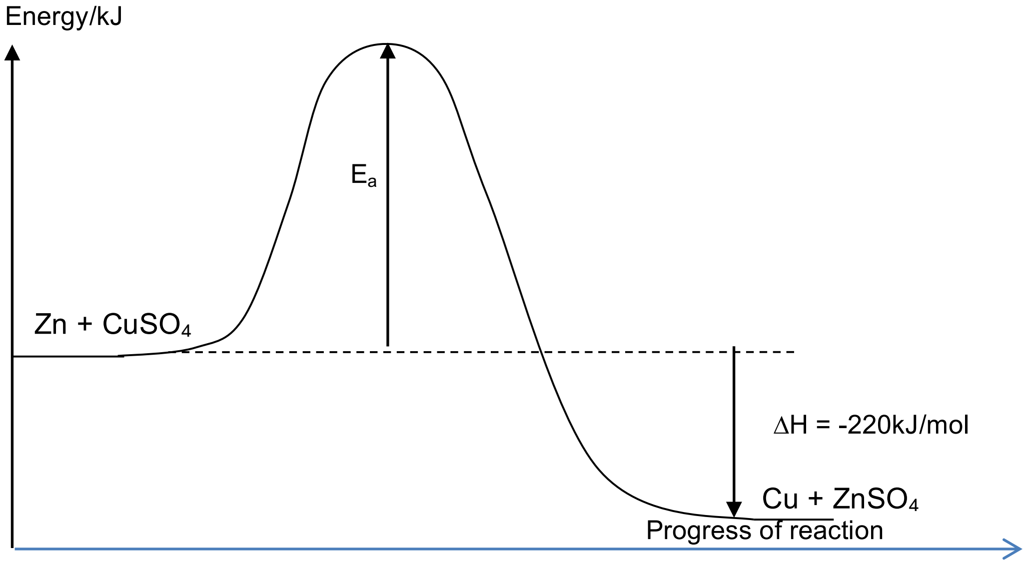
(c) **(i)** $Cu^{2+}(aq) + Fe(s) \rightarrow Fe^{2+}(aq) + Cu(s)$ [1] [1]

(ii) No. Magnesium and zinc is more reactive than iron [1] [2]
and will displace iron from the aqueous solution as well. [1]
Copper obtained would be contaminated with iron.

(d) Electrolyte: any aqueous copper(II) solution[;]
Anode: impure copper[;] [2]
Cathode: pure copper[;]
Battery and wires [;]

4; - [2]

A6 **(a)** [2]



E_a (arrow head upwards) ;
ΔH(arrow head downwards wards) ;
Label reactants & products: ;
3; - [2]
1-2; [1]

(b) No. of moles of $CuSO_4$ = 1.76/220 = 0.008 [1] [2]
Concentration of $CuSO_4$ used = 0.008/(20/1000) = 0.400 mol/dm^3 [1]

A7 **(a)** Non bonded electrons [;] [1]
Bonded electrons [;]

(b) Electrical conductivity: [4]
Tetrachloromethane molecules are electrically neutral. There are no mobile ions and electrons to conduct electricity.[1]

Whereas lead(II) chloride is insoluble in water and hence ions are held in fixed position and are not mobile[;]
Pb^{2+} and Cl^- ions are mobile in aqueous solution that can act as charged carriers.[;]
2; - 1

Melting point:
Tetrachloromethane has a simple molecular structure consisting of molecules held by weak intermolecular forces of attraction. [;]
Lead (II) chloride has a giant ionic lattice structure consisting of oppositely charged ions held by strong electrostatic forces of attraction. [;]
A larger amount of energy is required to overcome the forces in lead (II) chloride. [;]
3; [2]

B8

(a) The difference in electronegativity between each element and oxygen decreases from 2.6 for Na to 0.5 for C*l* across the period. [2]

Trend [1], quote data [1]

(b) Oxygen atom has one lesser electron shell (2 electron shells) than each element in Period 3 [1] [2]

Hence there is a stronger electrostatic attraction between the positively charged nucleus and the valence electrons [1]

(c) The student's conclusion is true for oxides. [3]
The difference in electronegativities between Si, P and Cl and O is less than 2.0 and bond character is covalent. [1]

His conclusion does not apply for chlorides.
The difference in electronegativities between Mg and Cl is less than 2.0 at 1.8 and the bond is ionic. [1]

Data cited for both statements [1]

(d) Bond nature in beryllium chloride is covalent and that in beryllium oxide is ionic .[1] [2]

Since the electronegativity of beryllium is approximately same as aluminium. [1]

(e) 0.0 [1] [2]
Argon is unreactive as it has a stable complete electronic configuration and
Hence unlikely to attract electrons to itself.[1]

B9

(a) **(i)** Hydrogen gas produced escapes from the reaction mixture. [1]

(ii) Loss in mass = mass of hydrogen = 0.05 g
No. of moles of hydrogen = 0.05/2 = 0.025
No. of moles of Zn required = 0.025
Actual no. of moles of Zn provided = 1.625/65 = 0.025
OR
No. of moles of acid used = 0.025× 2 = 0.05
Actual no. of moles of acid = 250/1000 × 0.500 = 0.125

[1] for working
The limiting reactant is Zn. [1] [2]

(b) As the temperature of the water decreases,
Nitric acid and Zn particles lose energy and move slower [;]
lesser reacting particles have energy equal or more than the activation energy[;]
1; to get first mark

leading to lowered frequency of effective collision between Zn and nitric acid. [1] [2]

(c) I disagree with student 1.
The initial rate of reaction is slower because adding 50 cm^3 of aqueous solution **decreases the concentration of H^+ ions in the solution** [1] thereby decreasing the rate of reaction.

I agree with student 2.
Zinc displaces copper from aqueous copper (II) sulfate. [;]
Lesser no. of moles of Zn is available for reaction with nitric acid.[;]
2; -[1] [3]
Hence lesser volume of hydrogen gas produced.[1]

B10 Either

(a) **(i)** Cracking [1]
Mixture of aluminium oxide and silicon(IV) oxide catalyst [1] [2]

(ii) Add samples of A and B to aqueous bromine. [;]
If reddish brown aq. bromine decolourises rapidly, sample is A,
If aq. bromine remains reddish brown, sample is B.

3; [2]
1-2; [1] [2]

(iii) $C_4H_{10} \rightarrow CH_4 + C_3H_6$ [1] [1]

(b) Add acidified potassium manganate(VII) and warm the mixture [1]
If acidified potassium manganate(VII) remains purple, C is 100% converted to D [1] [2]

(c) **(i)** M_r of **B**(propene) = 42

Number of monomers = 33600/42 = 800 [1]

(ii) Similarity:
Same empirical formula as the monomer. [1]
Difference:
Monomer is unsaturated while polymer is saturated[1] [2]

B10OR

(a) **(i)** The amounts of CO, SO_2 and PM10 emissions are lower when using biodiesel than fossil diesel. [1] On the contrary, the amount of NOx exhaust emission is higher when burning biodiesel than fossil diesel. [1] [2]

(ii) There is more amount of CO produced. CO is a pollutant which binds irreversibly with haemoglobin in red blood cell to form carboxyhaemoglobin, impairing its ability to transport oxygen causing breathing difficulties and death. [1]

There is more SO_2 produced. SO_2 irritate the eyes and lungs and causes breathing difficulties [1] [2]

(b) Burning of biodiesel releases CO_2 to the atmosphere. [;]
Biodiesel is formed from plants which absorb CO_2 in the atmosphere during photosynthesis. [;]
Hence there is no net increase of CO_2 in the atmosphere. [;]

3;[2]
1-2; [1] [2]

(c) **(i)** One molecule of $CFCl_3$ produces a Cl atom under UV light which reacts with one molecule of O_3 to form one molecule of ClO [1]

Another Cl atom is regenerated when one molecule of ClO reacts with an O atom. [1] [2]

(ii) From graph,

	C	F	Cl
moles	2	4	2
simplest ratio	1	2	1

The empirical formula is CF_2Cl.[1]

From graph,

	C	F	Cl
Mass of 1 mole of compound/g	24	76	71

Mr of CFCs = 171

n = 2

Molecular formula is $C_2F_4Cl_2$ [1]

Geylang Methodist School (Secondary)
Preliminary Examination 2017

CHEMISTRY **5073/01**

Paper 1 Multiple Choice **Sec 4 Express**

Additional materials : OAS **1 hour**

Setter : Mr Lim Zong Han **14 Aug 2017**

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Write your name, class and register number on the Answer Sheet in the spaces provided unless this has been done for you.

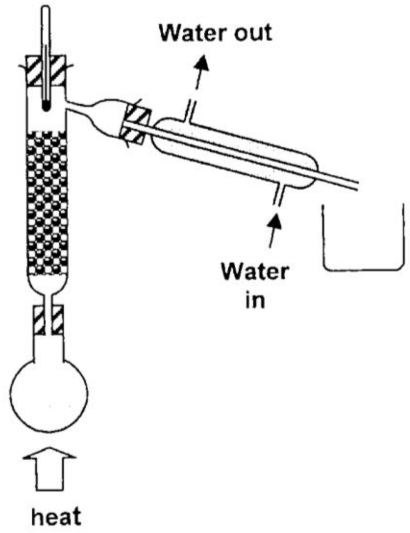
There are **forty** questions on this paper. Answer **all** questions.
For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark.
A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic table is printed on page 17

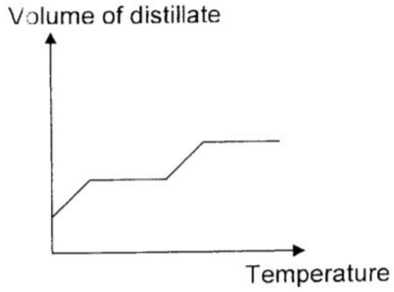
This document consists of **17** printed pages and **1** blank page.

1 The diagram shows the apparatus used to separate Methylcyclopentane (boiling point 70°C) and heptane (boiling point 98°C).



Which graph would be obtained if volume of distillate collected was plotted against temperature?

A



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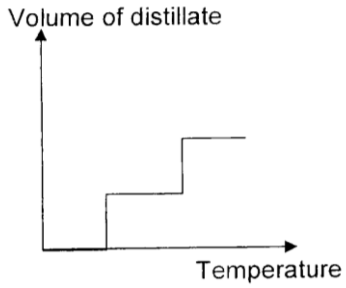

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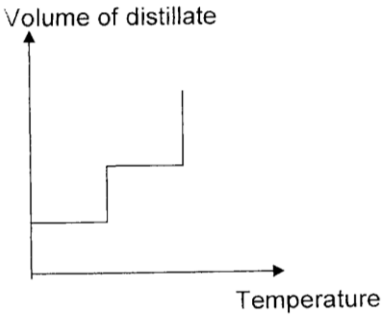

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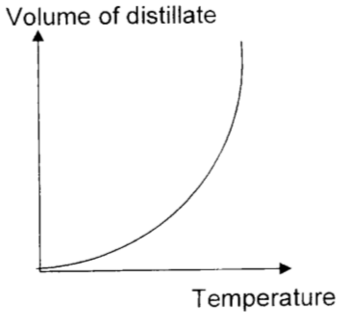


2 Which one of the following pairs of gases diffuses at the same speed?

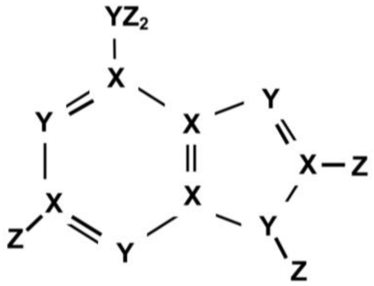
A nitrogen and oxygen
B nitrogen and carbon monoxide
C nitrogen and ammonia
D nitrogen and nitrogen dioxide

3 Sulfur dioxide gas is over twice as dense as nitrogen gas. A gas jar of sulfur dioxide was placed on top of a gas jar of nitrogen gas with the open ends together.

After half an hour, which of these statements would be true?

A The top gas jar contained nitrogen gas only.
B Some of each gas would have moved into the other gas jar.
C The gases would not have mixed.
D The bottom gas jar would contain nearly all the sulfur dioxide

4 A stable molecule containing atoms of the elements X, Y and Z has the following structure:



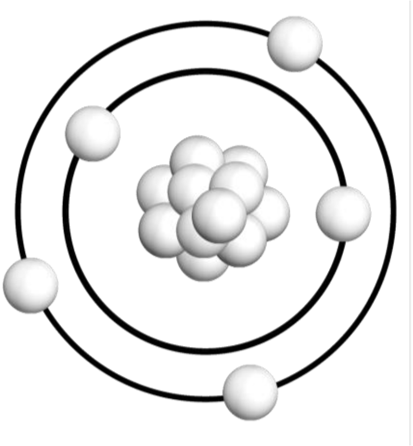
Which of the following is a possible combination of elements?

	X	Y	Z
A	Si	P	Na
B	P	Si	F
C	F	Si	P
D	Si	P	F

5 Which particle has the least number of electrons in its valence shell?

A I
B N^{3-}
C Ne
D O^{2-}

6 The diagram represents an atom of an isotope X of an element.



If the element consists of only two isotopes, which one of the following is likely to represent the particles of the other isotope of the element?

	Proton	Neutron	Electron
A	5	6	5
B	5	5	5
C	6	5	5
D	11	12	11

7 Which of the following substances contain delocalised electrons?

I copper
II graphite
III solid copper (II) chloride
IV molten copper (II) chloride

A I and II
B I and IV
C II and III
D III and IV

8 Elements P and R react to form compound S which is a liquid at room conditions. The formula of S is P_2R.

If R is a group VI element, P is

A sodium
B phosphorous
C hydrogen
D silicon

9 12.0 g of anhydrous magnesium sulfate combines with 12.6 g of water to form hydrated magnesium sulfate.

What is the formula of hydrated magnesium sulfate?

A $MgSO_4{\cdot}3H_2O$
B $MgSO_4{\cdot}5H_2O$
C $MgSO_4{\cdot}7H_2O$
D $MgSO_4{\cdot}9H_2O$

10 A hydrocarbon contains 86% carbon and 14% hydrogen by mass.

What is the probable molecular formula?

A CH_4
B C_4H_8
C C_6H_6
D C_8H_{18}

11 Compound X is a white solid. When X is warmed with sodium hydroxide solution, a gas with pungent smell is liberated. The gas turns moist red litmus paper blue. When a solution of X is treated with dilute hydrochloric acid, bubbles are seen in the solution.

What is X most likely to be?

A ammounium sulfate
B ammonium carbonate
C potassium nitrate
D potassium hydrogen carbonate

12 The following tests were carried out on a green solid.

I It produced water when it was gently heated alone.
II It gave a green precipitate when dissolved in water and added to aqueous ammonia
III It gave a white precipitate when dissolved in water and added to silver nitrate solution.

From these tests, identify the green solid.

A anhydrous copper (II) chloride
B hydrated iron (II) chloride
C hydrated iron (II) sulfate
D hydrated copper (II) sulfate

13 Which one of the following reagents gives a precipitate with a solution of Cu^{2+}(aq), which dissolves in excess reagent?

A NaOH (aq)
B NH_3 (aq)
C $AgNO_3$ (aq)
D Na_2CO_3 (aq)

14 The table below gives information about three indicators.

indicator	colour in strongly acidic solution	pH at which colour changes	colour in strongly alkaline solution
methyl orange	red	4.5	Yellow
bromothylmol blue	yellow	6.5	Blue
phenolphthalein	colourless	9.0	Pink

If equal amounts of indicators were added to separate samples of pure water, what would be the colours of the resulting solutions?

	methyl orange	bromothylmol blue	phenolphthalein
A	yellow	blue	pink
B	red	yellow	colourless
C	yellow	yellow	colourless
D	yellow	blue	colourless

15 **Which of the following mixtures produces ammonia when heated?**

A $CH_3COONH_4 + Ba(OH)_2$
B $NH_4NO_3 + NaCl$
C $NH_4NO_3 + HCl$
D $NH_4NO_3 + Al$

16 Which of the equation does **not** represent a redox reaction?

A $3Cl_2(g) + 2Fe\ (s) \rightarrow 2FeCl_3\ (s)$
B $Ba^{2+}\ (aq) + SO_4^{2-}\ (aq) \rightarrow BaSO_4\ (s)$
C $Fe^{2+}\ (aq) + Mg\ (s) \rightarrow Fe\ (s) + Mg^{2+}\ (aq)$
D $Zn\ (s) + 2HCl\ (aq) \rightarrow ZnCl_2\ (aq) + H_2\ (g)$

17 In which reaction does chromium undergo a change in oxidation number?

A $Cr_2O_3 + 3H_2SO_4 \rightarrow Cr_2(SO_4)_3 + 3H_2O$
B $Cr_2(SO_4)_3 + 6NaOH \rightarrow 2Cr(OH)_3 + 3Na_2SO_4$
C $K_2Cr_2O_7 + 4H_2SO_4 + 6HCl \rightarrow Cr_2(SO_4)_3 + K_2SO_4 + 7H_2O + 3Cl_2$
D $2K_2CrO_4 + H_2SO_4 \rightarrow Kr_2Cr_2O_7 + K_2SO_4 + H_2O$

18 Small portions of aqueous potassium iodide (KI) and acidified potassium manganate (VII) ($KMNO_4$) were separately added to four solutions.

The colour changes are shown in the table below:

solution number	potassium iodide	potassium manganate
1	colourless to brown	purple to colourless
2	colourless to brown	no change
3	no change	purple to colourless
4	no change	no change

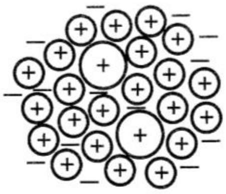
Which solution(s) contained an oxidising agent?

A 1 only
B 1 and 2
C 1 and 3
D 2 and 4

19 Which of the following diagrams shows the structure of bronze?

A

B



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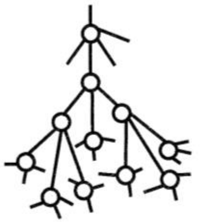

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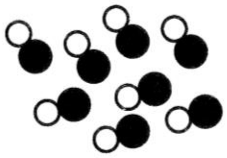
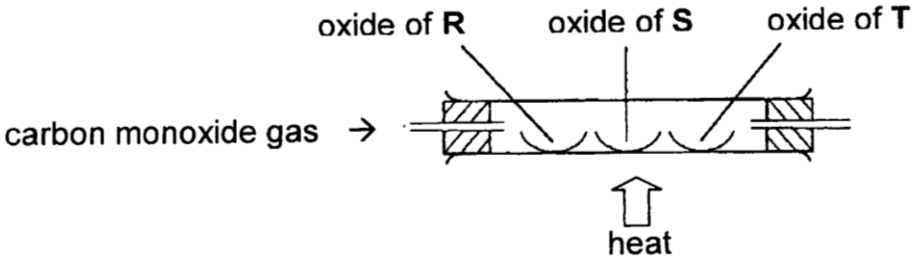


20 Three metallic oxide powders containing metals, R, S and T are heated strongly in a hard glass tube as shown below. At the same time, carbon monoxide gas is directed through the tube.



Oxide of R glows slightly, oxide of T glows strongly while oxide of S does not undergo any changes.

Based on these observations, which list shows the descending order of reactivity (most reactive first) of metal R, S and T?

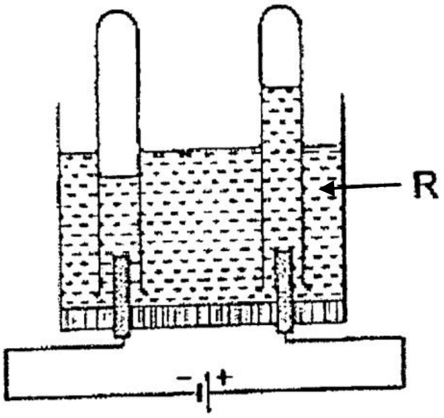
A R, S, T
B T, R, S
C S, R, T
D T, S ,R

21 Several properties of metals can be explained by the fact that layers of atoms can slide over each other.

Which one of the following properties of metals is **not** explained by this fact?

A Metals are malleable.
B Metals conduct electricity.
C Pure metals are softer than alloys.
D Metals are ductile.

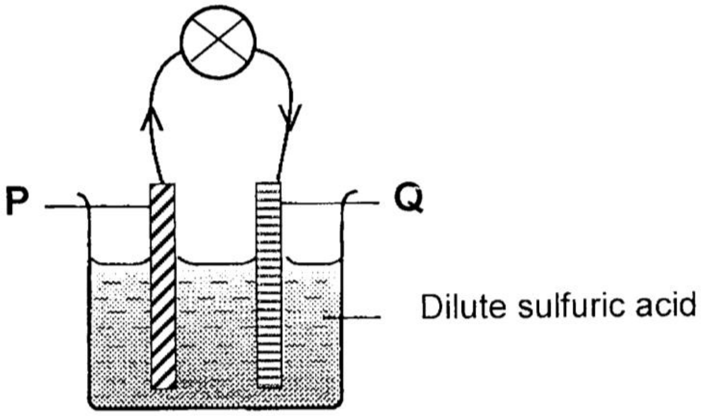
22 The diagram shows the results of an electrolysis using inert electrodes.



Which of the following could be liquid R?

A aqueous silver nitrate
B aqueous sodium carbonate
C concentrated hydrochloric acid
D molten magnesium iodide

23 The diagram below shows a simple electrochemical cell.



An electric current flows from P to Q. Suggest the identity of P and Q.

	P	Q
A	copper	magnesium
B	zinc	magnesium
C	zinc	iron
D	copper	iron

24 When an aqueous solution containing Fe^{2+} and V^{n+} ions is electrolysed, the same amount of charge produces 16.8 g of iron and 10.2 g of vanadium.

What is the value of n in V^{n+} ion?

A 1
B 2
C 3
D 4

25 The element astatine (At) is beneath iodine in Group VII of the Periodic Table.

Which one of the following is a likely property of astatine?

A It can be liberated from a solution of its salt by chlorine gas.
B It conducts electricity in molten state.
C It forms a basic oxide.
D It displaces iodine from aqueous potassium iodide.

26 The table below represents 8 elements P, Q, R, S, T, U V and W across Period 2 of the Periodic Table.

$_3$P	$_4$Q	$_5$R	$_6$S	$_7$T	$_8$U	$_9$V	$_{10}$W

Which of the following properties is **incorrect**?

A The chlorides of T have high melting points whereas chlorides of P have low melting points.

B The oxides of T are acidic whereas the oxides of P are alkaline.

C P and Q are metals whereas V and W are non-metals.

D V atoms are smaller than P atoms.

27 Which statement about groups in the Periodic Table is correct?

A All elements form either positively charged ions or negatively charged ions.

B In Group I, all the elements form covalent compounds with hydrogen.

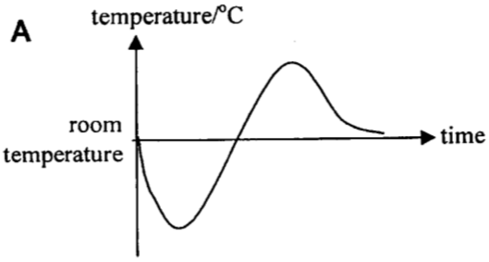
C In Group VII, all the elements form ionic bonds with most metals.

D All groups contain acidic and basic oxides.

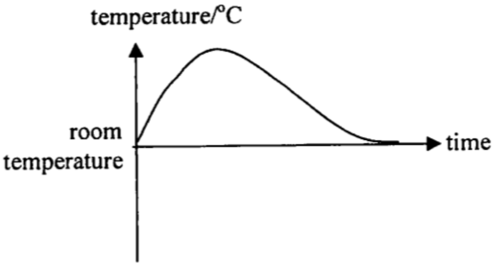
28 The process of dissolving potassium iodide in water is endothermic.

Which of the following graphs shows the temperature changes that occur when potassium iodide is stirred with water until no further change in temperature is observed?

A



B



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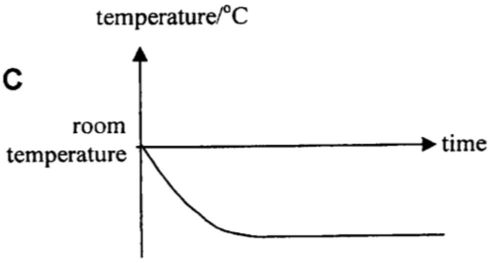
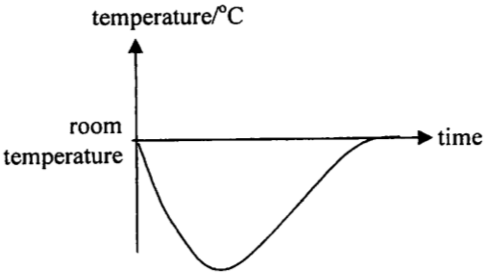


D



29 **Which one of the following is an endothermic process?**

A $C (s) + O_2 (g) \rightarrow CO_2 (g)$
B $HCl (aq) + NaOH (aq) \rightarrow NaCl (aq) + H_2O (l)$
C $6CO_2 (g) + 6H_2O (g) \rightarrow C_6H_{12}O_6(aq) + 6O_2(g)$
D $H_2O (g) \rightarrow H_2O (l)$

30 The combustion of methane is an exothermic process.

$$CH_4 (g) + 2O_2 (g) \rightarrow CO_2 (g) + 2H_2O (g) \qquad \Delta H = - 890 \text{ kJ}$$

How much methane should be used to produce 2670 kJ of heat?

A 48 g
B 64 g
C 96 g
D 120 g

31 Sodium thiosulfate reacts with hydrochloric acid to form sulfur.

Which sodium thiosulfate solution gives the highest initial rate of reaction?

A 4 g of sodium thiosulfate dissolved in 50 cm^3 of water.
B 10 g of sodium thiosulfate dissolved in 100 cm^3 of water.
C 20 g of sodium thiosulfate dissolved in 500 cm^3 of water.
D 40 g of sodium thiosulfate dissolved in 2000 cm^3 of water.

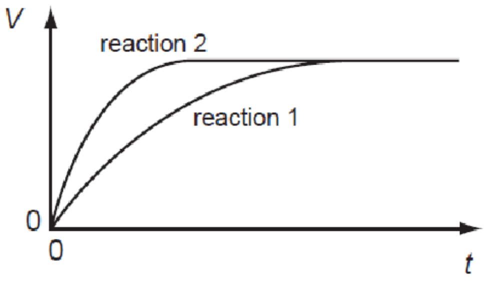
32 A student performs two reactions.

Reaction 1	10 g of magnesium ribbon with excess 2.0 mol/dm^3 dilute hydrochloric acid
Reaction 2	5 g of magnesium powder with excess 2.0 mol/dm^3 dilute hydrochloric acid

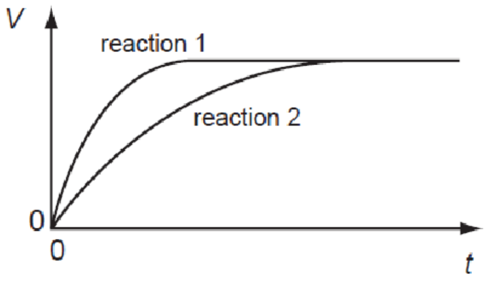
In both experiments, the volume of hydrogen produced, V, is measured against time, t, and the result plotted graphically.

Which set of graphs is correct?

A



B



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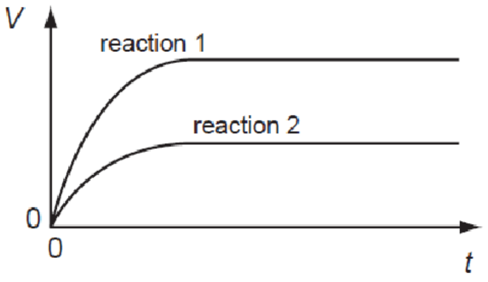

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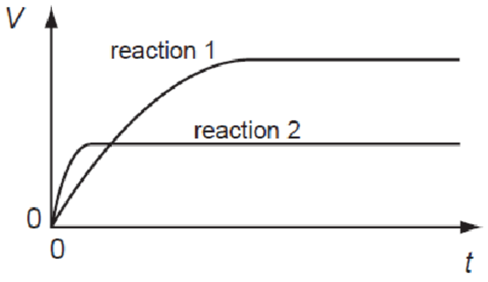


33 Ammonia is produced industrially by Haber process.

Which of the following statement is **not** true about the Haber process?

A Nitrogen is obtained from air.
B High temperature is applied to overcome the activation energy.
C A catalyst is added to decrease the enthalpy change of the forward reaction.
D High pressure is applied to increase the yield of ammonia.

34 Which one of the following pairs of gases are common pollutants of the atmosphere?

A nitrogen and sulfur dioxide
B chlorine and hydrogen
C carbon dioxide and ammonia
D sulfur dioxide and nitrogen dioxide

35 Which one of the following explains why carbon monoxide is poisonous?

A It is oxidised to carbon dioxide in the lungs.
B It is reduced to carbon in the lungs.
C It combines with haemoglobin.
D It is inflammable.

36 Which one of these pollutant gases in the air is mainly responsible for the greenhouse effect?

A sulfur dioxide
B carbon dioxide
C carbon monoxide
D nitrogen dioxide

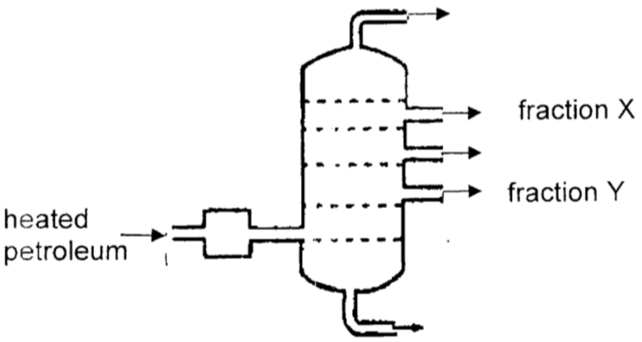
37 The reaction between the hydrocarbon C_xH_6 and hydrogen can be represented by the equation:

$$C_xH_6\ (g) + H_2\ (g) \rightarrow C_xH_8\ (g)$$

Which of the following statements about the above reaction is true?

A It is a substitution reaction.
B UV light is required for the reaction to take place.
C The molecular formula of the hydrocarbon is C_2H_6.
D The molecular formula of the hydrocarbon is C_3H_6.

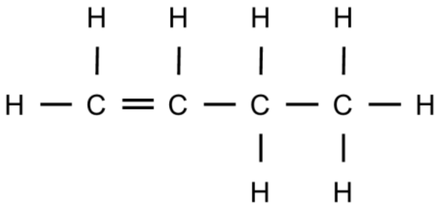
38 The diagram shows the fractional distillation of petroleum.



Which statements about fractions X and Y are correct?

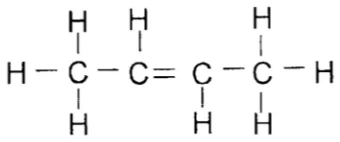
	X is more flammable than Y	X burns with a less sooty flame than Y	X is more viscous than Y
A	Yes	No	No
B	Yes	Yes	No
C	No	Yes	Yes
D	No	No	Yes

39 The diagram shows the structure of a hydrocarbon X.

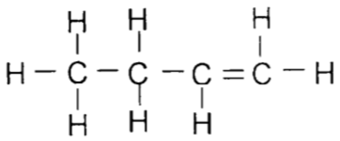


Which of the following structures are isomers of hydrocarbon X?

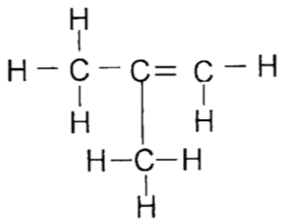
i



ii



iii



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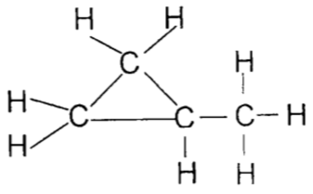
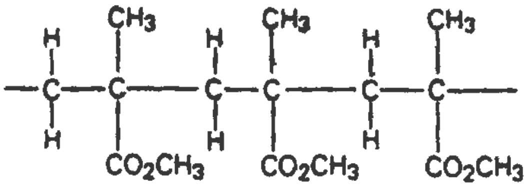


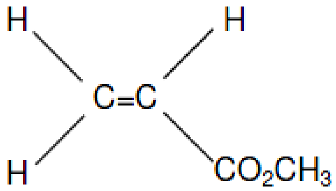
A i, ii
B i, iii
C i, iii, iv
D i, ii, iii, iv

40 The structure of the plastic Perspex is shown below.

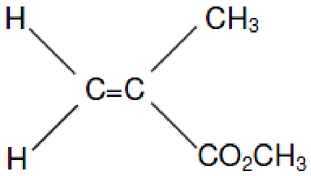


What is the molecular structure of the monomer from which this plastic is formed?

A



B



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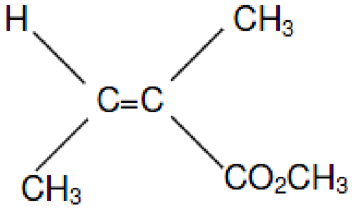
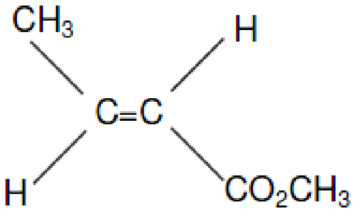


D



End of Paper

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Answers

1	2	3	4	5	6	7	8	9	10
C	A	B	A	D	B	C	C	A	B
11	12	13	14	15	16	17	18	19	20
B	C	A	D	C	C	B	A	D	C
21	22	23	24	25	26	27	28	29	30
A	B	D	A	B	B	B	C	C	C
31	32	33	34	35	36	37	38	39	40
A	B	A	D	C	A	A	C	D	C

Geylang Methodist School (Secondary)
Preliminary Examination 2017

Candidate Name			
Class		Index Number	

CHEMISTRY **5073/02**

Paper 2 **Sec 4 Express**

Additional materials : NIL **1 hour 45 minutes**

Setter : Mrs Loh Kim Woon **17 Aug 2017**

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions in the spaces provided.

Section B
Answer **all three** questions, the last question is in the form either/or.
Write your answers in the spaces provided.

At the end of the examination, detach Section A from Section B and hand them in separately.
The number of marks is given in brackets [ ] at the end of each question or part question.

A copy of the Periodic Table is printed on page 22.

For Examiner's Use	
Section A	**/50**
B7	**/12**
B8	**/ 8**
B9	**/10**
Total	**/80**

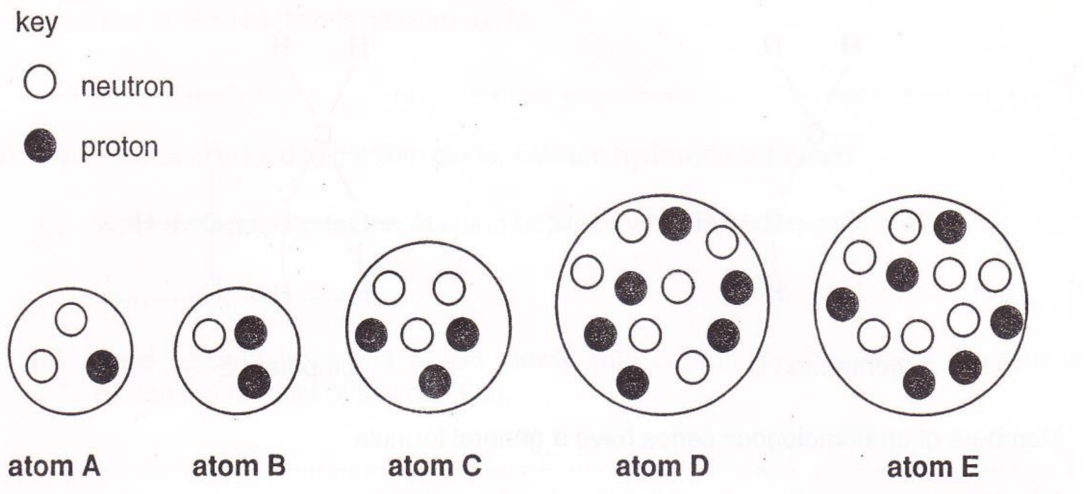
This document consists of **21** printed pages and **1** blank page.

[Turn over

Section A

Answer **all** the questions in this section in the spaces provided.
The total mark for this section is 50.

A1 The diagram shows the nuclei of five different atoms.



(a) Which atom is most likely to be in Group 0?

……………………………………………………………………………………[1]

(b) Which atom has an atomic number of 3?

……………………………………………………………………………………[1]

(c) Which atom has a nucleon number of 6?

……………………………………………………………………………………[1]

(d) Which **two** atoms are isotopes of the same element?

………………………………and……………………………………………………[1]

(e) Suggest the name of the element in **(d)**.

……………………………………………………………………………………[1]

(f) Which **two** atoms lose an electron when they form ions?

……………………………………………………………………………………[2]

[Total: 7]

A2 The table below shows the concentration of different ions found in a sample of aqueous industrial waste.

ion	concentration (mol/dm^3)
Ca^{2+}	0.125
H^+	2.300
K^+	0.234
NO_3^-	3.680
Cu^{2+}	0.450

Use the information in the table to answer the following questions.

(a) Write the chemical formula of a coloured salt that could be obtained from the sample.

....[1]

(b) A student wants to obtain the salt in **(a)** using the following method.

metal + dilute nitric acid $\longrightarrow$ salt in **(a)** + hydrogen

Why is this method **not** feasible?

.... [1]

(c) Suggest a modification to the method in **(b)** to obtain a pure and dry sample of the salt in **(a)**.

....

....

....

....

....

.... [3]

(d) Is the sample of aqueous industrial waste acidic, neutral or alkaline?
Explain your answer.

………………………………………………………………………………………………….

…………………………………………………………………………………………… [1]

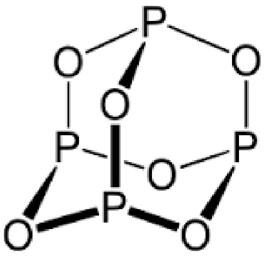
(e) What would be **observed** when aqueous sodium hydroxide is added to a sample of the aqueous industrial waste until no further change is seen?

………………………………………………………………………………………………….

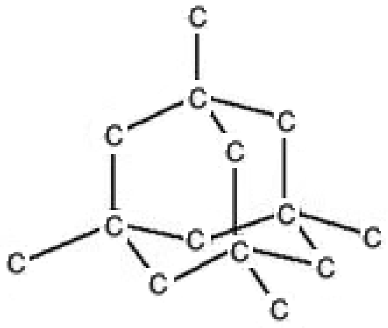
…………………………………………………………………………………………… [2]

[Total: 8]

A3 The structures of phosphorus trioxide and diamond are shown below. Phosphorus trioxide is a covalent compound with a simple molecular structure. Diamond has a giant molecular structure of carbon atoms.



phosphorus trioxide



diamond

(a) Write down the molecular formula of phosphorus trioxide.

…………………………………………………………………………………………… [1]

(b) Describe how a *simple molecular structure* differs from a *giant molecular structure*.

………………………………………………………………………………………………….

………………………………………………………………………………………………….

………………………………………………………………………………………………….

………………………………………………………………………………………………….

…………………………………………………………………………………………… [2]

(c) Explain why the melting point of phosphorus trioxide is lower than that of diamond.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

………………………………………………………………………………………………… [3]

(d) An oxide was found to have the following composition by mass.

element	percentage by mass
phosphorus	43.7
oxygen	56.3

Deduce whether this oxide could be phosphorus trioxide by determining its empirical formula.

…………………………………………………………………………………………………

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…………………………………………………………………………………………………

………………………………………………………………………………………………… [3]

[Total: 9]

A4 **(a)** Ammonia is manufactured by the Haber Process.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3 \qquad \Delta H = -92.4\ kJ/mol$$

The table below shows how the percentage yield of ammonia at equilibrium varies with both temperature and pressure.

pressure / atm	percentage yield of ammonia at equilibrium			
	200 °C	300 °C	400 °C	500 °C
40	72	34	13	5
100	81	51	25	10
200	86	63	36	18
300	88	69	40	24

(i) Describe how the percentage yield of ammonia at equilibrium changes with temperature.

……………………………………………………………………………………

……………………………………………………………………………………[1]

(ii) Describe how the percentage yield of ammonia at equilibrium changes with pressure.

……………………………………………………………………………………

……………………………………………………………………………………[1]

(iii) Explain how using a catalyst in the Haber Process has an economic advantage.

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………[2]

(b) Ammonia is used to manufacture nitric acid by a two-stage process.

Stage 1 Ammonia is converted to nitrogen monoxide.

$$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$$

Stage 2 Nitrogen monoxide is converted to nitric acid.

$$4NO(g) + 2H_2O(g) + 3O_2(g) \rightarrow 4HNO_3(aq)$$

(i) It is possible to find out whether the reaction in **Stage 1** has completed by following the pH changes during the reaction.
Samples of gas are taken from the reaction vessel at regular time intervals and bubbled through water to form a solution. The pH of each solution is measured.
Explain why the measured pH changes during the reaction.

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……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………[3]

(ii) Use the equations in the two stages to construct an overall equation for the conversion of ammonia to nitric acid.

……………………………………………………………………………………[1]

[Total: 8]

A5 The manufacture of sulfuric acid is described below.

step 1: Sulfur is burnt in excess air to form sulfur dioxide.

$$S(s) + O_2(g) \rightarrow SO_2(g)$$

step 2: Sulfur dioxide reacts with more oxygen to form sulfur trioxide.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H = -196 \text{ kJ/mol}$$

step 3: Sulfur trioxide is dissolved in concentrated sulfuric acid to form oleum, $H_2S_2O_7$.

$$H_2SO_4(l) + SO_3(g) \rightarrow H_2S_2O_7(l)$$

step 4: Oleum can then react safely with water to produce concentrated sulfuric acid.

$$H_2S_2O_7(l) + H_2O(l) \rightarrow 2H_2SO_4(l)$$

(a) Is step 3 a redox reaction? Use ideas about oxidation states to explain your answer.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [2]

(b) Explain, in terms of collisions between reacting particles, how a higher pressure affects the rate of reaction in step 1.

……………………………………………………………………………………………

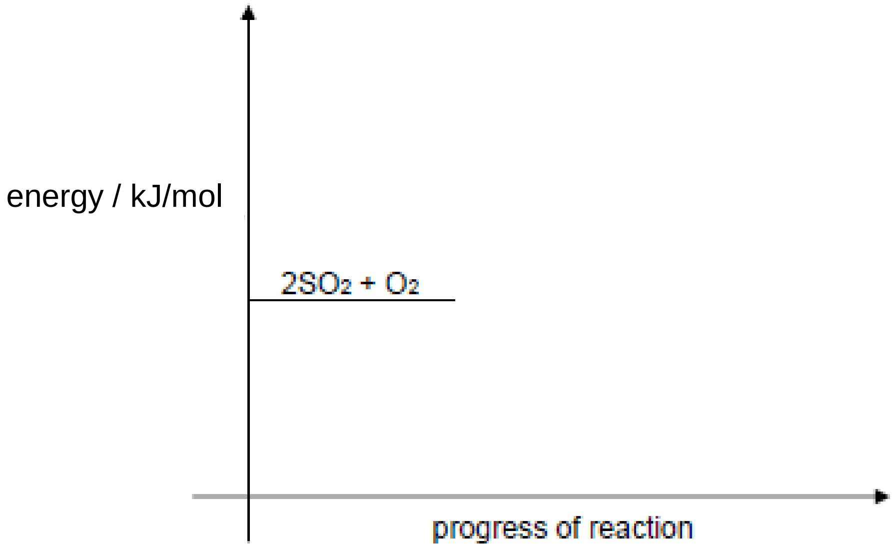
……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [2]

(c) **(i)** Complete the energy profile diagram below for the reaction of sulfur dioxide and oxygen to produce sulfur trioxide. The activation energy for this reaction is 2200 kJ/mol.

Label clearly the **reaction enthalpy change** and the **activation energy.**



[3]

(ii) State the values of the enthalpy change, ΔH, and the activation energy, Ea, of the reverse reaction.

ΔH = …………………………….kJ/mol

Ea = ……………………………..kJ/mol [2]

[Total: 9]

A6 The atmosphere contains a large number of gases including oxygen, nitrogen, carbon dioxide, sulfur dioxide, oxides of nitrogen, methane and chlorofluorocarbons (CFCs).

(a) Carbon dioxide, methane and CFCs are greenhouse gases.

(i) State **one** effect of an increase in the atmospheric concentration of carbon dioxide and methane.

……………………………………………………………………………………..

……………………………………………………………………………..........[1]

(ii) State **one** source of methane gas.

……………………………………………………………………………………..

..…………………………………………………………………………………..[1]

.

(iii) State one **other** environmental effect of the presence of CFCs in the atmosphere.

………………………………………………………………………………......

..………………………………………………………………………….........[1]

(b) The formula of one chlorofluorocarbon is CFCl_3.
Draw a dot-and-cross diagram to show the bonding in a molecule of CFCl_3.
You only need to show outer shell electrons.

[2]

(c) Oxides of nitrogen are produced during the combustion of petrol (gasoline) in a car engine.

(i) Describe the chemical reaction that takes place within a car engine to form nitric oxide, NO.

…………………………………………………………………………………......

…………………………………………………………………………………......[1]

(ii) Most of the nitric oxide and other pollutants present in the exhaust gases of a car are removed in a catalytic converter.
Describe the redox reactions that happen within a catalytic converter.

…………………………………………………………………………………......

…………………………………………………………………………………........

…………………………………………………………………………………......

…………………………………………………………………………………......[2]

(d) Nitrogen dioxide is one of the causes of acid rain.
Two moles of nitrogen dioxide react with one mole of water to make an aqueous solution of two acids only.
One of these acids is nitric acid.
Deduce the formula of the other acid.

....[1]

[Total: 9]

End of Section A

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Name: ______________________________( ) **Class:** ____________

Section B

Answer all **three** questions from this section.
The last question is in the form of an either/or and only **one** of the alternatives should be attempted.
The total mark for this section is 30.

B7 Alkenes are unsaturated hydrocarbons. They contain one or more carbon-carbon double bonds. Alkenes can exist as branched or unbranched hydrocarbons. Short-chain alkenes such as ethene and propene are used as starting materials for making ethanol and plastics.

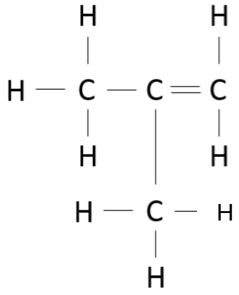
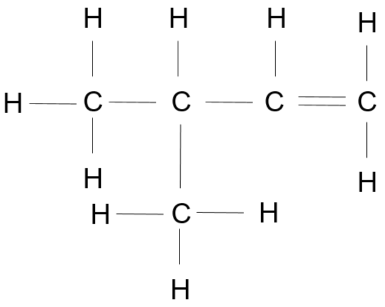
Table 1 shows the boiling points of some straight chain alkenes.

Table 1

name	formula	boiling point / °C
ethene	C_2H_4	-104
propene	C_3H_6	- 47
butene	C_4H_8	- 6
pentene	C_5H_{10}	30
hexene	C_6H_{12}	63

Table 2 shows properties of branched isomers of some of the alkenes.

Table 2

	number of carbon atoms in molecule	formula	boiling point / °C
branched alkene 1	4		-7
branched alkene 2	5		20

(a) How is the boiling point of a straight chain alkene affected by branching in isomerism?
Use evidence from **Table 1** and **Table 2** to explain your reasoning.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………[3]

(b) **X** is a gaseous hydrocarbon which can decolourise a solution of bromine and has a density of 1.75 g/dm^3 at room temperature and pressure.

(i) Calculate the relative molecular mass of **X**.

……………………………………………………………………………………………

……………………………………………………………………………………………[1]

(ii) Hence, identify **X**. Explain your reasoning.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………[2]

(c) Both ethene and ethane can react with chlorine to form dichloroethane.
Give **two** differences between the two reactions.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………[2]

(d) Alkynes are hydrocarbons containing carbon-carbon triple bond (C≡C). **Table 3** shows some properties of the first four members of the alkyne homologous series.

Table 3

alkyne	molecular formula	boiling point / ^oC
ethyne	C_2H_2	- 84
propyne	C_3H_4	- 23
butyne	C_4H_6	8
pentyne	C_5H_8	40

(i) Draw the full structural formula of the alkyne with 6 carbon atoms.

[1]

(ii) Do alkenes or alkynes burn with a smokier flame? Explain your answer.

…………………………………………………………………………………………...

…………………………………………………………………………………………...

…………………………………………………………………………………….[1]

(e) A Chemistry book has the following line.

…..in general, the higher the relative molecular mass of the molecule, the higher the melting and boiling points of the compound due to the higher intermolecular forces of attraction.

Use the data in **Table 1** and **Table 3** to justify whether the statement is valid.

…………………………………………………………………………………………

…………………………………………………………………………………………

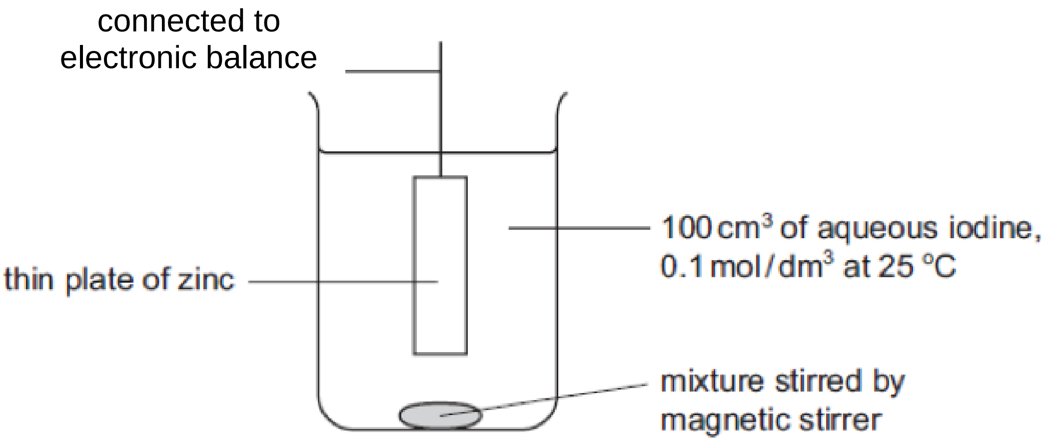
…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………[2]

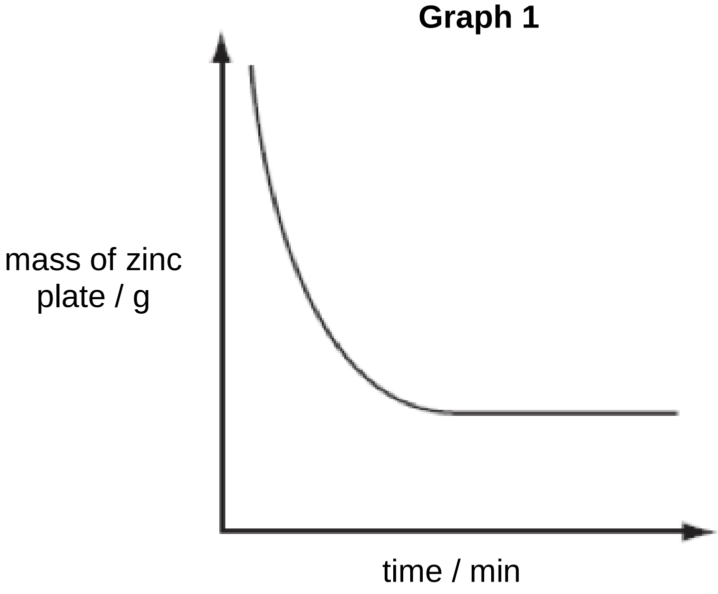
[Total: 12]

B8 Zinc reacts with aqueous iodine to form zinc iodide. The following apparatus was used to measure the rate of the reaction between zinc and aqueous iodine at 25°C.



The mass of the zinc plate was measured every minute until the reaction was complete.
Graph 1 shows the results obtained.

Graph 1



(a) Identify the reagent that was used in excess.

……………………………………………………………………………………………[1]

(b) (i) The experiment was repeated with 100 cm^3 of 0.05 mol/dm^3 aqueous iodine and keeping all other conditions the same. On the same axes as **Graph 1** above, sketch the curve that would be obtained and label it '**Y**'. [1]

(ii) Explain the shape of the graph obtained in **(b)(i)**.

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…………………………………………………………………………………..

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…………………………………………………………………………………

…………………………………………………………………………………

………………………………………………………………………………….[2]

(c) Explain, in terms of collisions between reacting particles, the effect on the speed of reaction if the experiment was repeated at 15^{o}C with all other conditions kept constant.

…………………………………………………………………………………

…………………………………………………………………………………

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…………………………………………………………………………………

…………………………………………………………………………………[2]

(d) Describe and explain what would be observed if aqueous chlorine was bubbled into the resulting zinc iodide solution.

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………[2]

[Total: 8]

EITHER

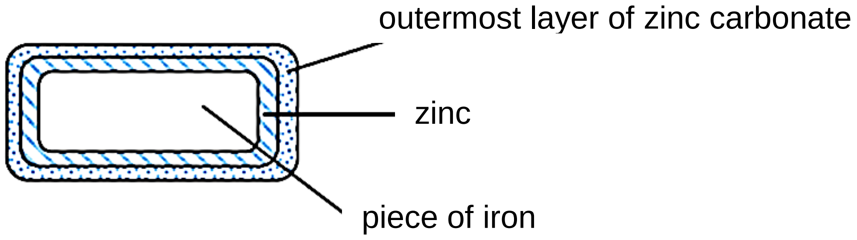
B9 Galvanisation is the process of coating the entire surface of a piece of iron with zinc to prevent it from rusting. Two common ways of galvanising iron are hot-dip galvanisation and electro-galvanisation.

(a) Hot-dip galvanisation

The piece of iron to be galvanised is dipped into a molten bath of zinc at a temperature of around 460°C. The piece of iron is then cooled and exposed to the air. The outermost layer of zinc then reacts with oxygen and carbon dioxide in the air as follows:

reaction 1: zinc reacts with oxygen to form zinc oxide
reaction 2: zinc oxide reacts with carbon dioxide to form zinc carbonate

The resulting iron piece is as shown.



(i) Write balanced chemical equations for reaction 1 and reaction 2**.**

reaction 1 ……………………………………………………………………………[1]

reaction 2 ……………………………………………………………………………[1]

(ii) Use reaction 2 to explain how zinc oxide acts as a basic oxide.

……………………………………………………………………………………….[1]

(b) A student says ‘galvanising a piece of iron is more effective in preventing it from rusting than painting it.’

Do you agree with the student? Explain your reasoning.

………………………………………………………………………………………..

………………………………………………………………………………………..

………………………………………………………………………………………..

………………………………………………………………………………………..[2]

(c) Electro-galvanisation (electroplating an object with zinc)

The piece of iron to be galvanised and a piece of zinc are used as electrodes and dipped into an electrolyte containing a mixture of aqueous zinc cyanide, $Zn(CN)_2$, and aqueous sodium hydroxide at room temperature and pressure. An external electrical power supply is used. Zinc ions are discharged to form zinc atoms, which are coated onto the piece of iron.

(i) Draw a labelled diagram of the experimental setup for electro-galvanisation.

[2]

(ii) What is the formula for the cyanide ion?

……………………………………………………………………..………………[1]

(iii) Some processes of electro-galvanisation employ the use of dilute acids in the electrolyte instead of aqueous sodium hydroxide.

Explain what problem this could pose.

……………………………………………………………………..…………………

……………………………………………………………………..………………[1]

(d) Suggest an **advantage** that electro-galvanisation has over hot-dip galvanisation.

……………………………………………………………………………………………..

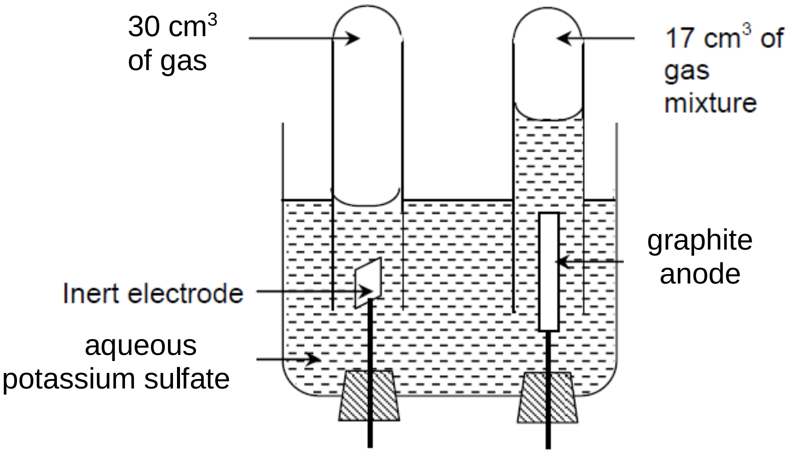
……………………………………………………………………………………………..

……………………………………………………………………………………………..[1]

[Total: 10]

OR

B9 The diagram below shows the electrolysis of an aqueous solution of potassium sulfate using inert electrodes.



(a) Write equations for the reactions that happen at each electrode during the electrolysis of aqueous potassium sulfate. Include state symbols.

At the cathode : ……………………………………………………………………………..

At the anode : ………………………………………………………………………………

[3]

(b) When graphite anode and a very high current are used in this electrolysis, the gas liberated is a mixture of oxygen, carbon monoxide and carbon dioxide. In the experiment illustrated above, 30 cm^3 of gas formed above the cathode and 17 cm^3 of gas formed above the anode.

(i) Explain, with the help of **two** equations, why the oxides of carbon are produced at the anode.

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………[3]

(ii) Using the equations in **b(i)**, explain why the volume of gas collected at the anode is larger than expected.

…………………………………………………………………………………………

…………………………………………………………………………………………[1]

(iii) The gas at the anode was collected and its volume was reduced to 9 cm^3 when shaken with aqueous sodium hydroxide.
Deduce the volume of carbon dioxide in the gas mixture at the anode and explain the reaction that results in the reduction of volume.

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………[2]

(c) An experiment is set up to electroplate a fresh flower with silver.
Suggest why the fresh flower must be coated with carbon particles first.

………………………………………………………………………………………………..

………………………………………………………………………………………………[1]

[Total: 10]

End of Paper

Marking Scheme

Geylang Methodist School (Secondary)
Prelim Exam 2017
Chemistry 5073

Paper 1

1	C	11	B	21	B	31	B
2	B	12	B	22	B	32	D
3	B	13	B	23	C	33	C
4	D	14	D	24	C	34	D
5	A	15	A	25	A	35	C
6	B	16	B	26	A	36	B
7	A	17	C	27	C	37	D
8	C	18	B	28	D	38	B
9	C	19	B	29	C	39	C
10	B	20	C	30	A	40	B

Paper 2

Qns	Answers	Marks
A1a	B	1
b	C	1
c	C	1
d	D and E	1
e	carbon	1
f	A and C	2
A2a	$Cu(NO_3)_2$	1
b	Copper does not react with dilute acids.	1
c	Add excess copper(II) oxide / copper(II) carbonate with dilute nitric acid and stir. Filter to remove the excess copper(II) oxide and collect copper(II) nitrate as the filtrate. Heat copper(II) nitrate solution until it is saturated. Cool the saturated solution. Wash the crystals with a little cold water and dry between sheets of filter paper.	1 1 1
d	Acidic. There are H^+ ions present.	1

<table>
<tr><th>Qns</th><th>Answers</th><th>Marks</th></tr>
<tr><td>e</td><td>A white precipitate is formed.
The precipitate is insoluble in excess sodium hydroxide.
OR
A blue precipitate is formed.
The precipitate is insoluble in excess sodium hydroxide.</td><td>1
1

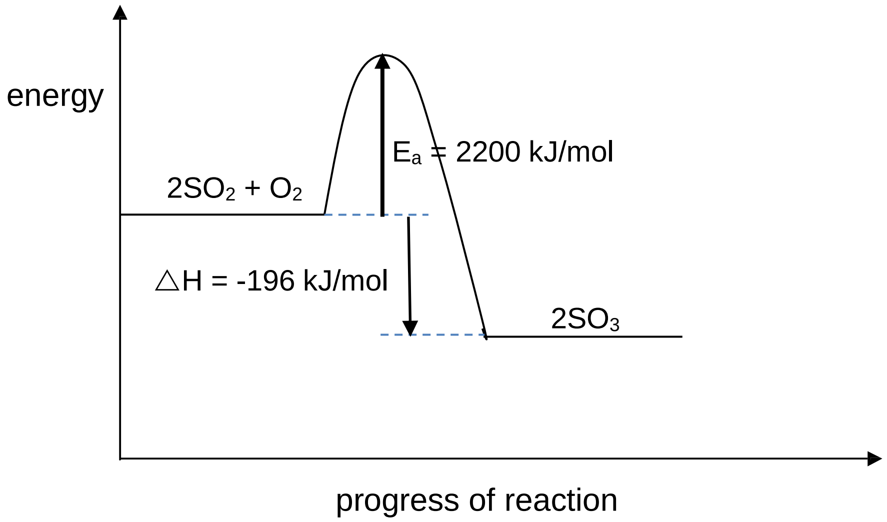
1
1</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>A3a</td><td>P_4O_6</td><td>1</td></tr>
<tr><td>b</td><td>A simple molecular structure has small discrete molecules with weak intermolecular forces while
a giant molecular structure is a lattice of many atoms covalently bonded together.</td><td>1

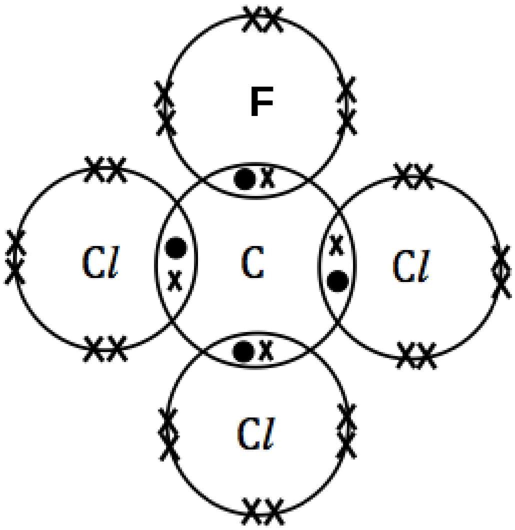
1</td></tr>
<tr><td>c</td><td>A small amount of energy is needed to overcome the weak intermolecular forces between the molecules in phosphorus trioxide.
A very large amount of energy is needed to overcome the strong covalent bonds between the carbon atoms in the structure of diamond.</td><td>1
1

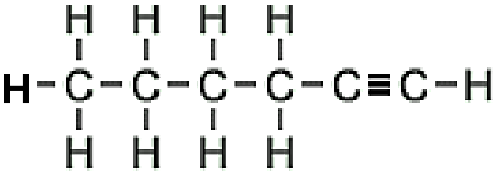
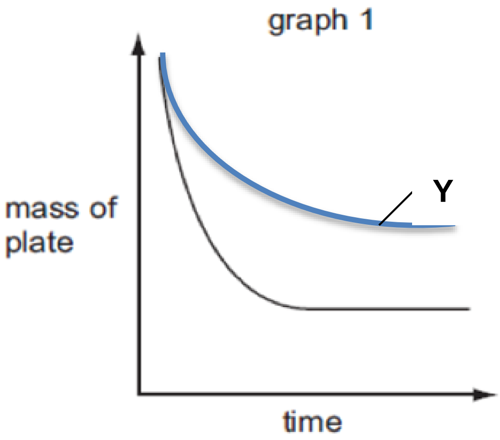
1</td></tr>
<tr><td>d</td><td>
<table>
<tr><td>element</td><td>P</td><td>O</td></tr>
<tr><td>mass (g) / % by mass</td><td>43.7</td><td>56.3</td></tr>
<tr><td>number of moles</td><td>$\frac{43.7}{31}$ = 1.410</td><td>$\frac{56.3}{16}$ = 3.519</td></tr>
<tr><td>molar ratio</td><td>$\frac{1.410}{1.410}$ = 1</td><td>$\frac{3.519}{1.410}$ ≈ 2.5</td></tr>
<tr><td>simplest ratio</td><td>2</td><td>5</td></tr>
<tr><td>empirical formula</td><td colspan="2">P_2O_5</td></tr>
</table>
Since the empirical formula of phosphorus trioxide is P_2O_3, not P_2O_5, this oxide cannot be phosphorus trioxide.</td><td>1

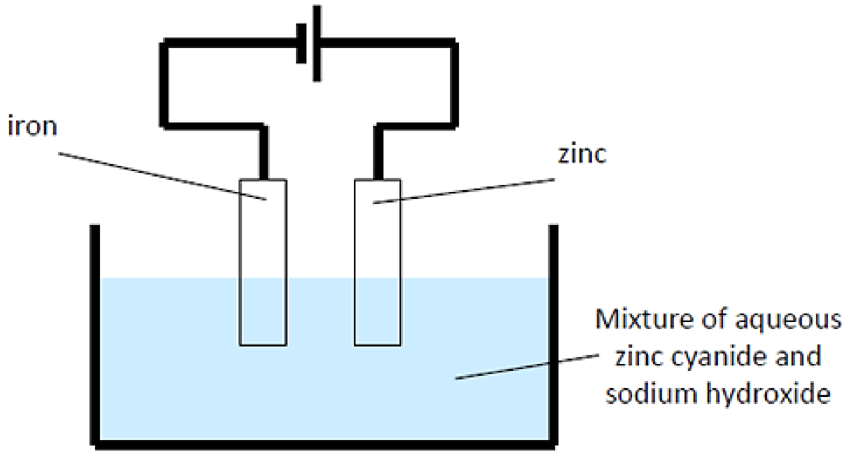
1

1</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>A4a(i)</td><td>The percentage yield of ammonia decreases with increasing temperature.</td><td>1</td></tr>
<tr><td>(ii)</td><td>Percentage yield of ammonia increases with increasing pressure.</td><td>1</td></tr>
<tr><td>(iii)</td><td>Catalyst speeds up the reaction / lowers activation energy.
Catalyst shortens the production time / lowers energy costs as less energy is used.</td><td>1
1</td></tr>
</table>

Qns	Answers	Marks
b(i)	Ammonia is an alkaline gas, while oxygen, nitrogen monoxide and water vapour are neutral gases. Ammonia gas is gradually used up, the pH decreases as the products are neutral. When pH value remains constant at 7, it indicates that ammonia gas is used up completely for reaction and left with the neutral gases.	1 1 1
(ii)	$NH_3 + 2O_2 \rightarrow HNO_3 + H_2O$	1
A5a	No. The oxidation states of S, O and H remains the same at +6, -2 and +1 respectively in both reactants and products.	Minus 1 mark for each mistake in oxidation states.
b	The rate of reaction is faster at higher pressure. The gas molecules are closer together. There are more molecules per unit volume of the gas and they collide more frequently.	1 1
c(i)		correct Ea – 1m correct △H – 1m correct exothermic graph – 1m
(ii)	ΔH = +196 kJ/mol Ea = 2396 kJ/mol	1 1
A6 a(i)	Global warming/ ice caps melting/ sea level rising	1
(ii)	One source of methane is rotting vegetation.	1
(iii)	CFCs cause ozone depletion.	1

Qns	Answers	Marks
b		Minus 1 mark for each mistake
c(i)	Reaction of nitrogen with oxygen at high temperature produces nitric oxide.	1
(ii)	Nitric oxide is reduced to form nitrogen gas. Carbon monoxide is oxidised to form carbon dioxide.	1 1
d	HNO_2	1
B7a	Branching in isomerism <u>decreases</u> the boiling point of straight chain alkenes. From the data, the boiling point of straight chain butene (-6 °C) is higher than the branched butene (-7 °C). The boiling point of straight chain pentene (30 °C) is also higher than the branched pentene (20 °C).	1 1 1
b(i)	M_r = density × 24 dm^3 = 1.75 × 24 = 42	1
(ii)	X is propene / C_3H_6 with M_r of propene = (12×3) + (1×6) = 42. As X decolourises aqueous bromine, it is unsaturated / an alkene with general formula C_nH_{2n}.	1 1
c	differences: any two - substitution in ethane requires UV light whereas addition in ethene does not. - substitution in ethane involves breaking of C-H bond whereas addition in ethene involves breaking of C=C bond. - substitution in ethane produces many products whereas addition in ethene produces only one product (dichloroethane). - substitution in ethane produces a by-product (HCl) whereas addition in ethene does not.	1m – each difference

Qns	Answers	Marks
d(i)	 $H-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-C\equiv C-H$	1
(ii)	Alkynes burn with a smokier flame because they have a higher percentage of carbon compared to alkenes.	1
e	Although ethyne (M_r = 26) has a relative molecular mass smaller than ethene (M_r = 28), the boiling point of ethyne is -84 ^oC whereas the boiling point of ethene is lower at -104 ^oC. The statement is invalid as alkynes have higher boiling points even though they have smaller relative molecular mass.	1 1
B8a	zinc	1
b(i)		1
(ii)	Gradient is less steep as the concentration of iodine is halved, resulting in a slower speed of reaction. Half the mass of zinc reacted since only half the number of mole of the limiting reagent, iodine is present.	1 1
c	At 15 ^oC, the zinc atoms and iodine molecules have lower kinetic energy. Hence, less particles have energy greater or equal to the activation energy. The frequency of effective collisions between the zinc atoms and iodine molecules decreases. Hence, speed of reaction decreases.	1 1
d	The colourless zinc iodide solution will turn brown. Chlorine displaces the iodine from zinc iodide solution as chlorine is more reactive than iodine.	1 1

Qns	**Answers**	**Marks**
EITHER B9a(i)	reaction 1: $2Zn + O_2 \rightarrow 2ZnO$ reaction 2: $ZnO + CO_2 \rightarrow ZnCO_3$	1 1
(ii)	It reacts with an <u>acidic oxide (carbon dioxide)</u> to form a salt (zinc carbonate).	1
b	Yes, galvanising protects the piece of iron from coming into contact with oxygen and water. If the protective layer is scratched, the exposed iron beneath will not rust as zinc is more reactive than iron and will corrode in place of iron. If the paint layer is scratched, the exposed iron beneath will start to rust when it reacts with oxygen and water.	1 1
c(i)	 Iron electrode connected to negative electrode of cell.	correct electrodes -1m correct electrolyte -1m
(ii)	CN^-	1
(iii)	The acids in the electrolyte will react with the zinc and iron pieces.	1
d	Electro-galvanisation is carried out at room temperature and no heating is needed. Hot-dip galvanisation is carried out at 460°C.	1

Qns	**Answers**	**Marks**
OR B9(a)	At the cathode : 2 H^+ (aq) + $2e^-$ $\rightarrow$ H_2 (g) At the anode : $4OH^-$ (aq) $\rightarrow$ $2H_2O$ (l) + O_2 (g) + $4e^-$	correct equations – 1m each correct state symbols – 1m
b(i)	Oxygen produced reacts with the carbon electrode to form carbon dioxide, which continues to react with the carbon electrode to form carbon monoxide. $C + O_2 \rightarrow CO_2$ $C + CO_2 \rightarrow 2CO$ or $2C + O_2 \rightarrow 2CO$	1 1 1
(ii)	1 mol of oxygen produces 2 mols carbon monoxide.	1
(iii)	8 cm^3 Carbon dioxide, an acidic oxide reacts with the alkali, sodium hydroxide.	1 1
c	Carbon is a conductor of electricity.	1

SINGAPORE CHINESE GIRLS’ SCHOOL
Preliminary Examination
Secondary Four

CANDIDATE NAME	

CLASS	4			REGISTER NUMBER		

Chemistry

5073/01

Paper 1 Theory

Friday **11 August 2017** **1 hour**

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, class and index number on the Question Paper and Answer Sheet in the spaces provided.

There are **forty** questions in this paper. Answer **all** questions. For each question, there are four possible answers, **A, B, C, D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

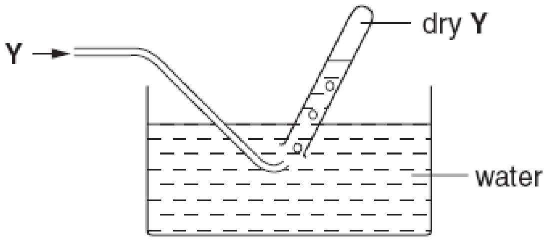
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 14.
The use of an approved scientific calculator is expected, where appropriate.

This question paper consists of 14 printed pages including the cover page.

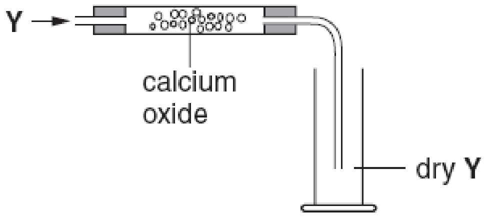
1. A gas Y, is less dense than air, very soluble in water and is alkaline.

Which method is used to collect a dry sample of the gas?

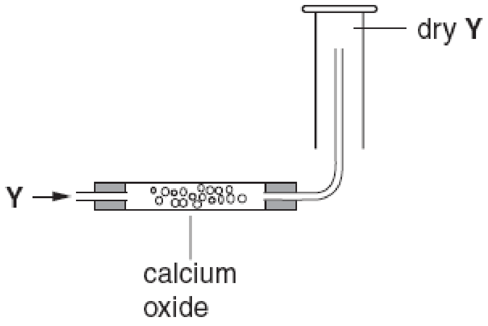
A



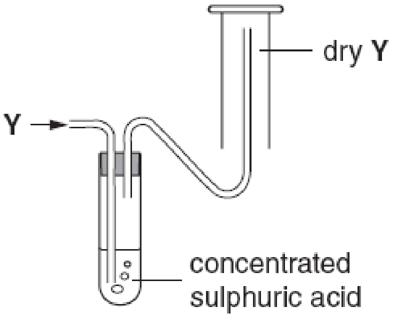
B



C



D



2. The table gives data about four substances.

Which substance has particles that are closely packed in a disorderly arrangement at room temperature?

	melting point/°C	boiling point/°C
A	-114	- 80
B	-15	45
C	750	1407
D	1610	2230

3. Which of the following is the best method of obtaining pure water from ink?

A chromatography

B distillation

C filtration

D sublimation

4. The following measurements are made on a sample pure water: its boiling point, its freezing point, and its pH.

Sodium chloride is now dissolved in the water and the measurements repeated.

How do the measurements change?

	boiling point	freezing point	pH
A	higher	lower	no change
B	higher	higher	increases
C	lower	higher	no change
D	lower	lower	decreases

5. How many electrons in total are shared between the atoms in a molecule of ethene, C_2H_4, and in a molecule of water, H_2O?

	ethene	water
A	6	2
B	10	4
C	12	4
D	14	8

6. Which element forms a positive ion with the same electronic configuration as an atom of neon?

A chlorine

B magnesium

C lithium

D oxygen

7. How does rubidium bond with bromine?

A Each atom of rubidium receives an electron from a bromine atom.

B Each atom of rubidium shares a pair of electrons with a bromine atom.

C Each atom of rubidium shares an electron with a bromine atom.

D Each atom of rubidium gives an electron to a bromine atom.

8. Given that 1 mole of oxygen contains 6 x 10^{23} molecules, what is the number of molecules in 500 cm^3 of oxygen under room conditions?

A 1.25 x 10^{22}

B 1.34 x 10^{22}

C 3.0 x 10^{22}

D 3.0 x 10^{26}

9. When 1 volume of gas X reacts with exactly 5 volumes of oxygen it forms carbon dioxide and water only.

What is gas X?

A methane, CH_4

B ethane, C_2H_6

C propane, C_3H_8

D butane, C_4H_{10}

10. Which sulfide contains the greatest mass of sulfur in a 10 g sample?

sulfide	formula	mass of 1 mole/g
A	NiS	90
B	FeS_2	120
C	MoS_2	160
D	PbS	239

11. The relative atomic mass of oxygen is 16 and that of hydrogen is 1.

This means that …(i)… of oxygen has the same mass as …(ii)… of hydrogen.

Which words correctly complete the blanks (i) and (ii)?

	blank (i)	blank (ii)
A	an atom	thirty-two molecules
B	an atom	eight molecules
C	a molecule	sixteen atoms
D	a molecule	eight atoms

12. A 25 cm^3 sample of dilute sulfuric acid contains 0.025 moles of the acid.

What is the hydrogen ion concentration in the solution?

A 0.25 mol/dm^3

B 0.50 mol/dm^3

C 1.00 mol/dm^3

D 2.00 mol/dm^3

13. Which statement is most likely to be true for astatine, which is in Group VII of the Periodic Table?

A Astatine and aqueous potassium chloride react to form aqueous potassium astatide and chlorine.

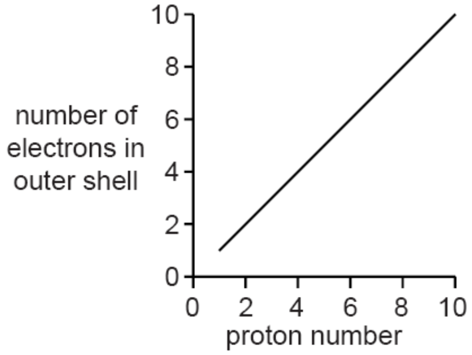
B Astatine reacts with hydrogen to form a compound with formula HAt_2.

C Aqueous potassium astatide reacts with aqueous silver nitrate to form aqueous silver astatide.

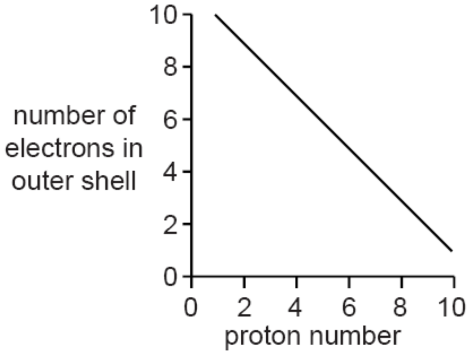
D Sodium astatide is less stable than sodium chloride.

14. Which graph shows the number of electrons in the outer shell of an atom, plotted against the proton (atomic) number for the first ten elements in the Periodic Table?

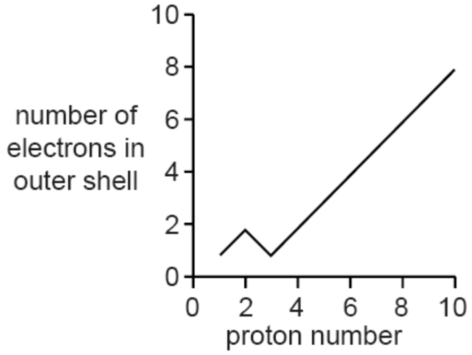
A



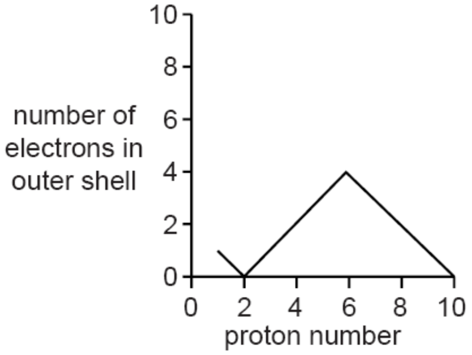
B



C



D



15. A chemist puts a sample of dilute aqueous hydrochloric acid into beaker 1. She adds a sample of zinc and measures the rate of production of hydrogen gas.

She then puts a different sample of dilute aqueous hydrochloric acid into beaker 2. She adds a different sample of zinc of the same mass and measures the rate of production of hydrogen gas.

The rate of the reaction in beaker 1 is slower than the rate of the reaction in beaker 2.

Which factors could help to explain this observation?

I The reaction in beaker 1 takes place at a lower pressure than the reaction in beaker 2.

II The zinc in beaker 1 is in larger pieces than the zinc in beaker 2.

III The acid in beaker 1 is at a lower concentration than the acid in beaker 2.

A I and II only

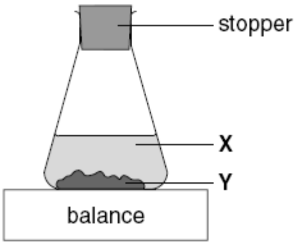
B II and III only

C I and III only

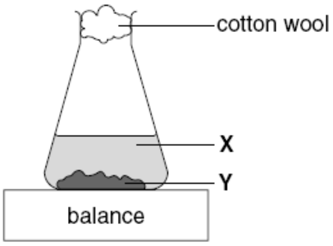
D I, II and III

16. A liquid X reacts with solid Y to form a gas. Which two diagrams show suitable methods for investigating the speed of the reaction?

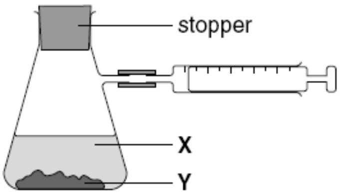
1



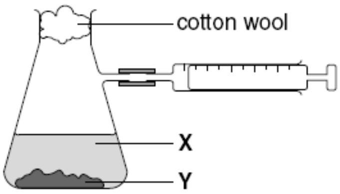
2



3



4



A 1 and 3

B 1 and 4

C 2 and 3

D 2 and 4

17. The table gives information about the reactivity of three metals P, Q and R.

Metal	metal reaction with air	reaction with steam	reaction with dilute hydrochloric acid
P	burns with sparks	forms an oxide	forms hydrogen
Q	slowly forms an oxide	no reaction	no reaction
R	slowly forms an oxide	no reaction	forms hydrogen

What is the order of reactivity of P, Q and R?

	most reactive ⟶ least reactive		
A	P	Q	R
B	P	R	Q
C	Q	R	P
D	R	Q	P

18. Which of the following oxides can be reduced by heating with hydrogen?

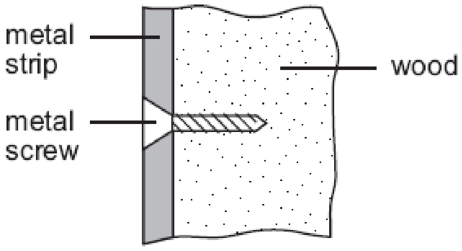
A copper(II) oxide

B calcium oxide

C potassium oxide

D zinc oxide

19. An old railway carriage is being restored. Metal strips are secured on to the outside of the wooden carriage by means of screws. After a few weeks open to the wind and rain, the screws are heavily corroded but the metal strips are not.



Which two metals would give this result?

	screws	strips
A	aluminium	steel
B	copper	aluminium
C	copper	steel
D	steel	aluminium

20. Which of the following is not a reaction that occurs when iron is extracted from haematite in the blast furnace?

A $CaCO_3 \rightarrow CaO + CO_2$

B $CO_2 + C \rightarrow 2CO$

C $FeO + CO \rightarrow Fe + CO_2$

D $CaO + SiO_2 \rightarrow CaSiO_3$

21. The oxide Pb_3O_4 reacts with dilute nitric acid to form lead(II) nitrate, lead(IV) oxide and another product.

What is the equation for this reaction?

A $Pb_3O_4 + 4HNO_3 \rightarrow 2Pb(NO_3)_2 + PbO_2 + 2H_2O$

B $Pb_3O_4 + 2HNO_3 \rightarrow 2PbNO_3 + PbO_4 + H_2$

C $Pb_3O_4 + 4HNO_3 \rightarrow Pb(NO_3)_4 + 2PbO + 2H_2O$

D $2Pb_3O_4 + 2HNO_3 \rightarrow 2Pb_2NO_3 + 2PbO_2 + H_2$

22. Magnesium oxide is added slowly to a beaker containing hydrochloric acid until the magnesium oxide is in excess.

Which of the following statements about this reaction are true?

I The temperature of the mixture increases.

II The pH of the mixture increases till pH 7.

III Effervescence is seen.

IV A white precipitate is observed.

A I and II only

B II and III only

C III and IV only

D I, II and IV only

23. Which reagent, when mixed and heated with ammonium sulfate, liberates ammonia?

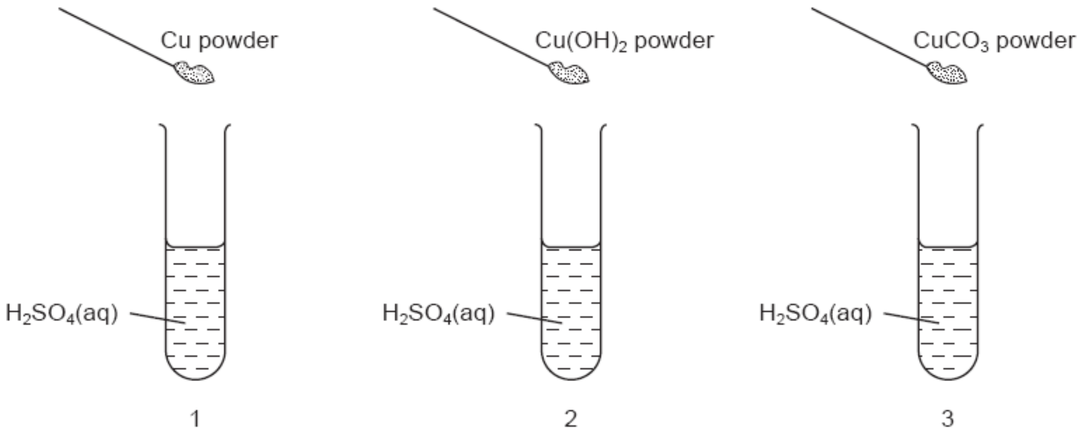
A aqueous bromine

B dilute hydrochloric acid

C limewater

D acidified potassium dichromate(VI)

24. The diagrams show three experiments using sulfuric acid. Three different powders are added to the acid. The mixtures are stirred.



Which test-tubes will contain aqueous Cu^{2+} ions?

A 1 and 2 only

B 2 and 3 only

C 1 and 3 only

D 1, 2 and 3

25. Which of the following reactants could be used to prepare a pure sample of potassium sulfate safely?

A potassium carbonate and sulfuric acid

B potassium and zinc sulfate

C potassium and sulfuric acid

D potassium nitrate and magnesium sulfate

26. A steel works and a chemical works are built near to a city. Limestone buildings in the city begin to crumble.

Which gas is most likely to cause this damage?

A oxygen

B carbon dioxide

C carbon monoxide

D nitrogen dioxide

27. Which of the following statements is true of sulfuric acid?

A It reacts with aqueous copper(II) chloride to produce a pale blue precipitate.

B It gives a white precipitate with aqueous barium nitrate.

C It reacts with aqueous silver nitrate to produce a white precipitate.

D It releases ammonia from aqueous ammonium sulfate.

28. The presence of nitrates in the soil can be shown by warming the soil with aqueous sodium hydroxide and aluminium foil. Which of the following shows that nitrates are present?

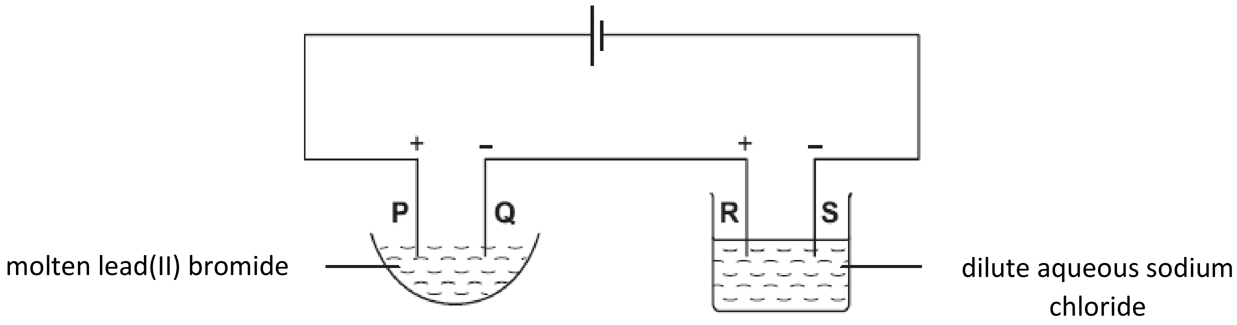
A A gas that extinguishes a lighted splint with a ‘pop’ sound is produced.

B A gas that turns moist red litmus blue is produced.

C A white precipitate is seen.

D Effervescence is seen.

29. The following electrolysis circuit is set up, using inert electrodes P, Q, R and S.

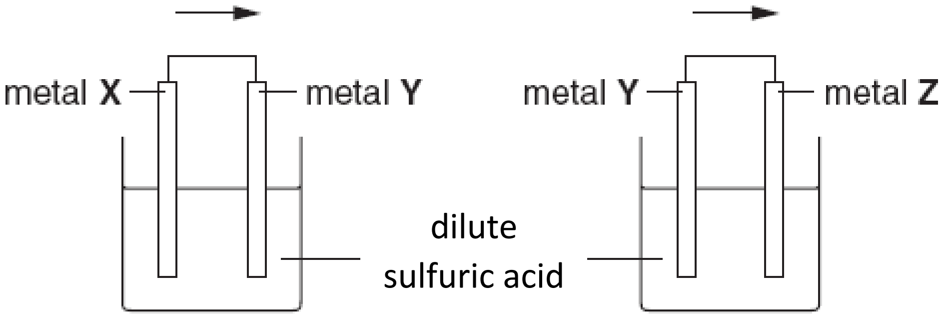


At which of the electrodes is a Group VII element produced?

A P only **B** P and R only **C** Q only **D** Q and S only

30. Two cells were set up as shown in the diagram. The arrow shows the direction of electron flow in the external circuit.

Which set of metals would produce an electron flow in the direction shown?



	metal X	metal Y	metal Z
A	Ag	Cu	Zn
B	Ag	Zn	Cu
C	Cu	Zn	Ag
D	Zn	Cu	Ag

31. The table compares the strengths of the bonds for reactions of the type below.

$$X_2 + Y_2 \rightarrow 2XY$$

Which reaction would be most exothermic?

	bonds in X_2	bonds in Y_2	bonds in XY
A	strong	strong	strong
B	strong	strong	weak
C	weak	weak	strong
D	weak	weak	weak

32. In which reaction is the sign of energy change, ΔH, correctly shown?

	equation	ΔH
A	$2AgCl(s) \rightarrow 2Ag(s) + Cl_2(g)$	positive
B	$CH_4(g) \rightarrow C(g) + 4H(g)$	negative
C	$H_2O(l) \rightarrow H_2O(g)$	negative
D	$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$	positive

33. Which compound contains two different elements with identical oxidation states?

A HClO **B** $Mg(OH)_2$ **C** Na_2SO_4 **D** NH_4Cl

34. In which of the following reactions is the underlined substance reduced?

A $\underline{FeCl_2} + Cl_2 \rightarrow FeCl_3$

B $3CuO + \underline{2NH_3} \rightarrow 3Cu + 3H_2O + N_2$

C $\underline{MnO_2} + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$

D $\underline{2H_2S} + SO_2 \rightarrow 2H_2O + 3S$

35. Bitumen is a substance obtained from the fractional distillation of crude oil. What are the boiling points and the sizes of the molecules in bitumen?

	boiling points	sizes of molecules
A	high	large
B	high	small
C	low	large
D	low	small

36. The table shows some properties of four hydrocarbons.

hydrocarbon	1	2	3	4
state at room temperature	gas	gas	liquid	liquid
reaction with aqueous bromine	decolourises bromine	no reaction	decolourises bromine	no reaction

Which of the following statements is true of the hydrocarbons?

A Hydrocarbons 1 and 2 are in the same homologous series.

B Hydrocarbons 2 and 4 are unsaturated.

C Hydrocarbon 1 has a lower relative molecular mass than hydrocarbon 3.

D Hydrocarbon 3 could be ethene.

37. Which of the following conditions are required to produce ethanol by fermentation?

	catalyst	temperature	Other condition
A	phosphoric acid	300°C	65 atm
B	enzymes in yeast	35 °C	Absence of oxygen
C	finely divided iron	450 °C	200 atm
D	nickel powder	150 °C	none

38. Which of the following compounds is produced in a reaction between propanoic acid and butanol?

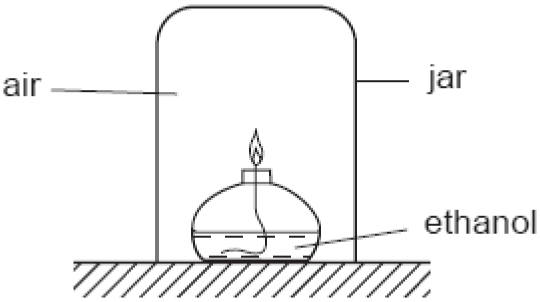
A $C_2H_5COOC_3H_7$

B $C_3H_7COOC_3H_7$

C $C_3H_7COOC_4H_9$

D $C_2H_5COOC_4H_9$

39. The diagram shows ethanol burning in a sealed jar.



The mass of one gas in the jar does not change. Which gas is this?

A oxygen

B nitrogen

C carbon dioxide

D water vapour

40. Which statement is correct about poly(chloroethene)?

A It is formed from the monomer chloroethane.

B It is a polymer formed when unsaturated monomers join together.

C Water molecules are eliminated in the process of polymerization.

D It is a macromolecule which conducts electricity like graphite.

The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 H hydrogen 1										4 He helium 2
7 Li lithium 3	9 Be beryllium 4											11 B boron 5	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	20 Ne neon 10
23 Na sodium 11	24 Mg magnesium 12											27 Al aluminium 13	28 Si silicon 14	31 P phosphorus 15	32 S sulfur 16	35.5 Cl chlorine 17	40 Ar argon 18
39 K potassium 19	40 Ca calcium 20	45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	55 Mn manganese 25	56 Fe iron 26	59 Co cobalt 27	59 Ni nickel 28	64 Cu copper 29	65 Zn zinc 30	70 Ga gallium 31	73 Ge germanium 32	75 As arsenic 33	79 Se selenium 34	80 Br bromine 35	84 Kr krypton 36
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	– Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54
133 Cs caesium 55	137 Ba barium 56	139 La lanthanum 57 *	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80	204 Tl thallium 81	207 Pb lead 82	209 Bi bismuth 83	– Po polonium 84	– At astatine 85	– Rn radon 86
– Fr francium 87	– Ra radium 88	– Ac actinium 89 †															

*58-71 Lanthanoid series

†90-103 Actinoid series

140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	– Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	162 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
232 Th thorium 90	– Pa protactinium 91	238 U uranium 92	– Np neptunium 93	– Pu plutonium 94	– Am americium 95	– Cm curium 96	– Bk berkelium 97	– Cf californium 98	– Es einsteinium 99	– Fm fermium 100	– Md mendelevium 101	– No nobelium 102	– Lr lawrencium 103

Key

a X b

a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

SINGAPORE CHINESE GIRLS' SCHOOL
Preliminary Examination
Secondary Four

CANDIDATE NAME	

CLASS	4			INDEX NUMBER		

CHEMISTRY

5073/02

Paper 2 Theory

2 August 2017

1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a HB pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid/tape.

Section A
Answer **all** questions in the spaces provided.

Section B
Answer **all three** questions, the last question is in the form either/or.
Answer **all** questions in the spaces provided.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page 21.

The use of an approved scientific calculator is expected, where appropriate.

For Examiner's Use	
Section A	**50**
Section B	**30**
Total	**80**

This question paper consists of 20 printed pages and 2 blank pages.

Section A

Answer **all** questions in this section in the spaces provided.
The total mark for this section is 50.

A1 Sulfur and sulfur compounds are common in the environment.

(a) A sample of sulfur from a volcano contained 88.0% by mass of sulfur-32 and 12.0% by mass of sulfur-34.

(i) Complete the table below to show the atomic structure of each isotope of sulfur.

isotope	number of		
	protons	neutrons	electrons
sulfur-32			
sulfur-34			

[2]

(ii) Calculate the relative atomic mass of the volcanic sulfur. Your answer should be given to three significant figures.

[2]

(b) One of the gases produced during volcanic eruptions is hydrogen sulfide. Hydrogen sulfide is a poisonous, colourless gas which smells of rotten eggs.

(i) Draw a dot-and-cross diagram to represent the bonding in a hydrogen sulfide molecule. Show outer electrons only.

[2]

[Turn Over

(ii) Using ideas of bonding and structure, explain why hydrogen sulfide gas does not conduct electricity.

....

....

....

.... [2]

(c) Every year, between 20 and 50 million tonnes of sulfur are released into the atmosphere from the oceans in the form of DMS, a compound of carbon, hydrogen and sulfur.

The percentage composition by mass of DMS is 38.6% carbon, 9.7% hydrogen and 51.7% sulfur. Calculate the empirical formula of DMS, showing your working clearly.

[2]

[Total: 10]

[Turn Over

A2 Zinc (proton number = 30) is not a typical transition element.

(a) State two properties of zinc that are not typical of transition elements.

....

....

.... [2]

(b) Name the reagents that can be used to prepare the following zinc salts and briefly describe how to obtain the solid product from the reaction mixture.

(i) Salt to be made: zinc carbonate

reagent 1: ……………………………………………

reagent 2: ……………………………………………

I could obtain solid zinc carbonate by: ....

....

(ii) Salt to be made: zinc chloride

reagent 1: ……………………………………………

reagent 2: ……………………………………………

I could obtain solid zinc chloride by: ....

.... [4]

(c) A student is given a colourless solution **T**.

(i) Describe one chemical test and its result that would confirm that solution **T** contains zinc ions.

....

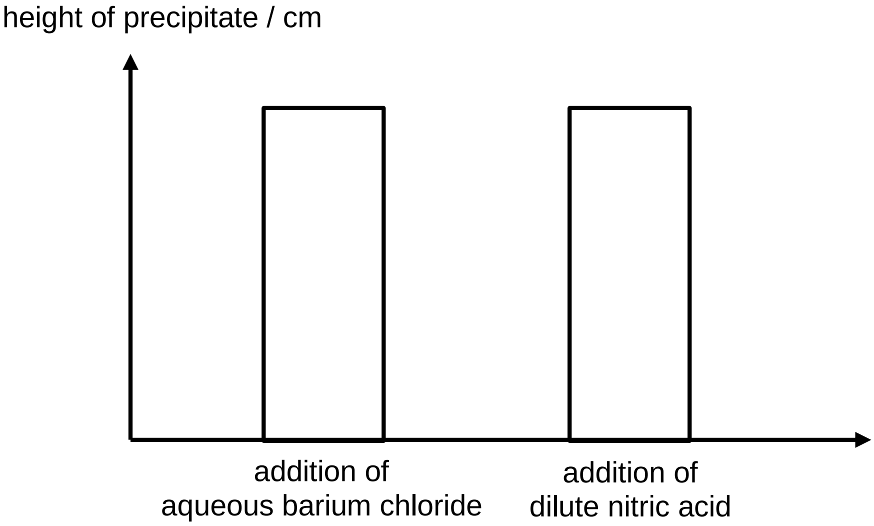
....

.... [2]

(ii) To identify the anion present, the student performed the following tests**.**

1. Add aqueous barium chloride to solution **T**.
2. Measure height of precipitate formed after 5 minutes.
3. Add dilute nitric acid to the above mixture.
4. Measure height of precipitate formed after 5 minutes.

She presented her results obtained in a graph as shown below.



Deduce the anion present in solution **T** and explain your deduction with reference to the graph.

....

....

.... [2]

[Total: 10]

A3 Poly(propene) and nylon are synthetic polymers.
Poly(propene) is an addition polymer. Nylon is a condensation polymer.

(a) Describe two differences between addition polymers and condensation polymers.

....

....

....

.... [2]

(b) Poly(propene) is formed by addition polymerisation of propene.

(i) Draw the structural formula of propene.

[1]

(ii) Draw the structural formula of the poly(propene).

[1]

(iii) Deduce the maximum mass of poly(propene) that could be produced from 1 kg of propene.

.... [1]

(c) The formula of the two monomers used to make nylon are shown below.

$HOOC(CH_2)_4COOH$ and $H_2N(CH_2)_6NH_2$

(i) Draw the repeat unit of nylon formed from these two monomers.

[1]

(ii) During the manufacturing process, the chain length of the nylon is controlled so that the nylon polymer molecules have an average relative molecular mass of 30 000.

What is the average number of repeat units in the nylon molecules? Show your working.

[2]

(d) Most synthetic polymers are non-biodegradable. Suggest one advantage and one disadvantage of using such polymers.

- advantage:

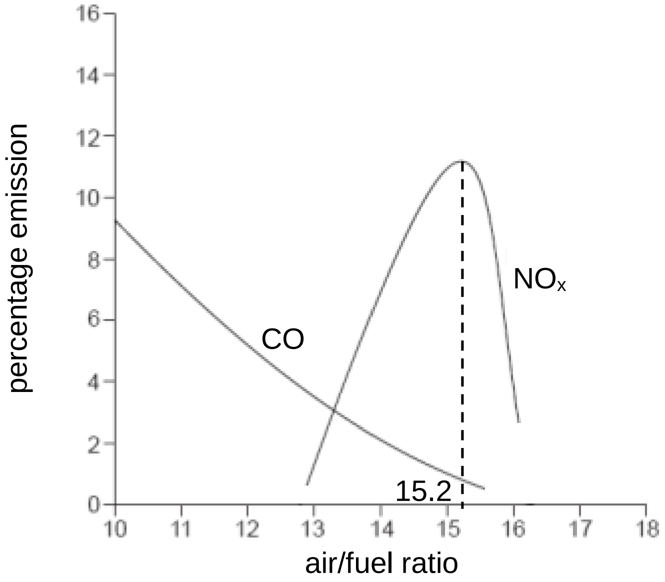
  ....

- disadvantage:

  .... [2]

[Total: 10]

A4 A car manufacturer conducted tests in which the air/fuel ratio in the engine was varied and the percentage emission of carbon monoxide, CO and nitrogen oxides, NO_x released was measured. The results are represented below.



(a) State and explain the effect of increasing the air/fuel ratio on CO emissions.

....

.... [2]

(b) Explain why there is an increase followed by a decrease in the percentage emission of nitrogen oxides (NO_x) as the air/fuel ratio increases from 13 to 16.

....

....

.... [2]

(c) Catalytic converters are used in cars to reduce the amounts of carbon monoxide and nitrogen oxides produced.
The equation for one reaction that happens in the catalytic converter is:

$$2CO + 2NO \rightarrow 2CO_2 + N_2$$

(i) Use oxidation states to explain why is this a redox reaction.

....

....

.... [2]

(ii) Explain why this reaction does not remove all the environmental problems caused by exhaust gases.

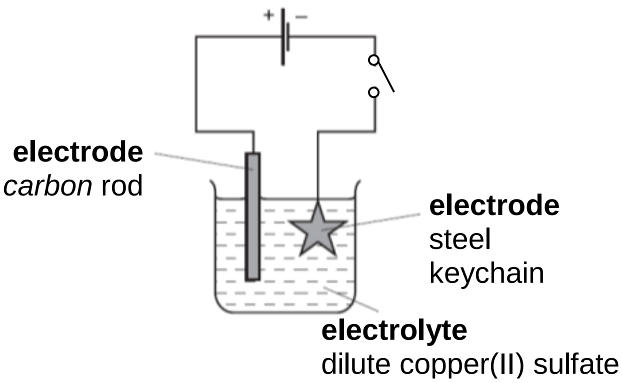
....

.... [1]

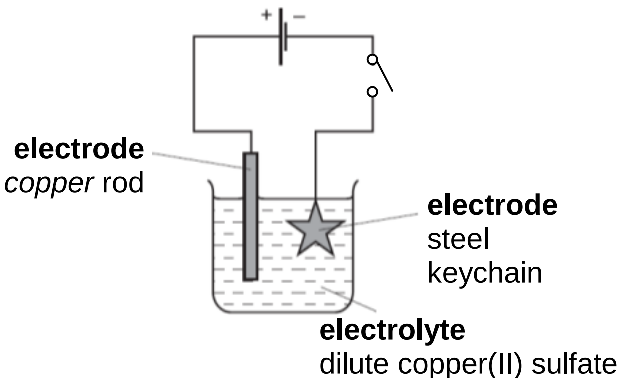
[Total: 7]

A5 A student set up two experiments for electroplating steel keychains with copper. She closed both circuits for a period of time.

Experiment 1



Experiment 2



(a) Complete the table of information about the experiments.

experiment	**electrodes**	**ionic equation, for reaction at each electrode**
1	carbon rod	
	steel keychain	
2	copper rod	
	steel keychain	

[3]

(b) Describe and explain the **observations** seen in the electrolyte in each experiment.

Experiment 1:

....

....

....

Experiment 2:

....

....

.... [4]

(c) **(i)** The student repeated **experiment 2** with another keychain. However, she left the keychain there without closing the circuit. Describe and explain one change she would **observe**.

....

....

....

.... [2]

(ii) Intrigued by what she saw in **c(i)**, the student modified the set-up in **experiment 2**. She removed the battery, replacing it with a voltmeter. A deflection in the voltmeter is seen immediately upon closing the circuit.

Explain why a deflection in the voltmeter is observed, giving the relevant ionic equations for both electrodes.

....

....

....

....

.... [4]

[Total: 13]

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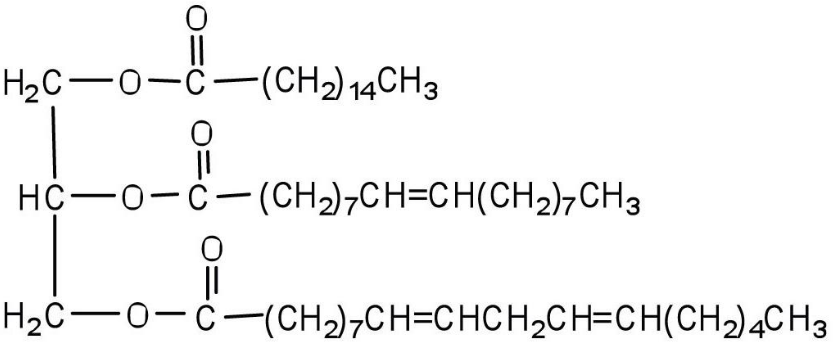
Section B

Answer all **three** questions in this section.

The last question is in the form of an either/or and only one of the alternatives should be attempted.

B6 Fats and oils are triglycerides formed from the condensation reaction of propane-1,2,3-triol with long chain carboxylic acids (fatty acids). Each triglyceride is formed from three fatty acids.

The structural formula of a triglyceride likely to be found in peanut oil is shown below.



A triglyceride is considered a fat if it is a solid at 25 °C; it is an oil if it is a liquid at that temperature. These differences in melting points reflect differences in the degree of unsaturation and molar mass of the constituent fatty acids.

One method for checking the unsaturation level in fatty acids is by determining the iodine number. Iodine number is the number of grams of iodine consumed by 100 g of fat or oil. A higher iodine value indicates a higher degree of unsaturation.

The table below shows average figures for the percentage fatty acid composition of some common fats and oils.

source of fat or oil	**% saturated fatty acids (total)**	**% monounsaturated fatty acid**	**% polyunsaturated fatty acids**	
		oleic acid ($C_{17}H_{33}COOH$)	**linoleic acid ($C_{17}H_{31}COOH$)**	**linolenic acid ($C_{17}H_{29}COOH$)**
beef fat	59	38	3	-
coconut oil	90	8	2	-
corn oil	25	26	47	2
cotton seed oil	22	35	43	-
olive oil	15	78	7	-
soybean oil	14	28	50	8

The polyunsaturated/saturated (P/S) index of a fat or oil is the ratio of polyunsaturated fat to saturated fat. It is sometimes used to compare the relative health benefits of different fats and oils in the diet.

Passage is adapted from:

1. https://2012books.lardbucket.org/books/introduction-to-chemistry-general-organic-and-biological/s20-lipids.html
2. http://vlab.amrita.edu/?sub=3&brch=63&sim=1111&cnt=1

(a) Propane-1,2,3-triol reacts with fatty acids to form triglyceride.

(i) Based on the structural formula given, name the chemical linkage formed in the triglyceride.

.... [1]

(ii) Name the other product formed in this reaction.

.... [1]

(iii) Give the structural formulae of **two** reactants that are used to produce the triglyceride found in peanut oil.

- structural formula of propane-1,2,3-triol:

- structural formula of one of the carboxylic acids:

[2]

(b) Deduce, using data given in the table, which fat or oil from the table above has the lowest iodine number. Explain your answer.

....

.... [1]

(c) Cotton seed oil and corn oil have similar iodine numbers but the melting point of cotton seed oil is higher than that of corn oil.
Suggest an explanation in terms of the structure and bonding in these two oils.

....

....

....

.... [2]

(d) Linoleic acid is a polyunsaturated fatty acid with molecular formula of $C_{17}H_{31}COOH$.

How many double bonds between carbon atoms are present in one molecule of linoleic acid? Explain your answer.

....

....

....

.... [2]

(e) A P/S value of greater than 1 is considered beneficial for health.

Calculate the P/S index of beef fat and soybean oil, giving your answers to 3 significant figures.

Hence determine which oil is more beneficial to health.

- P/S index of beef fat

- P/S index of soybean oil

.... [3]

[Total: 12]

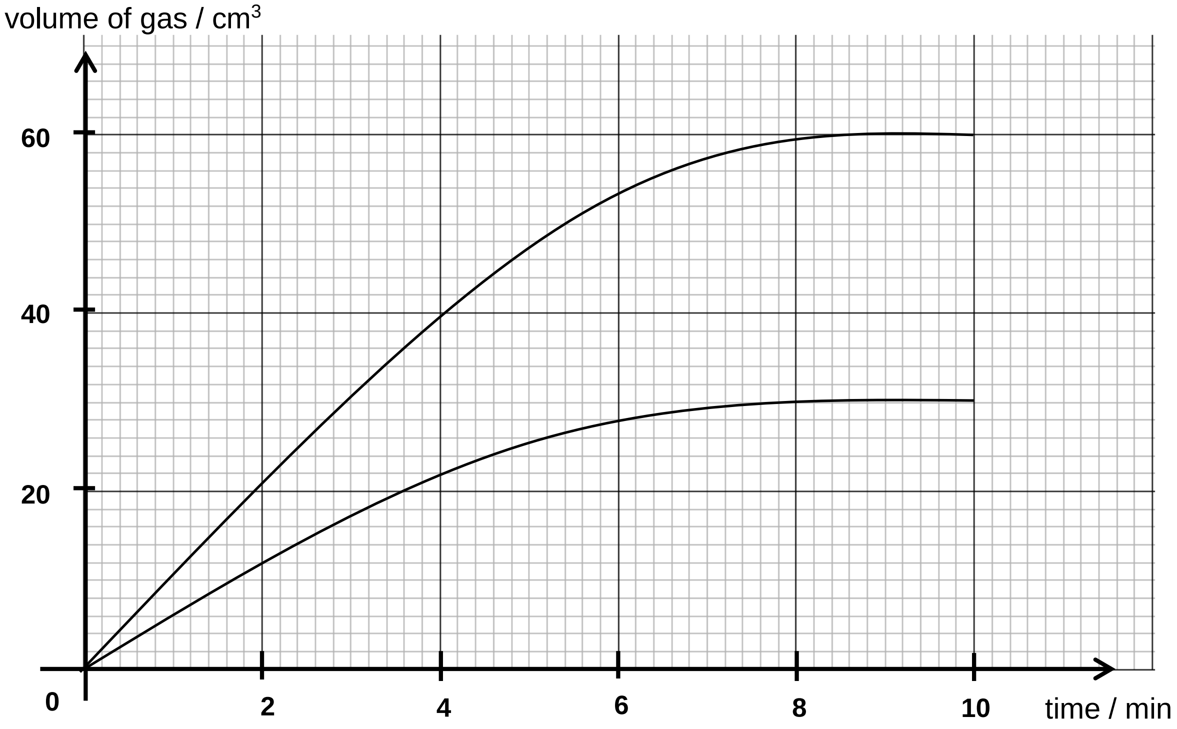
B7 A series of experiments was carried out to compare the rate of reaction of acid with magnesium carbonate under different conditions.

Excess magnesium carbonate and 25 cm^3 of acid were used. The conditions for each experiment are shown in the table below.

experiment	magnesium carbonate	type of acid used
A	lumps	0.1 mol/dm^3 of HC*l*
B	lumps	0.2 mol/dm^3 of HC*l*
C	lumps	0.1 mol/dm^3 of CH_3COOH
D	powder	0.2 mol/dm^3 of HC*l*

The gas given off was collected and its total volume was measured every 30 seconds for 10 minutes. The results obtained for experiment **A** and **B** were plotted in **Graph 1**.

Graph 1



(a) Label the curves **A** and **B** such that they correspond to the results for experiment **A** and experiment **B**. [1]

(b) Sketch and label on **graph 1** the curve you would expect for experiment **C**, assuming that the reaction stopped at the tenth minute. [1]

(c) Explain, in terms of collisions between reacting particles, why there is a difference in the initial rate of reaction between experiments **B** and **D**.

....

....

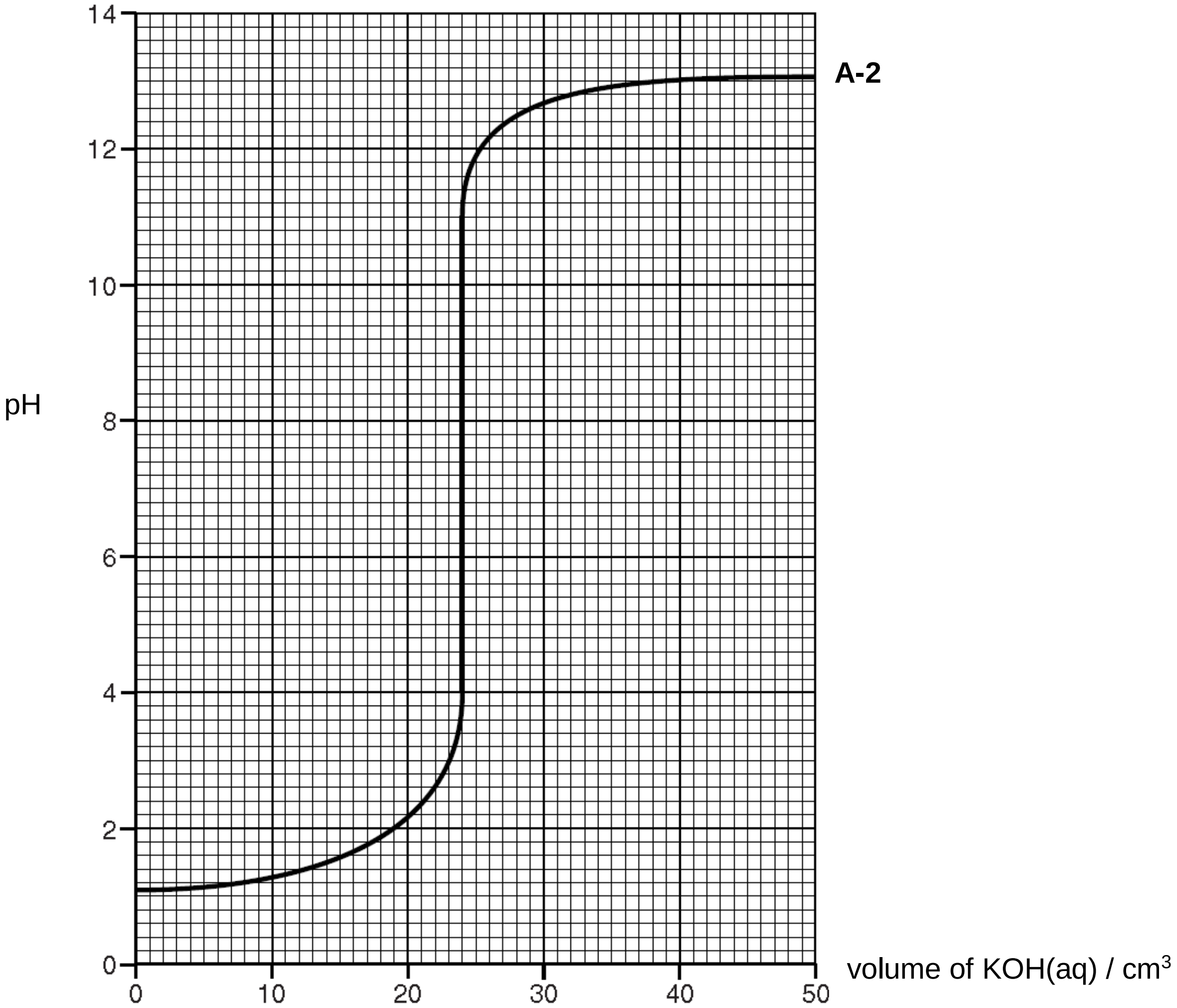
....

.... [2]

The acids from experiments **A** and **C** are used in titration experiments with potassium hydroxide.

In **experiment A-2**, 0.1 mol/dm^3 of potassium hydroxide was added from a burette to 24.0 cm^3 of dilute hydrochloric acid. A pH probe attached to a computer measured the pH during the titration experiment. **Graph 2** below shows the results.

Graph 2



In **experiment C-2**, 0.1 mol/dm^3 of potassium hydroxide was added from a burette to 24.0 cm^3 of dilute ethanoic acid.

(d) State the pH value of hydrochloric acid used in **experiment A-2**. …………………….. [1]

(e) Given that the pH value of the ethanoic acid used in **experiment C-2** is 4, sketch the curve you would expect for this experiment. You are to sketch the curve on **graph 2**. [1]

(f) The acids used in **experiment A-2** and **C-2** have the same concentration. Explain why they have different pH values.

....

....

....

.... [2]

[Total: 8]

EITHER

B8 Petroleum is a naturally occurring yellow-to-black liquid found beneath the earth's surface. It consists of mainly hydrocarbons of various molecular masses.

(a) What is meant by the term *hydrocarbon*?

....

.... [1]

(b) Dodecane is a hydrocarbon with molecular formula of $C_{12}H_{26}$. It undergoes cracking to produce butane and one other molecule **X**.

(i) Deduce the formula of **X**.

.... [1]

(ii) Draw the structure of

- straight chain **X**.

- branched chain isomer of **X**.

[2]

(iii) A few drops of aqueous bromine is added to separate samples of butane and **X**. Describe your observations.

....

....

....

.... [2]

(c) The complete combustion of hydrocarbons produces carbon dioxide and water only.

10 cm^3 of a gaseous hydrocarbon **Y** was mixed with an excess of oxygen of volume 100 cm^3. The mixture was ignited. After cooling, the volume of remaining gases is 70 cm^3. When passed over aqueous sodium hydroxide, the total gas volume is further reduced to 20 cm^3.

Deduce the formula of the hydrocarbon **Y**, showing your workings clearly. All volumes were measured at r.t.p..

[4]

[Total: 10]

OR

B8 Ethanol is a renewable alcohol fuel made from plant material, such as sugar cane.

(a) Name the process used to produce ethanol from sugar.

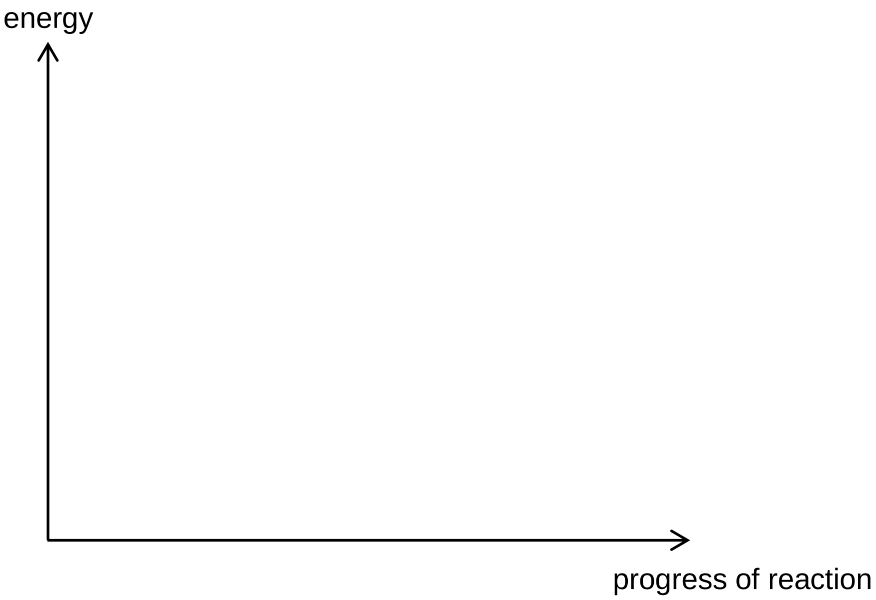
.... [1]

(b) The complete combustion of ethanol is represented by the following equation.

$$CH_3CH_2OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l) \quad \Delta H = -1367 \text{ kJ/mol}$$

(i) Draw an energy profile diagram for the combustion of ethanol.

Your diagram should include labels for the reaction enthalpy change and activation energy.



[2]

(ii) Explain, in terms of bond breaking and bond making, why **this reaction** is exothermic.

....

....

....

.... [2]

(c) Gasohol E10 is a mixture of ethanol and gasoline (petrol). The number after the "E" indicates the percentage of ethanol by volume. Most of the gasoline sold in the United States contains up to 10% ethanol.

Assume that the other 90% by mass of Gasohol E10 is octane, C_8H_{18}. 1.00 kg of this fuel mixture was burned.

$$CH_3CH_2OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l) \quad \Delta H = -1367 \text{ kJ/mol}$$

$$C_8H_{18}\,(l) + 12\tfrac{1}{2}\,O_2(g) \rightarrow 8CO_2(g) + 9H_2O(l) \quad \Delta H = -5470 \text{ kJ/mol}$$

(i) Complete the table by calculating the energy output for 1 g of each fuel, giving your answers to 3 significant figures.

name of fuel	**enthalpy change of combustion / kJ per mole**	**energy output / kJ per gram**
ethanol	– 1367	
octane	– 5470	

[2]

(ii) Calculate the total amount of energy, in kJ, released when 1.00 kg of the fuel mixture is completely burned, giving your answers to 3 significant figures.

[3]

[Total: 10]

The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 H hydrogen 1										4 He helium 2
7 Li lithium 3	9 Be beryllium 4											11 B boron 5	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	20 Ne neon 10
23 Na sodium 11	24 Mg magnesium 12											27 A*l* aluminium 13	28 Si silicon 14	31 P phosphorus 15	32 S sulfur 16	35.5 C*l* chlorine 17	40 Ar argon 18
39 K potassium 19	40 Ca calcium 20	45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	55 Mn manganese 25	56 Fe iron 26	59 Co cobalt 27	59 Ni nickel 28	64 Cu copper 29	65 Zn zinc 30	70 Ga gallium 31	73 Ge germanium 32	75 As arsenic 33	79 Se selenium 34	80 Br bromine 35	84 Kr krypton 36
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	– Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54
133 Cs caesium 55	137 Ba barium 56	139 La lanthanum 57 *	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80	204 T*l* thallium 81	207 Pb lead 82	209 Bi bismuth 83	– Po polonium 84	– At astatine 85	– Rn radon 86
– Fr francium 87	– Ra radium 88	– Ac actinium 89 †															

*58-71 Lanthanoid series

†90-103 Actinoid series

140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	– Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	162 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
232 Th thorium 90	– Pa protactinium 91	238 U uranium 92	– Np neptunium 93	– Pu plutonium 94	– Am americium 95	– Cm curium 96	– Bk berkelium 97	– Cf californium 98	– Es einsteinium 99	– Fm fermium 100	– Md mendelevium 101	– No nobelium 102	– Lr lawrencium 103

Key

a X b

a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

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SCGS 4E Chem Prelim 2017 Ans

2017 Sec 4 OLP Chemistry Preliminary Exam P1 answers

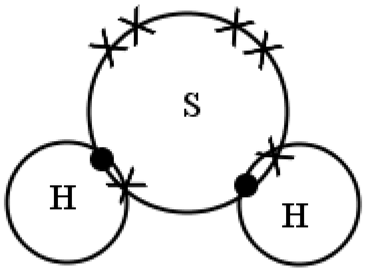
1-5	C	B	B	A	C
6-10	B	D	A	C	B
11-15	B	D	D	C	B
16-20	C	B	A	D	C
21-25	A	A	C	B	A
26-30	D	B	B	A	D
31-35	C	A	A	C	A
36-40	C	B	D	B	B

Marker's Copy

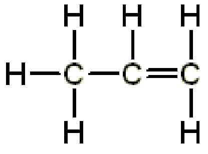
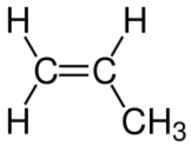
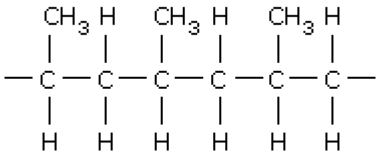
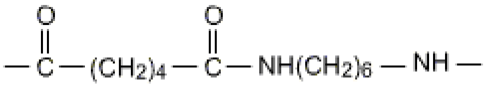
Singapore Chinese Girls' School
2017 Preliminary Exam
Secondary 4 OLP Chemistry

Suggested answers:

Section A [50 MARKS]

<table>
<tr><td>A1</td><td>(a)</td><td>(i)</td><td>Sulfur-32: 16, 16, 16 [1]
Sulfur-34: 16, 18, 16 [1]</td><td></td><td>2</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>Relative atomic mass
= $(\frac{88}{100} \times 32) + (\frac{12}{100} \times 34)$ [1]
= 32.24
= 32.2 (3sf) [1]</td><td></td><td>2</td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td> </td><td>• 1M – sharing of electrons between H and S
• 1M – correct valence electrons for S
• Allow: 3 shells for S atom</td><td>2</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>Hydrogen sulfide has a simple molecular / covalent structure and exists as neutral molecules. [1] There are no mobile charged particles to conduct electricity. [1]</td><td></td><td>2</td></tr>
<tr><td></td><td>(c)</td><td></td><td>
<table>
<tr><td>Element</td><td>C</td><td>H</td><td>S</td></tr>
<tr><td>Number of moles / mol</td><td>$\frac{38.6}{12}$
= 3.2167</td><td>$\frac{9.7}{1}$
= 9.7</td><td>$\frac{51.7}{32}$
= 1.6156
OR
$\frac{51.7}{32.24}$
= 1.6036</td></tr>
<tr><td>Simplest ratio</td><td>$\frac{3.2167}{1.6156}$</td><td>$\frac{9.7}{1.6156}$</td><td>$\frac{1.6156}{1.6156}$</td></tr>
</table>
</td><td>• 1M for correct number of moles
• 1M for correct empirical formula</td><td>2</td></tr>
</table>

			= 2 ; = 6 ; = 1 OR ; OR ; OR $\frac{3.2167}{1.6036}$; $\frac{9.7}{1.6036}$; $\frac{1.6036}{1.6036}$ = 2 ; = 6 ; = 1 Empirical formula of DMS = C_2H_6S [1]		
A2	(a)		Any two: • Zinc does not have variable oxidation state in its compounds / Zinc has only one (fixed) oxidation state in its compounds. • Zinc does not form coloured compounds. • Zinc has low melting and boiling points.	• 1M for each point • Reject: Zinc has low density / its elements and/or compounds are not catalysts	2
	(b)	(i)	Reagent 1: zinc nitrate (or any other solution containing zinc ions) Reagent 2: sodium carbonate (or any other solution containing carbonate ions) Filter the mixture. (Wash the residue with deionised water.) Dry residue with filter papers.	• 1M for both reagents • 1M for brief description	2
		(ii)	Reagent 1: zinc / zinc oxide / zinc hydroxide / zinc carbonate Reagent 2: hydrochloric acid Filter the mixture. Heat filtrate till saturation. Cool to allow crystals to form. Filter and dry crystals with filter papers.	• 1M for both reagents • 1M for brief description	2
	(c)	(i)	Add a few drops, then in excess of aqueous ammonia to solution T. [1] White precipitate formed will dissolve in excess aqueous ammonia to form a colourless solution. [1]	Ignore test and results with NaOH(aq) – no credit	2
		(ii)	The height of the precipitate formed remained unchanged on adding barium chloride and dilute		2

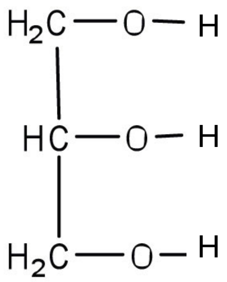
			nitric acid. This shows that an insoluble barium salt that does not react with acid is formed. [1] Hence, the anion present in solution T is sulfate ion / SO_4^{2-}. [1]		
A3	(a)		Any two: • Addition polymers are formed from (unsaturated) monomers containing carbon-carbon double bonds while condensation polymers are formed from monomers containing carboxyl and hydroxyl groups or carboxyl and amine groups. • Only the polymer is formed during the formation of addition polymers while the formation of condensation polymers produces the polymer and small molecules. • The empirical formula of the addition polymer is the same as its monomer while the empirical formula of condensation polymer is not the same as its monomer. • Addition polymers contain long chains of carbon-carbon atoms joined together while condensation polymers contain amide (or ester) linkages.	1M for each point	2
	(b)	(i)	 OR 		1
		(ii)	 $-\underset{H}{\overset{CH_3}{C}}-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{CH_3}{C}}-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{CH_3}{C}}-\underset{H}{\overset{H}{C}}-$		1
		(iii)	1 kg		1
	(c)	(i)	 $-\overset{O}{\overset{\|}{C}}-(CH_2)_4-\overset{O}{\overset{\|}{C}}-NH(CH_2)_6-NH-$		1

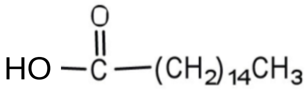
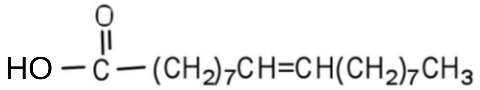
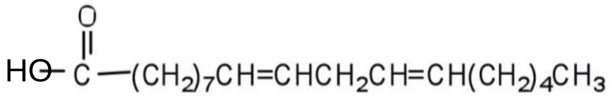
		(ii)	M_r of each nylon repeating unit = (12 x 6 + 8 + 16 x 2) + (14 x 2 + 12 x 6 + 14) = 226 [1] Minimum number of repeat units = $\frac{30000}{226}$ = 132.7 = 132 or 133 (Allow either) [1]		2
	(d)		Advantage: The polymers can be used over a long period of time. / The polymers are long lasting / durable. [1] Disadvantage: More landfills sites will be required for disposal of these polymers, which takes up land space. [1]	Accept: Any other logical answers	2
A4	(a)		As the air/fuel ratio increase, the percentage of CO emissions decreases. [1] This is due to higher concentration of oxygen to allow more complete combustion (in car engine). [1]		2
	(b)		As air/fuel ratio increases from 13 to 15.2, the amount of air found in car engine increases. As a result, there will be <u>more nitrogen and oxygen</u> to react in the high temperature of the engine, increasing the percentage emission of nitrogen oxides. [1] However, as the air/fuel ratio increases from 15.2 to 16, the <u>temperature in engine decreases</u> with less fuel burning. As a result, there will be a decrease in the percentage emission of nitrogen oxides. [1]		2
	(c)	(i)	The oxidation state of carbon increase from +2 in CO to +4 in CO_2. [1]		2

			The oxidation state of nitrogen decreases from +2 in NO to 0 in N_2. [1] It is a redox reaction as CO is oxidised and NO is reduced.		
		(ii)	Carbon dioxide is produced and it is a greenhouse gas. It traps heat on Earth and causes temperature to rise / global warming.		1
A5	(a)		Experiment 1 Carbon rod: $4OH^- \rightarrow 2H_2O + O_2 + 4e^-$ [1] Steel keychain: $Cu^{2+} + 2e^- \rightarrow Cu$ Experiment 2 Copper rod: $Cu \rightarrow Cu^{2+} + 2e^-$ [1] Steel keychain: $Cu^{2+} + 2e^- \rightarrow Cu$	1M for both equations at the steel keychain	3
	(b)		Experiment 1 The electrolyte changes from blue to colourless. [1] This is because the concentration of copper(II) ions decreases as the copper(II) ions are reduced at the cathode. [1] Experiment 2 No visible change for the electrolyte. / The electrolyte remains blue. [1] This is because the concentration of copper(II) ions remains the same, for every mole of copper(II) ions reduced at the cathode, one mole of copper is oxidised at the anode. [1]		4
	(c)	(i)	Any one: • 1st MP: The steel keychain is coated with a layer of reddish-brown / pink solid. OR Reddish-brown / pink solids are seen in the solution. OR The steel keychain decreases in size. 2nd MP:		2

			<u>Iron</u> (from the steel keychain) <u>displaces copper(II) ions</u> from its solution <u>to form</u> iron(II) ions and <u>copper</u>. • 1^{st} MP: Copper(II) sulfate solution changes from blue to pale green. 2^{nd} MP: <u>Iron</u> (from the steel keychain) <u>displaces copper(II) ions</u> from its solution <u>to form</u> <u>iron(II) ions</u> and copper.		
		(ii)	Iron being more reactive than copper, will oxidise/lose electrons to form iron(II) ions. [1] $Fe \rightarrow Fe^{2+} + 2e^-$ The electrons flow to the copper electrode. Copper(II) ions from the electrolyte gain electrons to form copper. [1] $Cu^{2+} + 2e^- \rightarrow Cu$ The movement of electrons causes the deflection in the voltmeter. [1]	1M for equations for both electrodes	4

Section B [30 MARKS]

B6	(a)	(i)	Ester linkage		1
		(ii)	Water		1
		(iii)	structural formula of propane-1,2,3-triol:  structural formula of one of the carboxylic acids:	1M each	2

			 $HO-\overset{O}{\overset{\|}{C}}-(CH_2)_{14}CH_3$ OR  $HO-\overset{O}{\overset{\|}{C}}-(CH_2)_7CH=CH(CH_2)_7CH_3$ OR  $HO-\overset{O}{\overset{\|}{C}}-(CH_2)_7CH=CHCH_2CH=CH(CH_2)_4CH_3$		
	(b)		Coconut oil, as the percentage of unsaturation adds up to 10%, which is the lowest.		1
	(c)		Both cotton seed molecules and corn oil molecules have similar iodine numbers. Hence, their melting points is not dependent on the degree of unsaturation. Cotton seed oil molecules have <u>higher molar mass / relative molecular mass</u> than corn oil molecules. [1] Hence <u>more energy</u> is taken in to <u>overcome the stronger intermolecular forces / Van der Waals' forces between molecules</u>. [1]		2
	(d)		A saturated fatty acid with 18 carbon atoms has a molecular formula of $C_{17}H_{35}COOH$. [1] Since a decrease in 2 hydrogen atoms indicates the present of one carbon-carbon double bond in each molecule, each molecule of linoleic acid will contain two carbon-carbon double bonds. [1]	OWTTE	2
	(e)		P/S of beef fat $= \frac{3}{59} = 0.0508$ [1] P/S of soybean oil $= \frac{50+8}{14} = 4.14$ [1] Soybean oil is more beneficial to health. [1]		3
B7	(a)		Curve A – Produced 30 cm^3 of gas at the end of reaction	1M for both labels	1

			Curve B – Produced 60 cm^3 of gas at the end of reaction		
	(b)		Curve C – In comparison to curve A: (1) initial gradient to be more gentle & (2) same height		1
	(c)		Experiment B uses lumps of magnesium carbonate, which has bigger particle size and less exposed surface area. [1] This decreases the probability of collisions between magnesium carbonate particles and the hydrogen ions from the acids, which decreases the frequency of effective collisions, leading to a slower initial rate of reaction. [1]	Accept: Reverse argument for experiment D	2
	(d)		pH 1.1		1
	(e)		Similar curve to A-2, except for an initial pH value of 1.1 (same volume of KOH used & same height at the end of the reaction)		1
	(f)		1st MP: In experiment A, hydrochloric acid, a strong acid, ionises completely to produce hydrogen ions, while in experiment C, ethanoic acid, a weak acid, ionises partially to produce hydrogen ions. 2nd MP: Link pH value to concentration of hydrogen ions: Any one: • Ethanoic acid has a lower concentration of hydrogen ions and therefore has a higher pH value. • Hydrochloric acid has a higher concentration of hydrogen ions and therefore has a lower pH value. • Since the concentration of hydrogen ions is different, the pH value will be different.	1M for each Marking Point (MP)	2

E B8	(a)		Hydrocarbons are organic compounds containing hydrogen and carbon only.		1
	(b)	(i)	C_8H_{16}		1
		(ii)	Straight chain of C_8H_{16}	Correct diagram	1
			Any branched chain of C_8H_{16}	Correct diagram	1
		(iii)	There will be no visible change when aqueous bromine is added to butane. / Aqueous bromine remains reddish-brown when added to butane. [1] Aqueous bromine will change from reddish brown to colourless rapidly when added to X.		2
	(c)		Volume of CO_2 = 70 – 20 = 50 cm^3 [1] Volume of O_2 = 100 – 20 = 80 cm^3 [1] Let the formula of the hydrocarbon be represented by C_xH_y. C_xH_y : O_2 : CO_2 10 : 80 : 50 1 : 8 : 5 [1] $1C_xH_y + 8O_2 \rightarrow 5CO_2 + \_\_H_2O$ total no. of C atoms = 5 total no. of O atoms = 16 no. of O atoms in H_2O = 16 – 10 = 6 total no. of H atoms = 12 Formula of hydrocarbon = C_5H_{12} [1]		4
O B8	(a)		Fermentation		1
	(b)	(i)	Correct diagram	• 1M for Reactants, R labelled as	2

				$CH_3CH_2OH + 3O_2$ and Products, P labelled as $2CO_2 + 3H_2O$ AND correct shape of curve (R higher than P) and • 1M for correct labels for enthalpy change (R to P) AND activation energy (R to tip of curve)	
		(ii)	<u>Energy taken in to break bonds in ethanol and oxygen</u> is less than <u>energy given out to form bonds in carbon dioxide and water</u>. [1]	1M for identifying that the energy taken in is less than energy given out	2
	(c)	(i)	Energy given out for 1 g of ethanol = $\frac{1367}{2\times12+5+16+1}$ = $\frac{1367}{46}$ = 29.7 kJ / g (3 sf) [1] Energy given out for 1 g of octane = $\frac{5470}{8\times12+18}$ = $\frac{5470}{114}$ = 48.0 kJ / g (3 sf) [1]		2
		(ii)	Energy released when 1 kg of the fuel mixture is burned = ($\frac{10}{100}\times 1000\ \times 29.717$) + ($\frac{90}{100}\times 1000\ \times 47.982$) = 2971.7 [1] + 43183.8 [1] = 46155.5 = 46200 kJ [1]		3

Name: ……………………………………………….(   )   Class: Sec ……………

St. Gabriel's Secondary School

2017 'O' Preliminary Examination

Subject	**:**	**Chemistry**
Paper No	**:**	**5073/1**
Level/Stream	**:**	**4 Express**
Duration	**:**	**1 hour**
Date	**:**	**29 August 2017**

Additional material: *Multiple Choice Answer Sheet*

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Write your name, class and index number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **forty** questions in this section. **Answer all questions**. For each question, there are four possible answers, A, B, C and D.

Choose the one you consider correct and record your choice in soft pencil on the separate Answer Sheet provided.

Read the instructions on the Answer Sheet carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

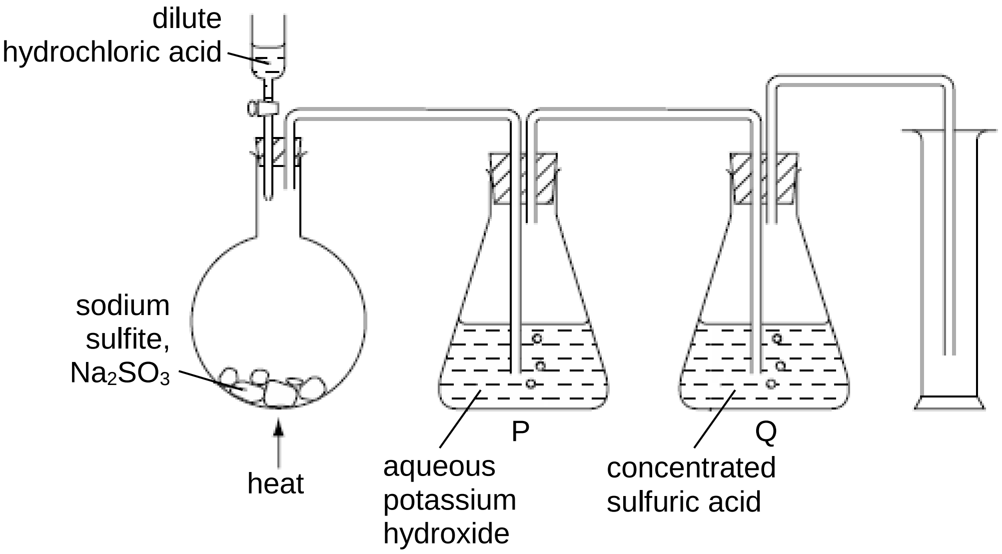
At the end of the examination, submit the Answer Sheet.

A copy of the Periodic Table is printed on page 17.

This question paper consists of **17** printed pages including this cover page.

[Turn over

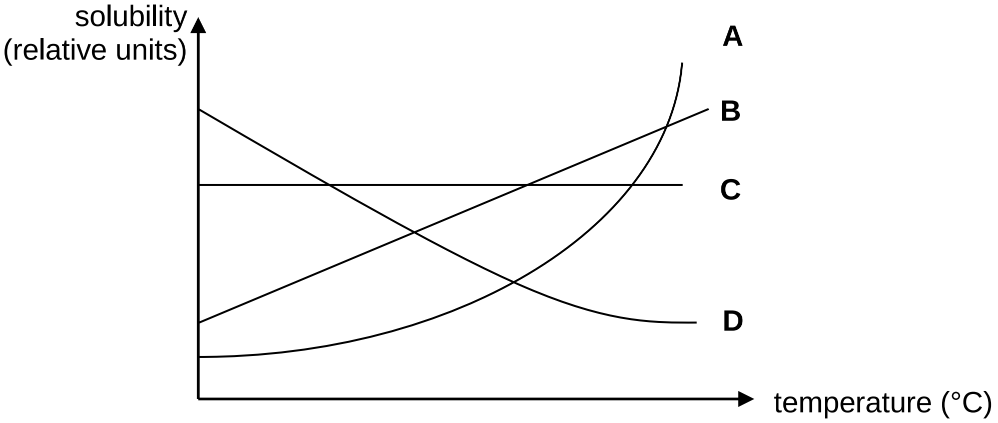
1 The apparatus shows an unsuccessful attempt to prepare and collect dry sulfur dioxide.



Which change would make the experiment successful?

A removing flask P containing aqueous potassium hydroxide
B removing flask Q containing concentrated sulfuric acid
C using upward delivery instead of downward delivery of gas
D using calcium oxide instead of concentrated sulfuric acid

2 The solubility curves for four solids, **A**, **B**, **C** and **D**, in water are shown below.
Which solid is most suitable to be prepared by crystallisation from its aqueous salt?



3 The table below shows the properties of some substances. Which substance has been wrongly classified as an element, compound or mixture?

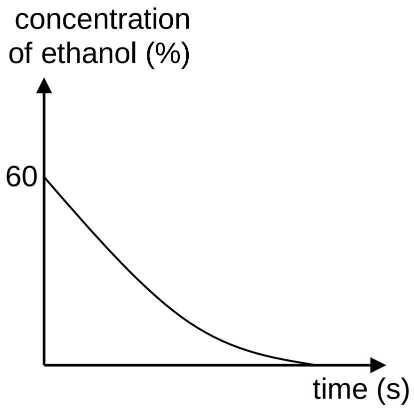
	property	classification
A	A white solid is formed when a silvery metal is burnt in air.	compound
B	Black powder burns in air to form a colourless gas.	element
C	Green powder on heating leaves a black residue and a colourless gas is evolved.	element
D	White solid melts over 45 °C to 50 °C.	mixture

4 Most alcoholic drinks are composed primarily of water and ethanol, with some traces of impurities and flavourings. Alcoholic drink **X** is made up of 40% by volume of ethanol.

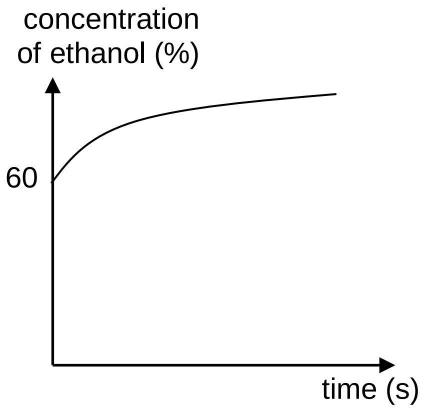
A sample of alcoholic drink **X** is distilled using fractional distillation. Boiling points of ethanol and water are 78 °C and 100 °C respectively.

Which graph shows the change in concentration of ethanol in the round-bottomed flask as the distillation proceeds?

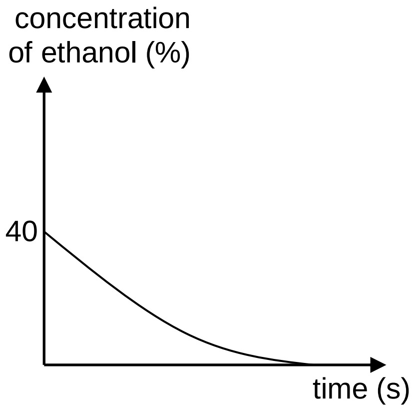
A



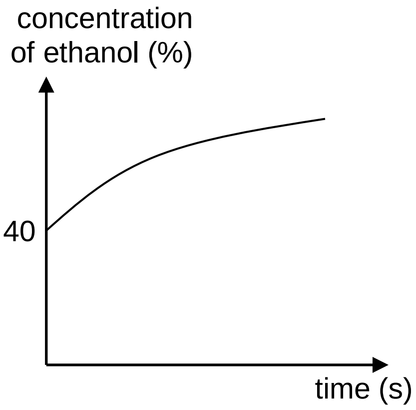
B



C



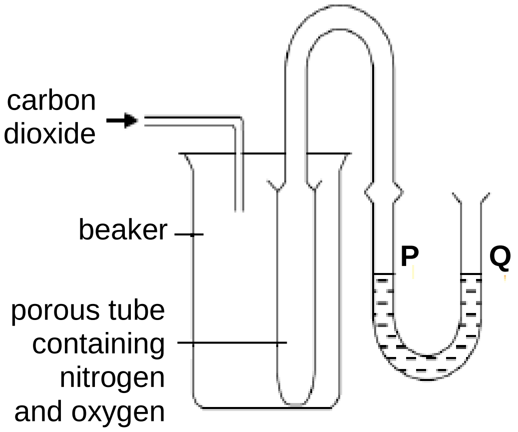
D



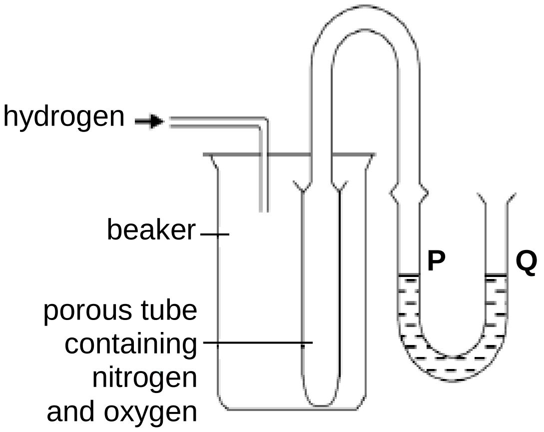
5 20 cm^3 of ethene diffused through a porous pot in 40 seconds. How long will it take for 40 cm^3 of carbon monoxide to diffuse under the same conditions of temperature and pressure?

A	10 seconds	**B**	20 seconds
C	40 seconds	**D**	80 seconds

6 Two experimental set-ups used to demonstrate diffusion of gases are shown in the diagram below. What changes, if any, to the water levels at **P** and **Q** would you expect to see in both experiments?



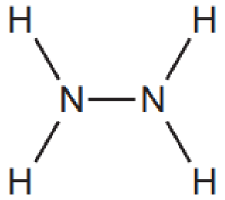
experiment 1



experiment 2

	experiment 1	experiment 2
A	**P** is higher than **Q**	**Q** is higher than **P**
B	**Q** is higher than **P**	**Q** is higher than **P**
C	**P** and **Q** remain the same	**P** and **Q** remain the same
D	**P** and **Q** remain the same	**Q** is higher than **P**

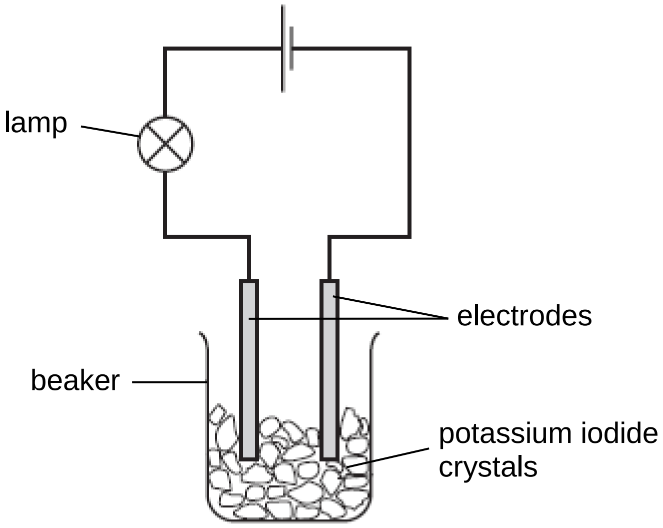
7 The diagram shows the structural formula of the covalent molecule hydrazine, N_2H_4.



Consider all the electrons in a molecule of hydrazine.
Which description fits the arrangement of these electrons in the molecule?

	total number of electrons involved in bonding	total number of electrons not involved in bonding
A	5	4
B	5	8
C	10	4
D	10	8

8 The experiment shown is used to test the electrical conductivity of potassium iodide crystals.

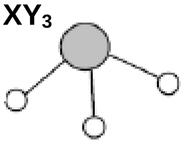


The lamp does not light up.
Distilled water is then added to the beaker and the lamp lights.
Which statement explains these results?

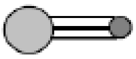
- **A** Metal ions are free to move when potassium iodide melts.
- **B** Metal ions are free to move when potassium reacts with water.
- **C** Electrons are free to move in the solution when potassium iodide dissolves.
- **D** Oppositely charged ions are free to move in the solution when potassium iodide dissolves.

9 The models and formulae for some molecules are shown below.

XY_3

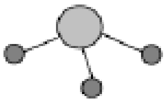


ZX

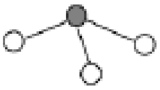


Which of the following, **A**, **B**, **C** or **D**, is the correct model for a molecule of the compound between **Y** and **Z**?

A

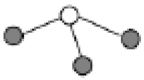


B



C

D



10 A piece of magnesium does not react when put into a solution of hydrogen chloride in chloroform. Which of the following changes will cause a reaction to occur?

- **A** adding a catalyst
- **B** adding water and stirring
- **C** increasing the temperature
- **D** increasing the concentration of hydrogen chloride in chloroform

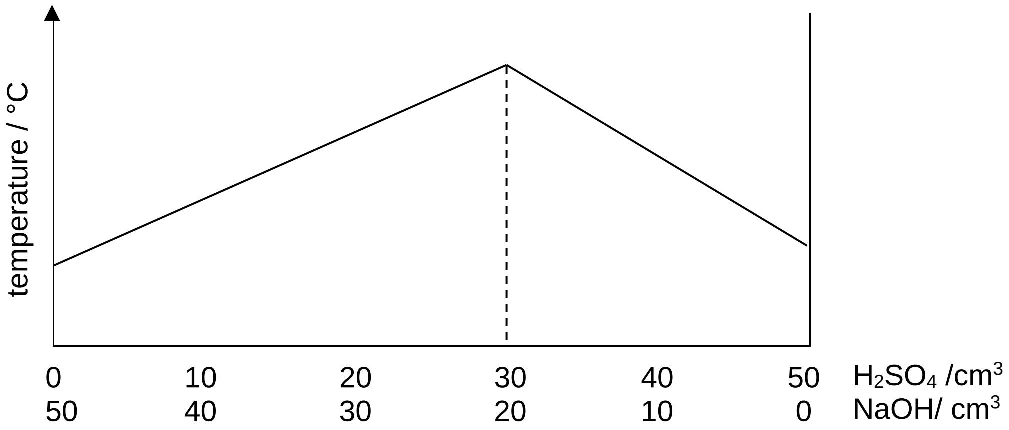
11 32 g of copper contains x atoms. How many atoms are there in 44 g of carbon dioxide?

A	0.5x	**B**	x
C	2x	**D**	4x

12 40 cm^3 of 1.0 mol/dm^3 solution of a magnesium salt contains 4.8 g of the dissolved compound. The salt is a __________.

A	carbonate	**B**	sulfate
C	nitrate	**D**	chloride

13 A solution of sulfuric acid has a concentration of 1 mol/dm^3.
Different volumes of the acid are added to different volumes of aqueous sodium hydroxide. The maximum temperature of each mixture is measured. The graph below shows the results.

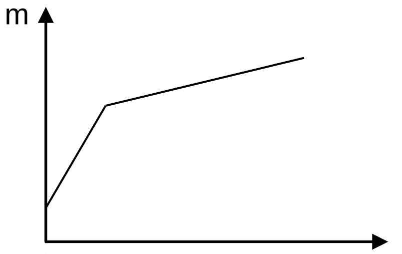


What is the concentration of the aqueous sodium hydroxide?

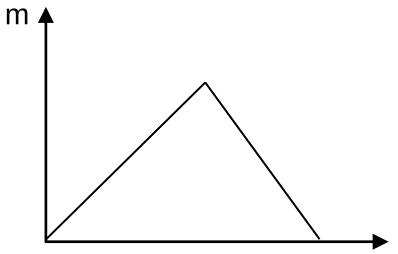
A	0.67 mol/dm^3	**B**	1.3 mol/dm^3
C	1.5 mol/dm^3	**D**	3.0 mol/dm^3

14 In a test for the presence of lead(II) ions in a solution, aqueous sodium hydroxide is added slowly till excess. Which of the following diagrams shows how the mass (m) of the precipitate varies with the volume (v) of the aqueous sodium hydroxide added?

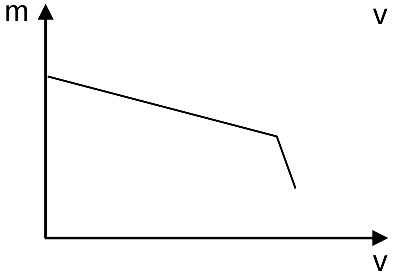
A



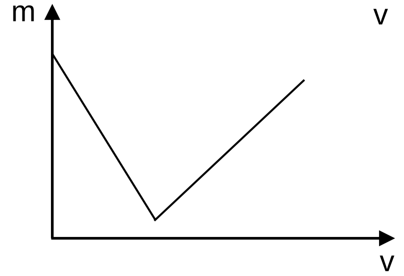
B



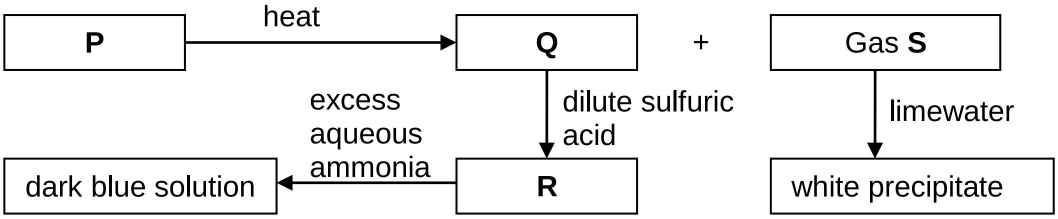
C



D



15 The diagram below shows a series of tests starting with **P**.



Which of the following statement(s) is/are true?

i. **P** can react directly with sulfuric acid to produce **R**.
ii. **Q** dissolves readily in water to form a blue solution.
iii. **R** forms a blue precipitate which remains insoluble in excess aqueous sodium hydroxide.

A i only
B iii only
C i and ii only
D i and iii only

16 Gabriel was given four bottles containing colourless solutions of four compounds, labelled **X**, **W**, **Y** and **Z**. He mixed two different solutions together and obtained the following results.

solution	observations
X and **W**	no visible reaction
X and **Z**	white precipitate
W and **Y**	white precipitate
W and **Z**	white precipitate
Y and **Z**	effervescence

Which of the following correctly identifies each solution?

	solution **X**	solution **W**	solution **Y**	solution **Z**
A	calcium nitrate	potassium carbonate	sulfuric acid	barium nitrate
B	barium nitrate	calcium nitrate	potassium carbonate	sulfuric acid
C	sulfuric acid	barium nitrate	calcium nitrate	potassium carbonate
D	potassium carbonate	sulfuric acid	barium nitrate	calcium nitrate

17 Two elements, **S** and **T** have proton numbers between 1 and 12. The atom **S** has two electrons less than a noble gas while the atom **T** has five electrons more than a noble gas. Which of the following compounds **cannot** be formed between **S** and **T**?

A TS
B TS_6
C TS_2
D TS_3^-

18 The reaction of manganate(VII) ions with hydrogen peroxide in acid solution may be represented by the following equation.

$$2MnO_4^-(aq) + 6H^+(aq) + 5H_2O_2(aq) \rightarrow 2Mn^{2+}(aq) + 5O_2(g) + 8H_2O(l)$$

The rate of reaction can be determined by measuring changes in different variables of the reaction.

Which of the following methods of monitoring the rate of reaction are suitable?

I. volume of gas produced
II. pH of the reaction mixture
III. mass of the reaction mixture
IV. amount of precipitate obtained
V. intensity of the purple colour of the reaction mixture

A I, II and III
B I, II and IV
C I, II, IV and V
D I, II, III and V

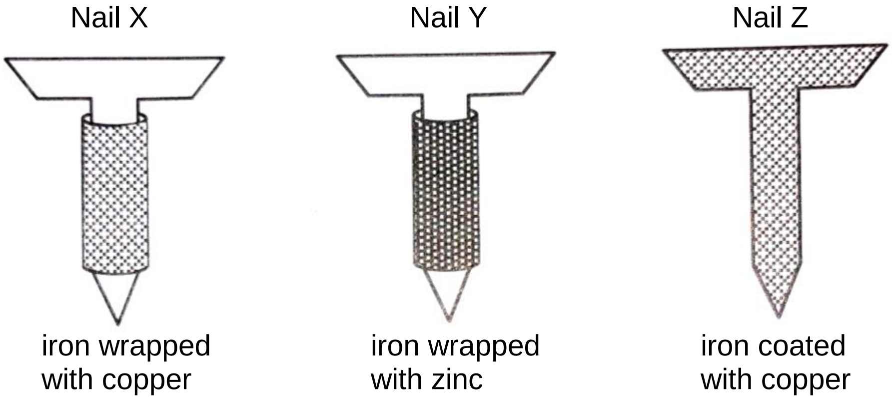
19 Titanium reacts with acid and cannot be extracted from its ore by heating with carbon. Where should titanium be placed in the reactivity series?

A below copper
B between zinc and iron
C between iron and copper
D between magnesium and zinc

20 Which statement about the extraction of iron from its ore is correct?

A Iron is more difficult to extract than zinc.
B Iron is more difficult to extract than copper.
C Iron is easy to extract because it is a transition metal.
D Iron cannot be extracted by reduction with carbon.

21 The diagram below shows the experiment of investigating rusting of iron nails.



Which of the nail(s) above shows(s) rusting?

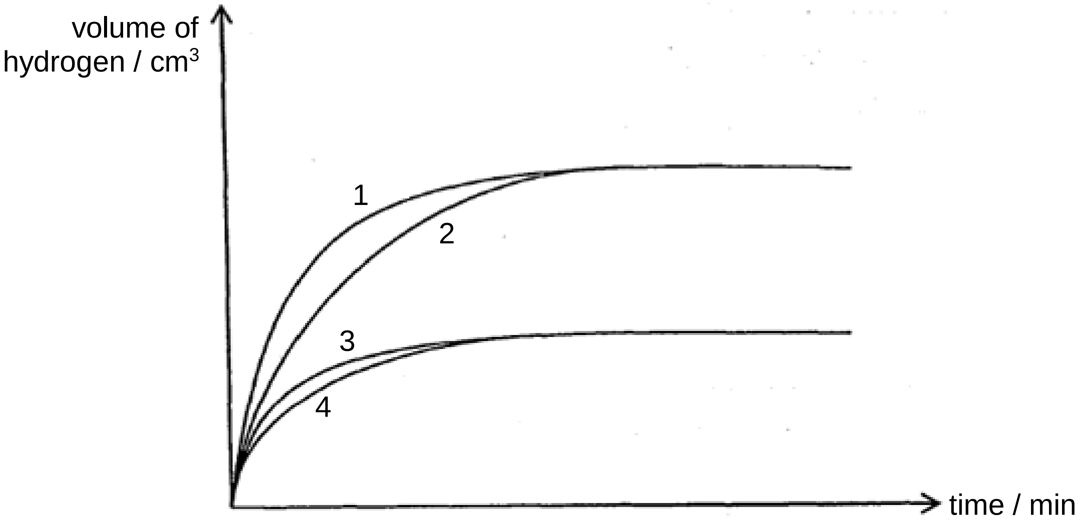
A X only
B X and Y only
C X and Z only
D Y and Z only

22 Four experiments were carried out by adding samples of zinc of different size and mass to excess 1.0 mol/dm^3 hydrochloric acid in four separate conical flasks. The volume of hydrogen gas evolved was collected and measured at regular time interval for each experiment.

The set of conditions for the four experiments are shown in the table below.

set of conditions	particle size of zinc	mass of zinc / g
W	granular	5.0
X	granular	10.0
Y	powder	5.0
Z	powder	10.0

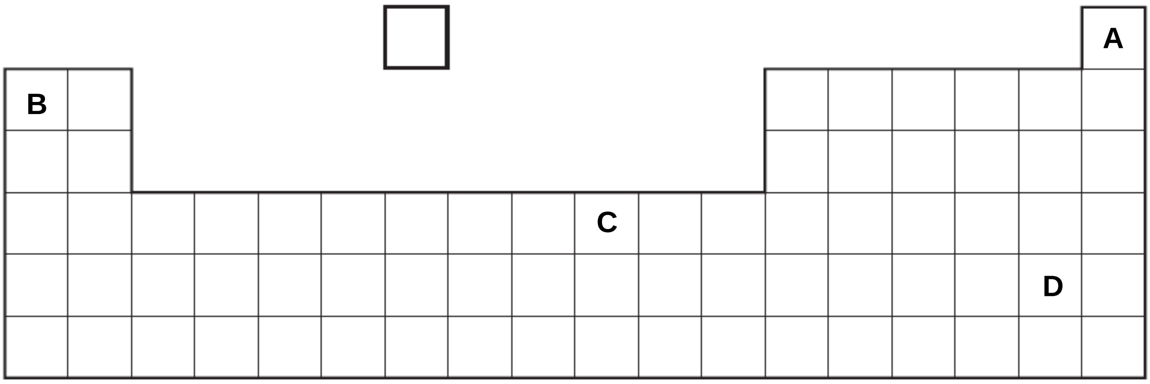
The graph of the results from the four experiments are labelled 1, 2, 3 and 4 as shown below.



Which of the following correctly matches the graphs of experiments 1, 2, 3 and 4 with the set of conditions W, X, Y and Z?

	W	X	Y	Z
A	3	2	1	4
B	3	2	4	1
C	4	1	3	2
D	4	2	3	1

23 An element melts at 1455 °C, has a density of 8.90 g/cm^3 and forms a green chloride. Where in the Periodic Table is this element found?



24 Sulfur and selenium, Se, are in the same group of the Periodic Table. From this, we would expect selenium to form compounds having the formulae ________________.

A Se_2O, Na_2Se and $NaSeO_4$ **B** SeO_2, Na_2Se and $NaSeO_4$
C SeO_2, Na_2Se and Na_2SeO_4 **D** SeO_3, $NaSe$ and $NaSeO_4$

25 The reaction scheme represents the process for obtaining pure silicon.

$$SiO_2 \xrightarrow[\text{heat with carbon}]{\textbf{I}} \underset{\text{(impure)}}{Si} \xrightarrow[\text{react with chlorine}]{\textbf{II}} \underset{\text{(impure)}}{SiCl_4} \xrightarrow[\text{distill}]{\textbf{III}} \underset{\text{(pure)}}{SiCl_4} \xrightarrow[\text{heat with hydrogen}]{\textbf{IV}} \underset{\text{(pure)}}{Si}$$

In which stages is silicon reduced?

A **I** only **B** **I** and **II** only
C **I** and **IV** only **D** **II** and **III** only

26 In which of the following experiments will a redox reaction occur?

A adding zinc granule to silver nitrate solution
B adding calcium oxide powder to aqueous sulfuric acid
C adding aqueous sodium hydroxide to aqueous nitric acid
D adding calcium(II) chloride solution to copper(II) sulfate solution

27 After adding acidified potassium manganate(VII) solution to a sample of solution X, the potassium manganate(VII) solution was decolourised and the resulting solution was brown. When starch solution was added to a fresh sample of solution X, the solution turned dark blue. What conclusion can be drawn about solution X?

A It is a reducing agent and it contains iodide ions.
B It is a reducing agent and it contains bromide ions.
C It is an oxidising agent and it contains iodide ions.
D It is an oxidising agent and it contains bromide ions.

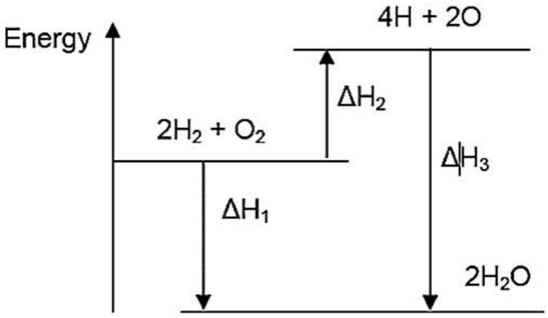
28 Which row shows the correct enthalpy change for its process?

	process	enthalpy change, ΔH
A	$CO_2(g) \rightarrow C(g) + 2O(g)$	negative
B	$PbCl_2 \rightarrow Pb(s) + Cl_2(g)$	positive
C	$C_2H_4(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O(l)$	positive
D	$N_2(l) \rightarrow N_2(g)$	negative

29 Hydrogen and oxygen react to form steam as shown in the equation below.

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$$

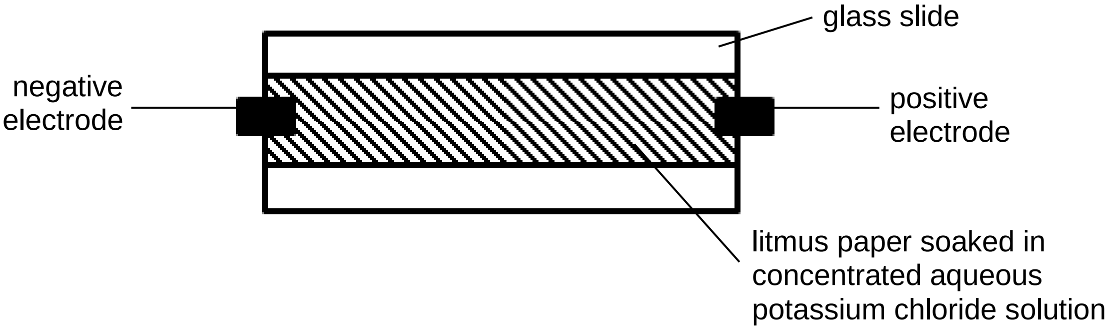
The following energy level diagram represents this reaction.



Which symbols represent the energy involved in the bond breaking and formation?

	energy involved in bond breaking only / kJ	energy involved in bond formation only / kJ
A	ΔH_1	ΔH_2
B	ΔH_1	ΔH_3
C	ΔH_2	ΔH_1
D	ΔH_2	ΔH_3

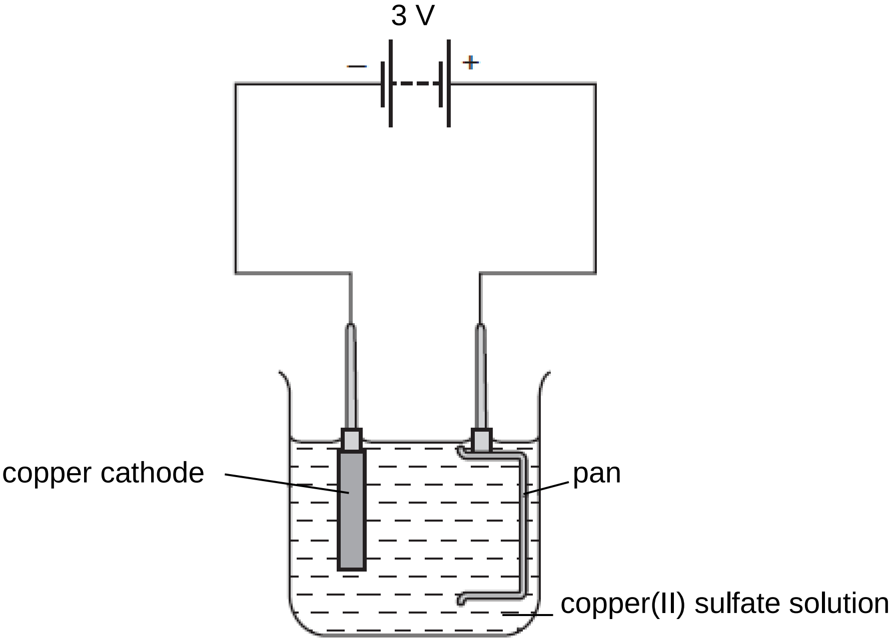
30 A piece of litmus paper soaked in concentrated aqueous potassium chloride solution was placed on a glass slide. The paper was connected to a battery.



Which of the following shows the correct observations near the negative electrode and positive electrode after the current had flowed for some time?

	at negative electrode	at positive electrode
A	red	blue
B	red	bleached
C	bleached	blue
D	blue	bleached

31 The diagram shows a failed attempt to copper-plate a pan.



Which action will plate the pan with copper?

A increasing the voltage from 3 V to 6 V
B making the pan the cathode and the copper the anode
C cooling the copper(II) sulfate solution in an ice bath
D heating the copper(II) sulfate solution to boiling point

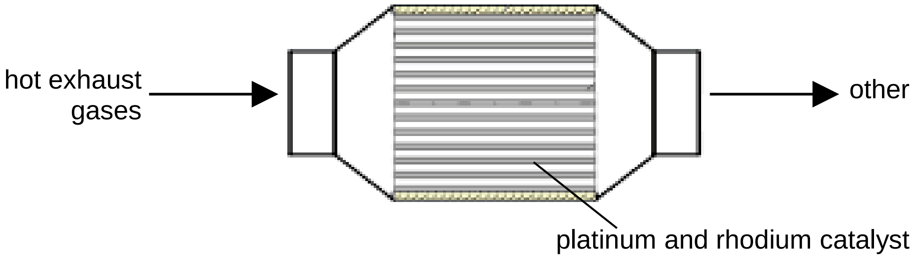
32 Which of the following statements concerning the Haber process is incorrect?

A A catalyst of finely divided iron is used.
B Nitrogen and hydrogen are fed into the reactor in the volume ratio of 1:3.
C The cost of high pressure technology means that the reaction is carried out at the more economical pressure of 4 atm.
D The equilibrium yield of ammonia is favoured by the use of low temperatures, although temperatures of around 450 °C are actually used.

33 To produce ammonia gas, which of the following methods below cannot be used?

A heating concentrated aqueous ammonia
B heating ammonium chloride with calcium hydroxide
C heating ammonium sulfate with sodium hydroxide
D heating ammonium sulfate with dilute hydrochloric acid

34 The diagram below represents a section of a catalytic converter in the exhaust system of a car.

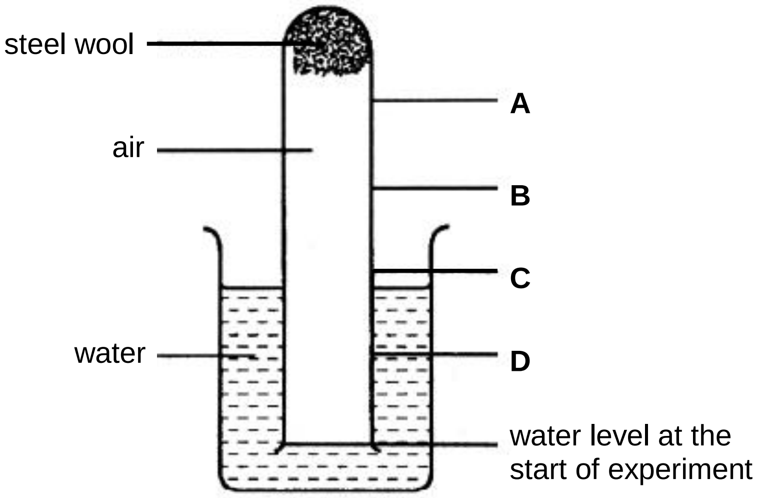


Which processes take place in this catalytic converter?

I. Carbon monoxide and hydrocarbons react together.
II. Carbon monoxide and nitrogen oxides react together.
III. Platinum and rhodium catalyse redox reactions.

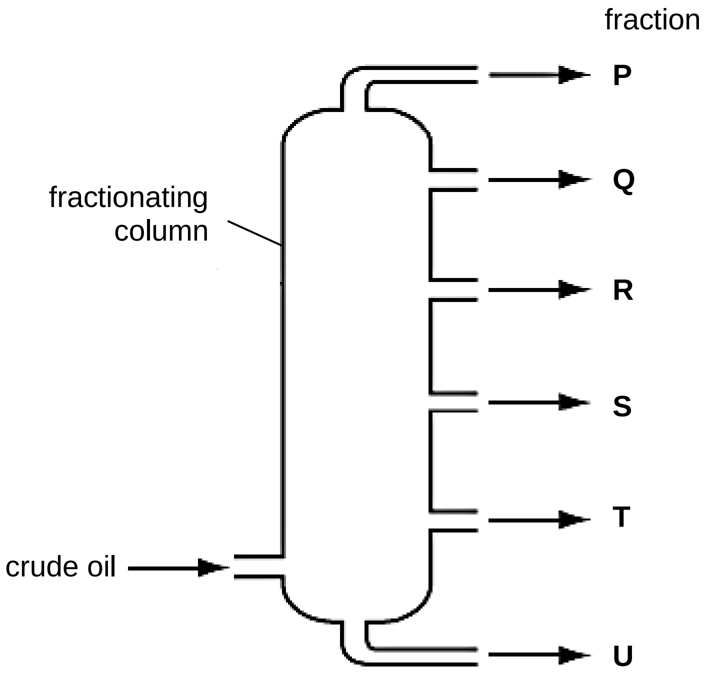
A I and II
B I and III
C II and III
D I, II and III

35 The diagram shows a ball of steel wool placed inside the end of a test tube. The test tube is inverted in a beaker of water, trapping air inside.



What is the level of water after several days?

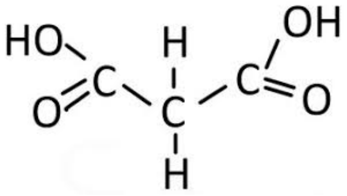
36 The diagram shows the fractional distillation of crude oil.



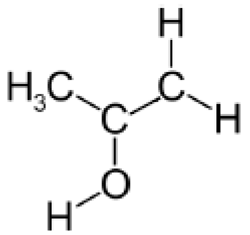
Which row explains why fraction **Q** is collected above fraction **S**?

	boiling point of **Q**	average molecular mass of **Q**	enthalpy change of combustion of **Q** (kJ/mol)
A	lower than **S**	smaller than **S**	less than **S**
B	lower than **S**	greater than **S**	less than **S**
C	higher than **S**	smaller than **S**	more than **S**
D	higher than **S**	greater than **S**	more than **S**

37 The structure of propanedioic acid and propanol are shown below.



propanedioic acid



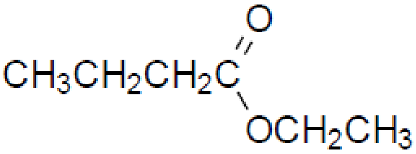
propanol

How many of the following substances can be used to distinguish between the two compounds?

I. aqueous bromine
II. zinc carbonate
III. acidified potassium manganate(VII) solution

A	0	**B**	1
C	2	**D**	3

38 Rum flavouring is based on the compound with the formula shown below.



$CH_3CH_2CH_2C(=O)OCH_2CH_3$

The compound can be made from ___________________.

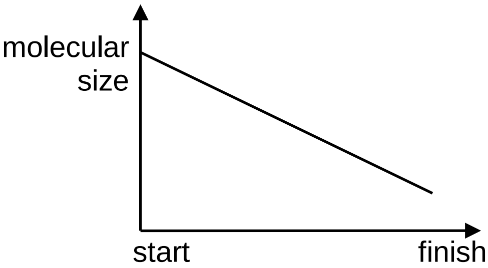
A propanol and methanoic acid
B ethanol and butanoic acid
C butanol and ethanoic acid
D propanol and propanoic acid

39 Poly(ethene) can be manufactured by the process below.

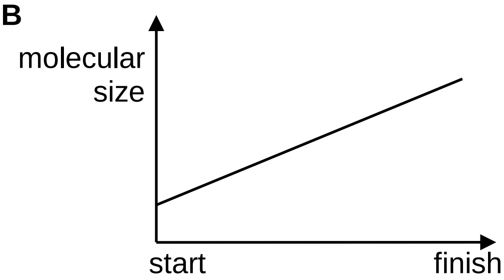
$$\boxed{\text{octane}} \xrightarrow{\textit{cracking}} \boxed{\text{ethene}} \xrightarrow{\textit{polymerisation}} \boxed{\text{poly(ethene)}}$$

Which diagram shows the change in molecular size during this process?

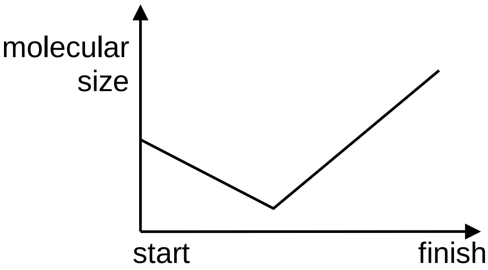
A



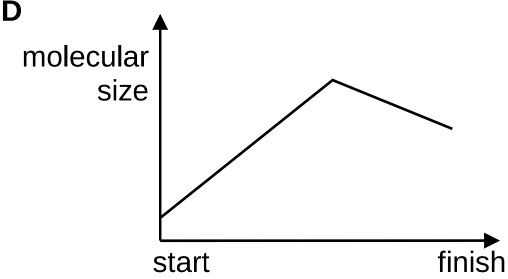
B



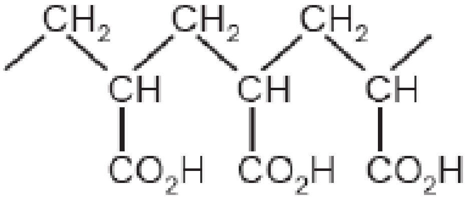
C



D



40 The absorbent material in babies' disposable nappies is made from the polymer shown below.



From which monomer could this polymer be obtained?

A $H_2C=CHCO_2H$
B $HO_2CCH=CHCO_2H$
C $HOCH_2CH_2CO_2H$
D $CH_3CH_2CH_2CO_2H$

End of Paper 1

The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 H Hydrogen 1										4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57 *	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radium 88	227 Ac actinium 89 †															

*58-71 Lanthanoid series

†90-103 Actinoid series

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

Key

a X b

a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

The volume of one mole of any gas is 24 $\mathrm{dm^3}$ at room temperature and pressure (r.t.p.).

Name: ……………………………..…….…..………( ) Class: Sec ………………..

St. Gabriel's Secondary School

2017 'O' Preliminary Examination

Subject	:	**Chemistry**
Paper No	:	**5073/2**
Level/Stream	:	**4 Express**
Duration	:	**1 hour 45 mins**
Date	:	**24 August 2017**

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number in the spaces above.

Write in dark blue or black pen.

You may use a soft pencil for any diagrams, graphs or rough working.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A

Answer **all** questions. Write your answers on the spaces provided.

Section B

Answer **all three** questions, the last question is in the form **either/or**.

Write your answers on the spaces provided.

The number of marks is given in brackets [ ] at the end of each question or part question.

A copy of the Periodic Table is printed on page 17.

FOR EXAMINER'S USE	
Section A **[50 marks]**	
B9	
B10	
B11 **[EITHER / OR]**	
Total	**80**

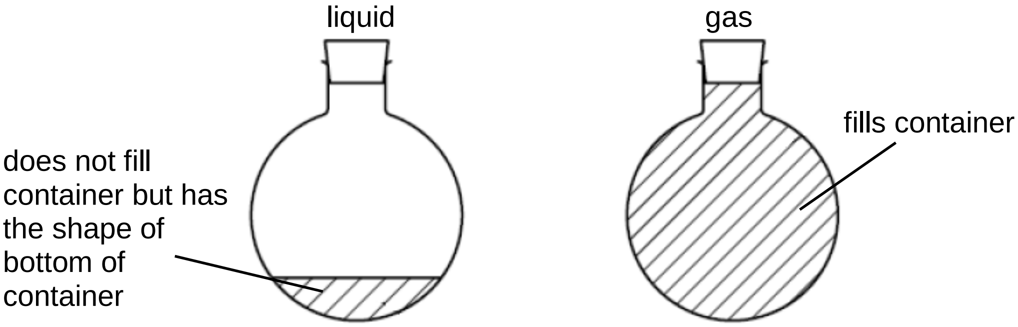
This question paper consists of **17** printed pages including this cover page.

[Turn over

Section A [50 marks]

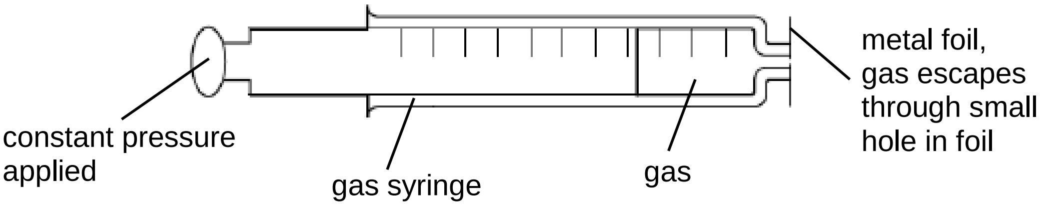
Answer **all** questions in the spaces provided.

A1 **(a)** Using the Kinetic Particle Theory, explain why liquids and gases both take the shape of the container but a gas always fills the container.



[3]

(b) The following apparatus can be used to measure the rate of diffusion of a gas.



(i) What measurements would need to be taken to calculate the rate of diffusion of a gas?

[2]

(ii) Which gas, nitrogen dioxide or sulfur dioxide, would diffuse faster? Explain your choice.

[2]

[Total: 7 marks]

A2 Use the information in the table below to answer the questions.

element	formula(e) of oxide(s)	density of element at r.t.p (g/cm^3)	volume of 1 mole of atoms at r.t.p (cm^3)
A	A_2O, A_2O_2	0.00008	12 000
B	None formed	0.00346	24 000
C	C_2O	0.53	13.20
D	D_2O	0.97	23.71
E	EO_2, EO_3	2.07	15.46
F	F_2O_3	3.00	15.00
G	GO, G_2O_3	7.86	7.11

(r.t.p refers to room temperature and pressure)

(a) Which two elements are in the same group of the Periodic Table.
Explain your answer.

....

....

.... [2]

(b) Which element could be argon? Explain your answer.

....

....

.... [2]

(c) Using information in the third and fourth columns, calculate the mass of 1 mole of **F** and identify **F**.

[2]

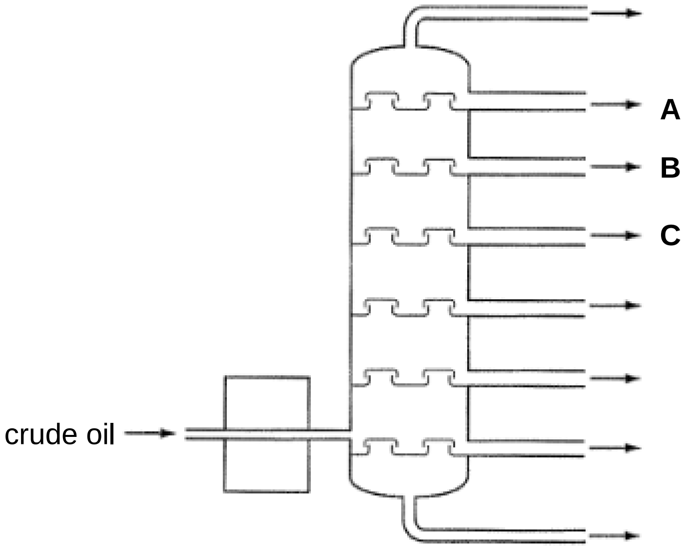
(d) Write down two observations you would expect to see when element **G** is added to dilute nitric acid.

....

.... [2]

[Total: 8 marks]

A3 The diagram below shows a fractionating column for the separation of crude oil.



(a) The properties of three fractions in crude oil are given in the table below. Complete the table below by identifying the fractions at **A**, **B** and **C** in the diagram.

	number of carbon atoms per molecule	boiling point (°C)	fraction
A	5 to 11	50 to 80	
B	7 to 14	90 to 150	
C	9 to 16	150 to 240	

[1]

(b) Give two pieces of evidence to show why the fractions identified in **(a)** are classified as mixtures.

....

....

.... [2]

(c) Describe the process of separating the fractions **A** and **C** by this method.

....

....

....

.... [2]

(d) Cracking is carried out on **B** to produce other useful products. The table below shows some information on the percentage yield of the products from a cracking plant.

product	percentage yield (%)
methane	15
ethene	32
propene	16
C_4 hydrocarbons	11
C_5 to C_8 hydrocarbons	25

(i) Cracking is often described as a key source of alkenes.
Use the information given to support the above statement.

....

.... [1]

(ii) Suggest a reason why the data for C_4 hydrocarbons and C_5 to C_8 hydrocarbons are grouped together, whereas the data for the first few products are classified individually.

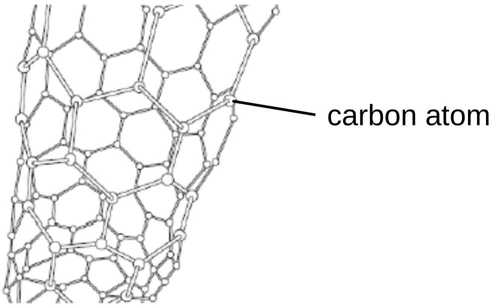
....

....

.... [2]

[Total: 8 marks]

A4 An airplane contains many miles of electrical wiring made of copper. This adds to the mass of the airplane. It has been suggested that the electrical wiring made of copper could be replaced by lighter carbon nanotubes. The diagram shows the structure of a carbon nanotube. Like graphite, each carbon atom is joined to three other carbon atoms.



(a) Explain why the carbon nanotube can conduct electricity.

....

....

.... [2]

(b) Another reason why copper is replaced by the carbon nanotubes is that the copper wiring will react eventually with atmospheric oxygen to form copper(II) oxide, decreasing its electrical conductivity.

Explain in terms of its structure and bonding why the metal oxide has a poor electrical conductivity.

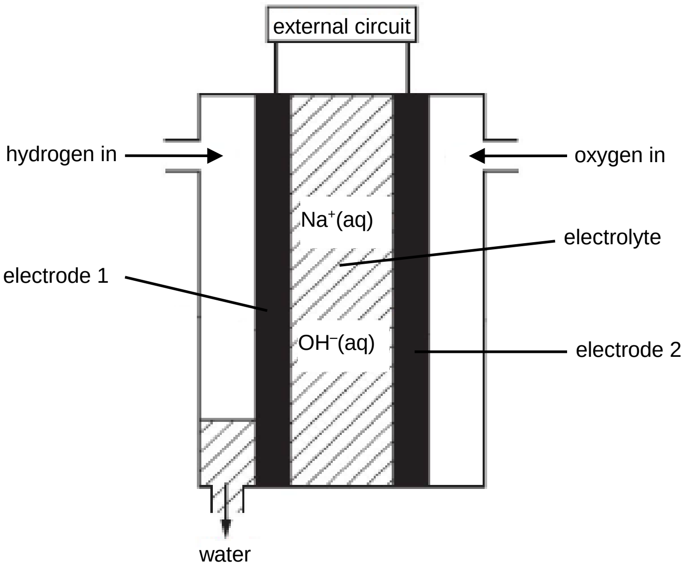
....

....

.... [2]

[Total: 4 marks]

A5 The NASA space shuttle uses fuel cells to generate electricity. The diagram shows a hydrogen-oxygen fuel cell.



(a) Identify which electrode above is an anode, and which is a cathode.

.... [1]

(b) Describe how electricity is generated in the fuel cell.

....

....

....

.... [3]

(c) Give one source for hydrogen for use in a fuel cell.

....

.... [1]

[Total: 5 marks]

A6 30 cm^3 of 1 mol/dm^3 dilute hydrochloric acid is added to two different test tubes containing substances **A** and **B**. The results are recorded in the table below.

substance	appearance of substance	gas produced	colour of solution formed
A	green solid	gas formed white precipitate with limewater	pale blue
B	black solid	no gas produced	pale blue

(a) Suggest the name of substance **A** and write down a balanced chemical equation for the reaction between **A** and dilute hydrochloric acid.

....

.... [2]

(b) Substance **B** is impure copper(II) oxide. The mass of **B** in the test tube is 3 g. To test for the purity of substance **B**, the following is carried out. It is assumed that the impurities do not react with dilute hydrochloric acid.

(i) The excess hydrochloric acid that did not react with **B** was titrated with 1 mol/dm^3 of dilute sodium hydroxide. The average volume of sodium hydroxide required for the titration was 10.0 cm^3.

Calculate the number of moles of excess hydrochloric acid and hence, calculate the number of moles of hydrochloric acid that has reacted with substance **B**.

[3]

(ii) The reaction between copper(II) oxide and hydrochloric acid is given by the equation below.

$$CuO + 2HCl \rightarrow CuCl_2 + H_2O$$

Calculate the percentage purity of **B** in the test tube.

[2]

[Total: 7 marks]

A7 The table below shows the time taken for the same mass of zinc to react completely with sulfuric acid of various concentrations at room temperature and pressure.

concentration (mol/dm^3)	0.5	1.0	2.0	4.0
time taken (s)	450	45	22	5

(a) Explain, using collision theory, how the rate of reaction change when the concentration of sulfuric acid used increases from 0.5 mol/dm^3 to 4.0 mol/dm^3.

....

....

.... [2]

(b) Suggest a reason why very little hydrogen gas is produced when the concentration of sulfuric acid used is increased to 10.0 mol/dm^3.

....

....

.... [2]

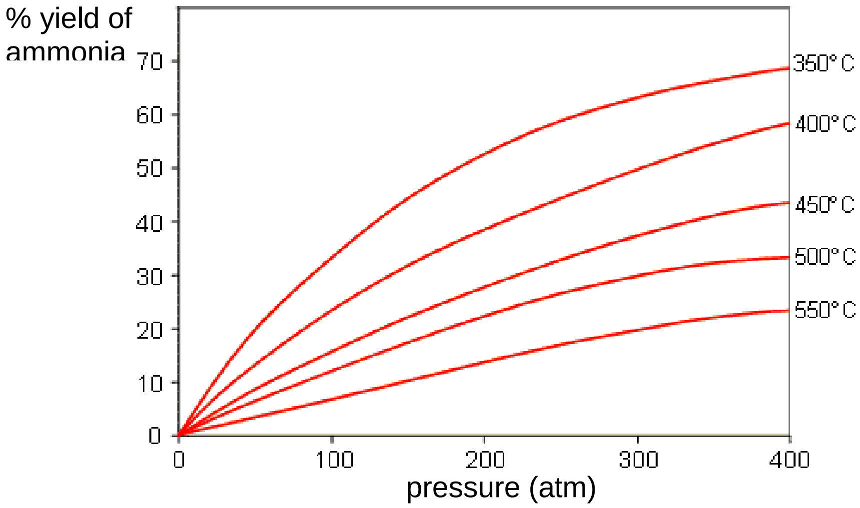
(c) A student repeated the above experiments using calcium while keeping all the other conditions the same. However, it was observed that the reaction stopped shortly. Explain why.

....

.... [1]

[Total: 5 marks]

A8 Ammonia is manufactured from nitrogen and hydrogen via the Haber process, using iron as catalyst. The graph below shows how the amount of ammonia produced (percentage yield) varies with both temperature and pressure.



(a) **(i)** From the graph, suggest whether a higher or lower temperature would result in more ammonia being formed from the Haber Process.

.... [1]

(ii) Suggest why this temperature is not used in the Haber Process?

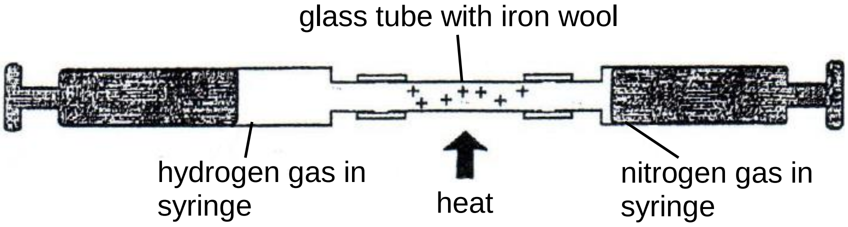
.... [1]

(b) Explain how using a catalyst in the Haber process has an economic advantage.

....

.... [1]

(c) The Haber Process can be demonstrated in the laboratory by the method shown below.



The mixture of nitrogen and hydrogen is passed back and forth over the hot iron wool until there is no further reaction.

Suggest why it is important to ensure that no air is present in the apparatus shown above.

....

.... [1]

(d) The equation below shows the reaction for the conversion of ammonia to nitrogen(II) oxide.

$$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g) \qquad \Delta H = -950 \text{ kJ/mol}$$

Is the reaction exothermic or endothermic? Explain your answer, in terms of the energy changes that take place during bond breaking and bond making, why the reaction is exothermic or endothermic.

....

....

....

.... [2]

[Total: 6 marks]

End of Section A

Section B [30 marks]

Answer all **three** questions in the spaces provided.
Question **B11** is in the form of an either/or and only one of the alternatives should be attempted.

B9 The information below is about the extraction of zinc.

The method of extraction of zinc has changed, as different ores containing the element have been discovered, and as technology has improved.

Extraction Process 1

In the earliest process, calamine (impure zinc carbonate) was heated with charcoal in earthenware pots. This two-stage process gives a low yield of zinc.

$$ZnCO_3(s) \rightarrow ZnO(s) + CO_2(g)$$

$$ZnO(s) + C(s) \rightarrow Zn(s) + CO(g)$$

Extraction Process 2

A new two-stage process was developed using zinc sulfide ores. All of the waste gases from this process were released into the atmosphere.

$$2ZnS(s) + 3O_2(g) \rightarrow 2ZnO(s) + 2SO_2(g)$$

$$ZnO(s) + C(s) \rightarrow Zn(s) + CO(g)$$

Extraction Process 3

This uses the electrolysis of aqueous solutions of very pure zinc sulfate. The first step in this process is the same as the first step in Extraction Process 2. The second step uses sulfuric acid made from SO_2 collected in the first step. The third step involves the electrolysis of zinc sulfate solution to form pure zinc.

$$2ZnS(s) + 3O_2(g) \rightarrow 2ZnO(s) + 2SO_2(g)$$

$$ZnO(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2O(g)$$

$$ZnSO_4(aq) \rightarrow Zn(s) \quad \text{[electrolysis]}$$

The electrolysis of zinc sulfate solution can be carried out by using graphite or zinc as anode. When zinc is used, the anode needs to be replaced frequently.

(a) **(i)** Identify one equation that represents a redox equation.

.... [1]

(ii) Explain, in terms of oxidation states, why the equation identified in **(a)(i)** is a redox reaction.

[2]

(b) Suggest which of the three extraction processes is the most environmentally friendly. Give a reason for your answer.

[3]

(c) Zinc sulfate solution is electroysed in Extraction Process 3.

(i) If zinc is used as the anode, write the ionic half-equations, including state symbols, for the reaction occurring at each electrode.

Anode:

Cathode: [2]

(ii) Explain why the zinc anode needs to be replaced periodically?

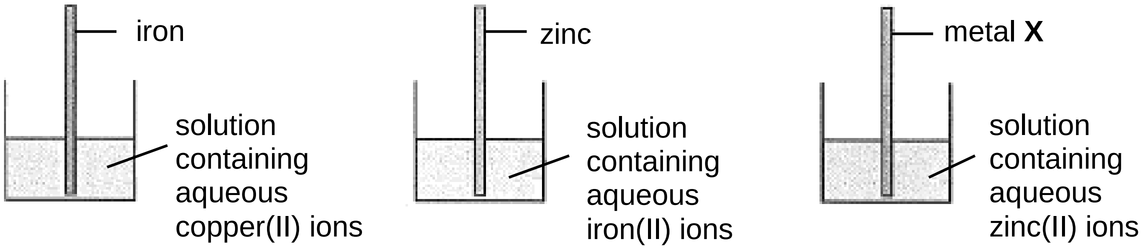
[2]

(d) A factory replaced zinc sulfate solution with molten zinc chloride.
Suggest why molten zinc chloride may not be a good choice to replace zinc sulfate solution.

[1]

[Total: 11 marks]

B10 A student investigate the reactivity of four metals, iron, copper, zinc and metal **X**.



experiment 1 **experiment 2** **experiment 3**

(a) In **experiment 1**, the student sees changes happen to both the iron and the solution. Describe the changes that the student sees and explain why these changes occur.

[3]

(b) Write an ionic equation, including state symbols, for the reaction that happens in **experiment 2**.

[1]

(c) The student observes that a reaction happens in all three experiments.

(i) Arrange the four metals in order of **increasing** reactivity. Explain your answer.

[2]

(ii) Suggest the name of metal **X**.

[1]

(d) At the end of **experiment 3**, the student wanted to check if there are any zinc ions left in the solution. What can the student do to confirm this?

[2]

[Total: 9 marks]

Either

B11 Alkenes are unsaturated organic compounds consisting of a carbon-carbon double bond.

Table **1** lists the boiling points of some straight chain alkenes.

alkene	**boiling point (°C)**
ethene	–104
propene	–47
butene	–6
pentene	30
hexene	63

Table **1**

Table **2** shows the properties of branched isomers of some of the alkenes.

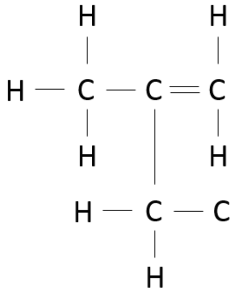
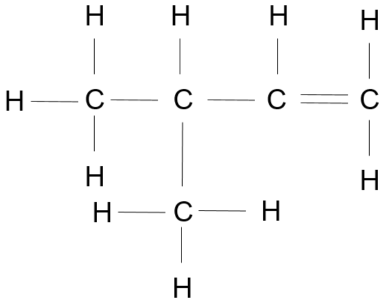
	number of carbon atoms in molecule	**formula**	**boiling point (°C)**
branched alkene 1	4		–7
branched alkene 2	5		20

Table **2**

(a) What trend is shown by the data in Table **1**?

[1]

(b) Using evidence from Tables **1** and **2**, explain how the boiling point of a straight chain alkene is affected by branching in isomerism.

[3]

(c) **Q** is a gaseous hydrocarbon which can decolourise a solution of bromine and has a density of 1.75 g/dm^3 at room temperature and temperature.

(i) Calculate the relative molecular mass of **Q**.

[1]

(ii) Hence, identify **Q**. Explain your reasoning.

....

....

....

.... [2]

(iii) Hence, write a chemical equation for the reaction between **Q** and bromine solution.

.... [1]

(d) Both ethane and ethene can react with chlorine.
Give one similarity and one difference between the two reactions.

....

....

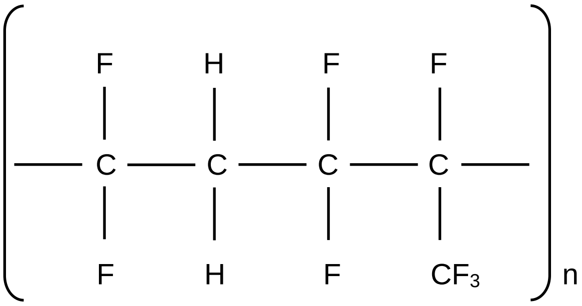
....

.... [2]

[Total: 10 marks]

OR

B11 A *copolymer* is formed from more than one type of monomer unit.
Viton elastomer is a copolymer used in fuel injection seals. The following shows the structure of a *copolymer*, *Viton*, showing one repeat unit. There is **no** by-product formed.



(a) **(i)** What type of polymerisation does it undergo?

.... [1]

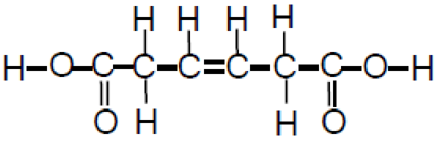
(ii) Draw the structures of the monomers that react to form this polymer.

[2]

(iii) The relative molecular mass of the *Viton* molecule is about 500 000.
Calculate the minimum number of monomers in one *Viton* molecule.

[2]

(b) Polyesters are polymers used in the manufacture of numerous products such as fabrics and eyeglass lenses. The starting material of one such polyester is compound **P** which has the structural formula shown below:



compound **P**

(i) State the observation when compound **P** reacts with aqueous bromine and with aqueous sodium carbonate

....

....

.... [2]

(ii) Draw the full structural formula when compound **P** reacts with excess ethanol.

[2]

(iii) State the condition for the reaction in **(ii)** above.

.... [1]

[Total: 10 marks]

End of Section B

The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 H Hydrogen 1										4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57 *	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radium 88	227 Ac actinium 89 †															

*58-71 Lanthanoid series
†90-103 Actinoid series

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

Key

a X b

a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

St Gabriel's Secondary School
2017 'O' Preliminary Examination
Sec 4E Chemistry
Marking Scheme

Paper 1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A	A	C	C	D	A	D	D	B	B	C	B	D	B	D	B	B	D	D	B
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
A	D	C	C	C	A	A	B	D	B	B	C	D	C	D	A	C	B	C	A

Paper 2 Section A

Question			Answer	Marks
A1	**(a)**		In liquid, the particles are close together; the strong forces of attraction between the particles do not allow them to move apart. Hence, liquid cannot fills up the container. However, liquid particles can slide over each other to take up the shape of the container. In gas, the forces are much weaker and the particles can move in all directions /freely to fill the container.	1 1 1
	(b)	**(i)**	Measure the volume of gas left in the gas syringe (or volume of gas that escapes) at regular intervals of time	1 1
		(ii)	Nitrogen dioxide It has lower relative molecular mass / molar mass / mass.	1 1
A2	**(a)**		C and D. Both elements form oxides of the same chemical formulae, C_2O and D_2O. This shows that the elements formed ions that have a charge of +1 and they both belong in Group I of the Periodic Table as they have the same number of valence electron.	1 1
	(b)		B. Its volume of 1 mole of atoms is 24 000 cm^3, indicating that B is monoatomic. (Reject: it does not form any oxide or reacts with oxygen)	1 1
	(c)		Mass of 1 mole of F = 3 x 15 = 45 g F is scandium.	1 1
	(d)		Effervescence / Bubbles is seen, pale green solution is formed.	1 1

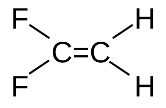
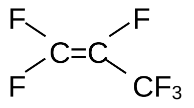
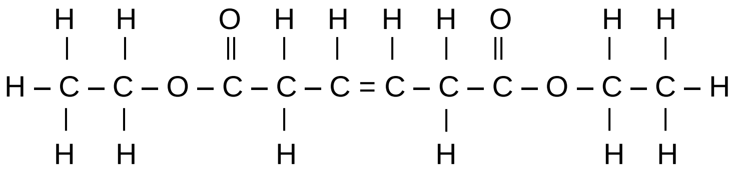
A3	**(a)**		Petrol; Naptha; Kerosene/Paraffin	1
	(b)		There is no fixed boiling point for each fraction. / Each fraction boils over a range of temperatures. There is a range in the number of carbon atoms in each fraction.	1 1
	(c)		Crude oil is heated and the vapour rises and enters the fractionating column. Fraction **A** (petrol) is condensed and collected at higher outlet as it has a lower boiling point than fraction **C** (kerosene). Fraction **C** (kerosene) is condensed and collected at the lower outlet of the fractionating column.	1 1
	(d)	**(i)**	For both processes, the yield of ethene and propene alone (excluding the alkenes in the C_4 to C_8 hydrocarbons), accounts for 48%.	1
		(ii)	From C_4 onwards, there are isomers for both the alkanes and alkenes. Hence there are many compounds with the same number of carbon atoms. The smaller hydrocarbons have no isomers, so they are classified individually.	1 1
A4	**(a)**		Each carbon atom uses 3 out of 4 valence electrons for bonding and has 1 unbonded/free valence electron which is mobile to act as charge carrier. (Reject: ‘sea of delocalised electrons’ without explaining where these electrons come from)	1 1
	(b)		The metal oxide has a giant ionic lattice structure with strong electrostatic forces of attraction between the metal ions and the negative oxide ions. In the solid state, the ions are held in fixed arrangement/positions and will not be able to carry electrical charges.	1 1
A5	**(a)**		Anode: electrode 1 Cathode: electrode 2	1
	(b)		Hydrogen gas is oxidised and releases electrons and water. These electrons flow from the anode to the cathode. Oxygen is then reduced to form hydroxide ions. The movement of electron flow from hydrogen to oxygen in the cell generates electricity.	1 1 1
	(c)		Cracking of crude oil / petroleum / large alkane, alkene, hydrocarbon OR Electrolysis of water	1

A6	**(a)**		Copper(II) carbonate $CuCO_3 + 2HCl \rightarrow CuCl_2 + H_2O + CO_2$ (allow e.c.f. if candidate gives the wrong substance)	1 1
	(b)	**(i)**	NaOH + HCl → NaCl + H2O Mol of NaOH = 10/1000 x 1 = 0.01 mol Mol of excess HCl = 0.01 mol Mol of HCl added initially = 30/1000 x 1 = 0.03 mol Mol of HCl that react with $CuCO_3$ = 0.03 – 0.01 = 0.02mol	1 1 1
		(ii)	Mol of CuO = 0.02/2 = 0.01 mol Mass of CuO = 0.01 x 80 = 0.8 g % purity = 0.8/3*100 = 26.7%	1 1
A7	**(a)**		As the concentration increases, there are more H^+ ions in the same volume of solution. This increases the frequency of the successful collisions between the reacting particles and hence increases the rate of the reaction	1 1
	(b)		When concentration of sulfuric acid is increased to 10 mol/dm^3, there is very little water present. Most of the acid molecules do not dissociate to form H^+ ions.	1 1
	(c)		Insoluble calcium sulfate is formed on the calcium carbonate. This prevent the remaining calcium from reacting.	1
A8	**(a)**	**(i)**	Lower temperature	1
		(ii)	Lower temperature results in a slower rate of reaction.	1
	(b)		speeds up the reaction / lowers the activation energy lowers energy costs / less energy used/only a small amount is needed (Reject: Catalyst can be re-used and hence save cost as this is not a significant contributing economic advantage)	1
	(c)		This to prevent hydrogen from reacting with oxygen in the air.	1
	(d)		Exothermic More heat energy is given out when bonds between N–O and H–O are formed than is taken in for breaking the N–H bonds and O=O bonds.	1 1

Paper 2 Section B

Question		Answer		Marks
B9	**(a)**	**(i)**	$ZnO\ (s) + C\ (s) \rightarrow Zn\ (s) + CO\ (g)$ **or** $2ZnS\ (s) + 3O_2\ (g) \rightarrow 2ZnO(s) + 2SO_2\ (g)$	1
		(ii)	$ZnO\ (s) + C\ (s) \rightarrow Zn\ (s) + CO\ (g)$ Oxidation state of zinc decreases from +2 in ZnO to 0 in Zn. Hence, ZnO is reduced. Oxidation state of carbon increases from 0 in carbon to + 2 in CO. Hence, C is oxidised. (Accept 2+ or +2) OR $2ZnS\ (s) + 3O_2\ (g) \rightarrow 2ZnO(s) + 2SO_2\ (g)$ Oxidation state of sulfur increases from -2 in ZnS to +4 in SO_2. Hence, ZnS is oxidised. Oxidation state of oxygen deceases from 0 in O_2 to -2 in ZnO (or SO_2). Hence, oxygen is reduced.	1 1 1 1
	(b)	Process 3. (with at least one reason) SO_2 is used to make sulfuric acid. *(Any answer)* No CO is produced, unlike processes 1 and 2. CO causes headaches / fatigue /breathing difficulties / death / Reduces ability of haemoglobin to transport oxygen SO_2 from process 2 may irritate the eyes / lungs / Cause breathing difficulties / inflammation of the lungs (bronchitis) / Reacts with water in the atmosphere to form acid rain, which corrodes buildings and harms aquatic life and plants (R: no air pollutant is released to the environment.)		1 1 1
	(c)	**(i)**	Anode: $Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$ Cathode: $Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$	1 1
		(ii)	Zinc is the reactive anode and will be oxidised / ionised to from Zn^{2+} ions (don't accept zinc oxide is formed, without stating the oxidation of zinc) and hence needs to be replaced	1 1
	(d)	A high amount of energy is required to maintain the molten zinc chloride, increasing the cost of production of zinc.		1

B10	**(a)**		Pink copper metal formed on iron rod; as it is displaced out of the solution by iron. Blue solution turns pale green; as the Cu^{2+} ions are being replaced by Fe^{2+} ions. Iron is more reactive than copper, iron displaces copper out from its salt solution to form copper and Fe^{2+}.	1 1 1
	(b)		$Zn(s) + Fe^{2+}(aq) \rightarrow Zn^{2+}(aq) + Fe(s)$	1
	(c)	**(i)**	Copper, iron, zinc, **X**. Metal X is more reactive than zinc as there is a reaction in experiment 3. The rest of the arrangement follows the reactivity series.	1 1
		(ii)	Magnesium or aluminium or calcium	1
	(d)		Add aqueous ammonia / ammonium hydroxide solution till excess; (Reject: addition of sodium hydroxide) If zinc(II) ions are left in the solution, a white precipitate will be formed which will dissolve in excess of aqueous ammonia to form a colourless solution.	1 1
B11	**Either**			
	(a)		The greater the number of C atoms/ the larger the molecule/ down the series, the higher the boiling point;	1
	(b)		Branching in isomerism decreases the boiling point of straight chain alkenes; From the data, the boiling point of straight chain butene (-6 °C) is higher than the branched butene (-7 °C); The boiling point of straight chain pentene (30 °C) is also higher than the branched pentene (20 °C);	1 1 1
	(c)	**(i)**	Volume of Q = no. of mol of Q × 24 dm^3 (Mass/density) = (mass/Mr) × 24 dm^3 Mr = density × 24 dm^3 = 1.75 × 24 = 42 (no unit)	1
		(ii)	Q is propene/ C_3H_6; with Mr of propene = (12×3) + (1×6) = 42; As Q decolourises aqueous bromine, it is unsaturated/ an alkene with general formula C_nH_{2n};	1 1
		(iii)	$C_3H_6 + Br_2 \rightarrow C_3H_6Br_2$ (allow e.c.f)	1

	(d)	*Similarity* (any one) • both reactions can form dichloroethane (Accept: chloroethane) • both reactions involve formation of C-C*l* bond *Difference* (any one) • substitution in ethane requires UV light whereas addition in ethene does not require. • substitution in ethane involve breaking of C-H bond whereas addition in ethene does not. • substitution in ethane produces many products whereas addition in ethene produces only one product (dichloroethane). • substitution in ethane produces a byproduct (HC*l* or H_2) whereas addition in ethene does not. or any reasonable answers which include comparison of both reactions.		1 1
B11	**OR**			
	(a)	**(i)**	Addition polymerization	1
		(ii)	 	1 1
		(iii)	Mr of repeating unit = 214 No. of repeating units = 500 000 ÷ 214 = 2336 No. of monomers = 2336 × 2 = 4672 (or 4673)	1 1
	(b)	**(i)**	Aq bromine: <u>Reddish brown</u> aqueous bromine is rapidly decolourised/turned colourless. Aq sodium carbonate: Effervescence occurs/ colourless gas produced/ bubbling.	1 1
		(ii)	 $H-CH_2-CH_2-O-CO-CH_2-CH=CH-CH_2-CO-O-CH_2-CH_2-H$	1: 1 ethyl on left 1: 1 ethyl on right
		(iii)	Warming with concentrated sulfuric acid	1

NAME: ______________________________ **(   )** **CLASS:** ___________

ST JOSEPH'S INSTITUTION

PRELIMINARY EXAMINATION 2017
SECONDARY 4 ('O' Level Programme)

CHEMISTRY 5073 / 01

Paper 1 Multiple Choice

23 August 2017

1 hour

1045 – 1145 h

Additional materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, class and index number on the Answer Sheet in the spaces provided.

There are **forty** questions on this paper. Answer **all** questions. For each question, there are four possible answers **A, B, C and D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in the question paper.
The use of an approved scientific calculator is expected, where appropriate.
A copy of the Periodic Table is printed on page 2.

This question paper consists of **24 printed pages** including the Cover Sheet.

[Turn over]

DATA SHEET
The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 **H** Hydrogen 1										4 **He** Helium 2
7 **Li** Lithium 3	9 **Be** Beryllium 4											11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
23 **Na** Sodium 11	24 **Mg** Magnesium 12											27 **Al** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulfur 16	35.5 **Cl** Chlorine 17	40 **Ar** Argon 18
39 **K** Potassium 19	40 **Ca** Calcium 20	45 **Sc** Scandium 21	48 **Ti** Titanium 22	51 **V** Vanadium 23	52 **Cr** Chromium 24	55 **Mn** Manganese 25	56 **Fe** Iron 26	59 **Co** Cobalt 27	59 **Ni** Nickel 28	64 **Cu** Copper 29	65 **Zn** Zinc 30	70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **As** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
85 **Rb** Rubidium 37	88 **Sr** Strontium 38	89 **Y** Yttrium 39	91 **Zr** Zirconium 40	93 **Nb** Niobium 41	96 **Mo** Molybdenum 42	**Tc** Technetium 43	101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47	112 **Cd** Cadmium 48	115 **In** Indium 49	119 **Sn** Tin 50	122 **Sb** Antimony 51	128 **Te** Tellurium 52	127 **I** Iodine 53	131 **Xe** Xenon 54
133 **Cs** Caesium 55	137 **Ba** Barium 56	139 **La** Lanthanum 57 *	178 **Hf** Hafnium 72	181 **Ta** Tantalum 73	184 **W** Tungsten 74	186 **Re** Rhenium 75	190 **Os** Osmium 76	192 **Ir** Iridium 77	195 **Pt** Platinum 78	197 **Au** Gold 79	201 **Hg** Mercury 80	204 **Tl** Thallium 81	207 **Pb** Lead 82	209 **Bi** Bismuth 83	**Po** Polonium 84	**At** Astatine 85	**Rn** Radon 86
Fr Francium 87	226 **Ra** Radium 88	227 **Ac** Actinium 89 †															
				140 **Ce** Cerium 58	141 **Pr** Praseodymium 59	144 **Nd** Neodymium 60	**Pm** Promethium 61	150 **Sm** Samarium 62	152 **Eu** Europium 63	157 **Gd** Gadolinium 64	159 **Tb** Terbium 65	162 **Dy** Dysprosium 66	165 **Ho** Holmium 67	167 **Er** Erbium 68	169 **Tm** Thulium 69	173 **Yb** Ytterbium 70	175 **Lu** Lutetium 71
				232 **Th** Thorium 90	**Pa** Protactinium 91	238 **U** Uranium 92	**Np** Neptunium 93	**Pu** Plutonium 94	**Am** Americium 95	**Cm** Curium 96	**Bk** Berkelium 97	**Cf** Californium 98	**Es** Einsteinium 99	**Fm** Fermium 100	**Md** Mendelevium 101	**No** Nobelium 102	**Lr** Lawrencium 103

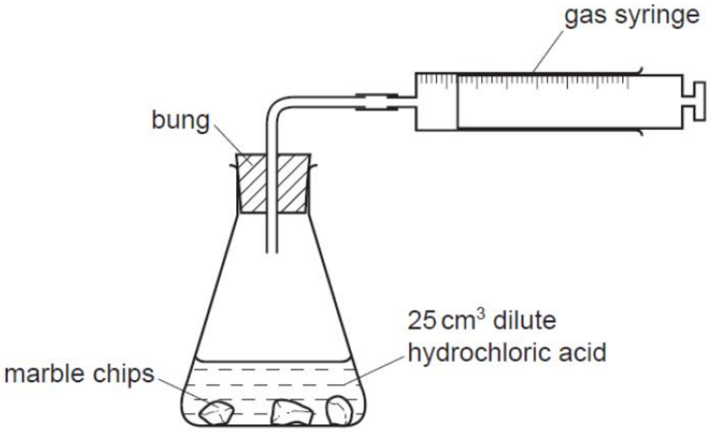
*58-71 Lanthanoid series
†90-103 Actinoid series

Key

Key	
a **X** b	a = relative atomic mass **X** = atomic symbol b = proton (atomic) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

1 The apparatus shown in the diagram below was set up by Peter to measure the volume of carbon dioxide gas made when different masses of marble chips were added to 25 cm^3 of dilute hydrochloric acid.



Which other apparatus did he use for his experiment?

A Filter funnel and mass balance

B Filter funnel and stopwatch

C Measuring cylinder and mass balance

D Measuring cylinder and stopwatch

2 The table gives data about four substances.
In which substance are the particles closely packed and arranged randomly at room temperature?

Substance	**Melting point / °C**	**Boiling point / °C**
A	15	145
B	40	1407
C	-114	-30
D	-20	10

3 The nucleon number and number of electrons of an atom of **X** and an atom of **Y** are shown.

Atom	**X**	**Y**
Nucleon number	51	51
Number of electrons	23	27

Which statement about **X** and **Y** is **incorrect**?

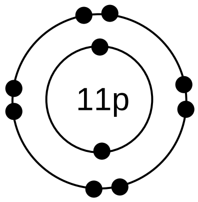
A An atom of **X** has fewer protons than an atom of **Y**.

B An atom of **Y** has fewer neutrons than an atom of **X**.

C **X** is above **Y** in the same group of the Periodic Table.

D **X** is in the same period in the Periodic Table as **Y**.

4 Which of the following statements describes a particle with the following electronic structure?



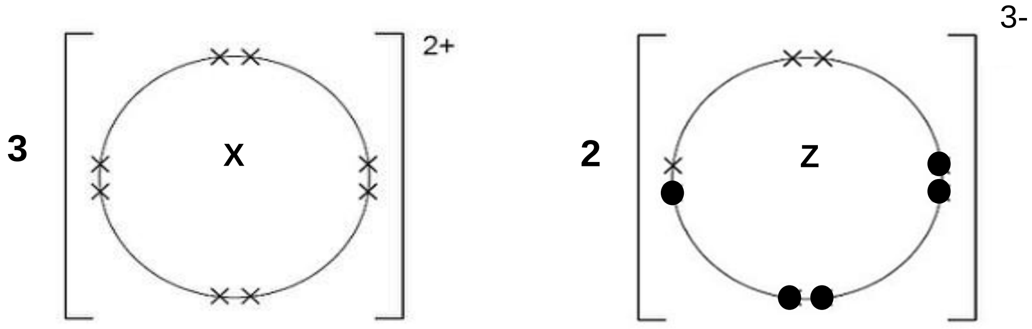
A an anion with an oxidation state of –1

B a cation with an oxidation state of +1

C an atom in the second period

D an inert gas atom

5 The dot-cross diagram (with only the outer electrons) of the compound formed between element **X** and **Z** is shown.



Which of the following is the correct set of formula of the chloride of **X** and **Z**?

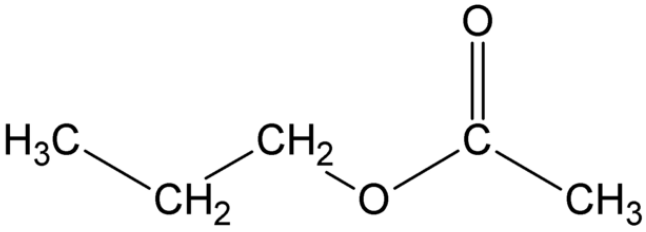
A $\mathbf{X}\mathrm{C}l$, $\mathbf{Z}_3\mathrm{C}l$

B $\mathbf{X}\mathrm{C}l$, $\mathbf{Z}\mathrm{C}l_3$

C $\mathbf{X}\mathrm{C}l_2$, $\mathbf{Z}_3\mathrm{C}l$

D $\mathbf{X}\mathrm{C}l_2$, $\mathbf{Z}\mathrm{C}l_3$

6 The diagram shows the molecule propyl ethanoate.



How many pairs of electrons are used in bonding in the molecule?

A 1

B 7

C 14

D 17

7 The table below shows the physical properties of substances **P**, **Q**, **R** and **S**.

Substance	**Melting point /°C**	**Electrical Conductivity**	
		in solid state	**in molten state**
P	High	Poor	Good
Q	High	Good	Good
R	High	Poor	Poor
S	Low	Poor	Poor

Using the information from the table, which statement is true about substances **P**, **Q**, **R** and **S**?

A Substance **R** consists of weak bonds between the atoms.

B Substance **S** exists in a simple molecular structure.

C Substance **P** contains mobile electrons to conduct electricity when in molten state.

D Substance **Q** consists of strong electrostatic attractions between oppositely charged particles.

8 Chlorine gas is a severe irritant to the eyes and respiratory system. The maximum safe toleration level of chlorine gas in air is 0.005 mg dm^{-3}.

How many molecules of chlorine gas are present in 1 dm^3 of air at the toleration level? (*Note: 1g =1000 mg*)

A $\frac{0.005}{6\times10^{23}}\times71$

B $\frac{0.005}{71}\times6\times10^{23}$

C $\frac{0.005}{1000}\times\frac{1}{71}\times6\times10^{23}$

D $\frac{0.005}{1000}\times71\times6\times10^{23}$

9 Dinitrogen tetroxide, N_2O_4 is a poisonous gas. It can be disposed of safely by reaction with sodium hydroxide. In the experiment, the concentration of aqueous sodium hydroxide used is 1.5 mol/dm^3.

N_2O_4 (g) + 2NaOH (aq) → $NaNO_3$ (aq) + $NaNO_2$ (aq) + H_2O (l)

Which of the following is the least volume of aqueous sodium hydroxide required to dispose of 300 cm^3 of N_2O_4 at room temperature and pressure?

A 10 cm^3

B 20 cm^3

C 200 cm^3

D 600 cm^3

10 Sulfuric acid and nitric acid are both strong acids.
Ethanoic acid is a weak acid.

20.00 cm^3 solutions of 0.10 mol/dm^3 concentration of each of these three acids were separately titrated with a 0.10 mol/dm^3 solution of sodium hydroxide.

In order to react completely

A all three acids would require the same volume of sodium hydroxide solution.

B ethanoic acid and nitric acid would require the same volume of sodium hydroxide solution but sulfuric acid would require more.

C nitric acid would require more sodium hydroxide solution than ethanoic acid but less than sulfuric acid.

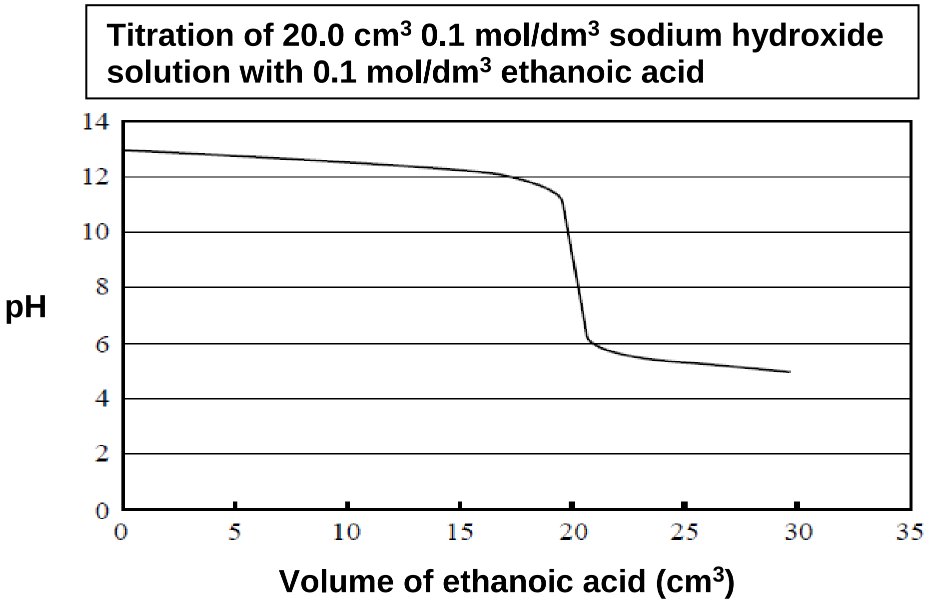
D sulfuric acid and nitric acid would require the same volume of sodium hydroxide solution but ethanoic acid would require less.

11 Solution **X** and solid **Y** are mixed in a beaker. After mixing, the final mass of the substances and the beaker is lesser than the initial mass.

What could solution **X** and solid **Y** be?

	solution **X**	solid **Y**
A	hydrochloric acid	iron(III) hydroxide
B	nitric acid	magnesium oxide
C	potassium hydroxide	ammonium carbonate
D	sulfuric acid	copper

12 The graph below shows the change in pH of a reaction solution during a titration of 0.10 mol/dm^3 sodium hydroxide solution with 0.10 mol/dm^3 ethanoic acid.



Below are the approximate pH changes for a few indicators.

Indicator	**Approximate pH range for colour change**
Methyl orange	3.2-4.4
Phenolphthalein	8.2-10
Litmus solution	5.5-8.2
Bromocresol green	3.8-5.4

Which indicator is the ***most suitable*** to identify the end point of this titration?

A Bromocresol green

B Litmus solution

C Methyl orange

D Phenolphthalein

13 An excess of sodium hydroxide is added to an aqueous solution of salt **L** and boiled. Ammonia gas is only given off after aluminium foil is added to the hot solution. What could be salt L?

A Ammonium chloride

B Ammonium nitrate

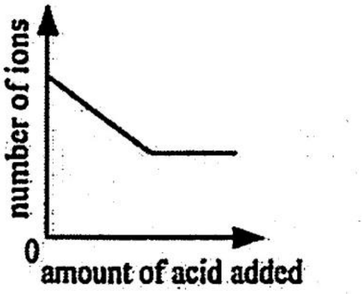
C Sodium chloride

D Sodium nitrate

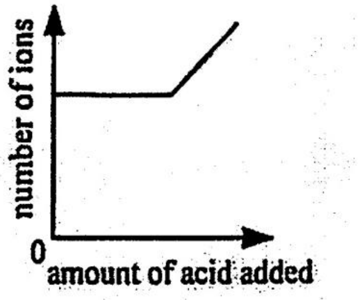
14 Excess dilute sulfuric acid was added to a fixed volume of aqueous barium hydroxide.

Which graph best represents the variation in the total number of mobile ions present in the solution?

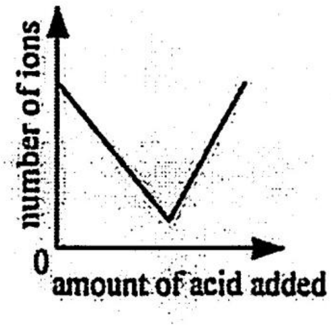
A



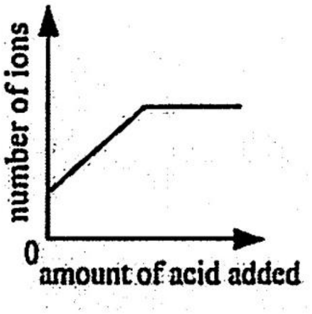
B



C



D



15 Elements **Q**, **X**, **Y** and **Z** are found in consecutive groups of the Periodic Table starting from group IV. They also belong to the same period.

In which molecule are all the outer electrons of the atoms involved in bonding?

A $\mathbf{Q}H_4$

B $\mathbf{X}H_3$

C $\mathbf{Y}H_2$

D $\mathbf{Z}H$

16 **X** is a Group I element while **Y** is a transition element.

Which of the following states the correct similarity and difference in their properties?

	Similarity	**Difference**
A	**X** and **Y** have high melting point.	**Y** has higher density than **X**.
B	**X** and **Y** have high melting point.	**Y** is harder than **X**.
C	**X** and **Y** conduct electricity.	**X** is soluble in water while **Y** is insoluble in water.
D	**X** and **Y** form coloured compounds.	**X** does not conduct electricity while **Y** conducts electricity.

17 Adrian carried out four experiments to arrange metals **X**, **Y** and **Z** in order of decreasing reactivity.

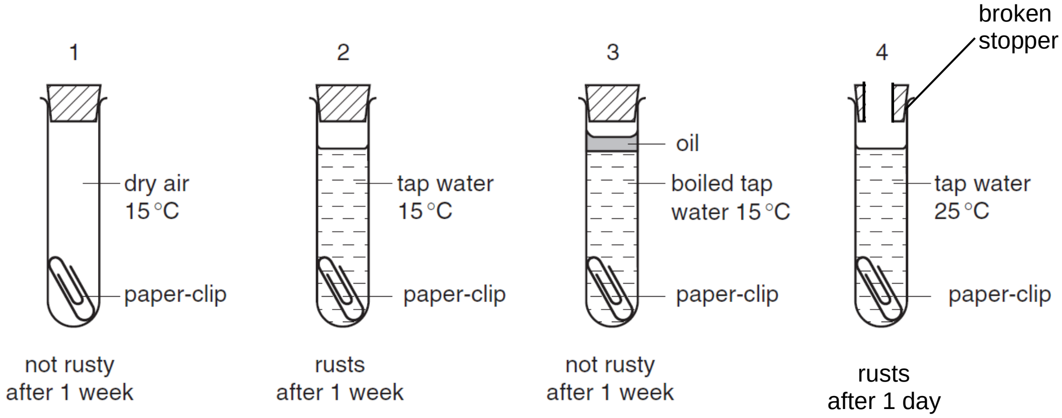
The table shows the results of his experiments:

Experiment	**X**	**Y**	**Z**
Does the metal react with dilute hydrochloric acid?	yes	no	yes
Is the oxide of the metal reduced by heating with carbon?	yes	yes	no

What is the order of reactivity of the metals?

	Most reactive	→	**Least reactive**
A	**X**	**Z**	**Y**
B	**Y**	**X**	**Z**
C	**Z**	**X**	**Y**
D	**Z**	**Y**	**X**

18 Joseph performed four experiments on rusting as shown below.



Which two of these experiments can Joseph use to show that air is needed for iron to rust?

A 1 and 2

B 1 and 3

C 2 and 3

D 2 and 4

19 Which of the following is a redox reaction?

A $NH_3 + H^+ \longrightarrow NH_4^+$

B $N_2 + 3H_2 \longrightarrow 2NH_3$

C $NH_4^+ + Cl^- \longrightarrow NH_4Cl$

D $NH_4^+ + OH^- \longrightarrow NH_4OH$

20 A piece of clean copper wire is suspended in a beaker of aqueous silver nitrate. Crystals of silver are deposited on the copper wire and the solution in the beaker gradually turns blue.

Which deduction is **not** correct?

A Copper is oxidised.

B Silver nitrate is reduced.

C The total number of negative ions in the solution is unchanged.

D The total number of positive ions in the solution is unchanged.

21 Aqueous potassium iodide and acidified potassium manganate (VII) were added to separate samples of hydrogen peroxide.

The observations are summarised in the table.

Reagent added to hydrogen peroxide	**Observations**
Aqueous potassium iodide	Aqueous potassium iodide turns from colourless to brown
Acidified potassium manganate (VII)	Acidified potassium manganate (VII) turns from purple to colourless.

Which of the following set of properties is correct for the above observations?

	Aqueous potassium iodide	**Acidified potassium manganate(VII)**
A	Oxidising agent	Reducing agent
B	Oxidising agent	Oxidising agent
C	Reducing agent	Oxidising agent
D	Reducing agent	Reducing agent

22 In the electrolysis of molten aluminium oxide, 4 moles of aluminium ions (Al^{3+}) were discharged at the cathode.

Which one of the following would be discharged by the same amount of electricity?

A 4 moles copper(II) ions (Cu^{2+}) in the electrolysis of aqueous copper (II) sulfate

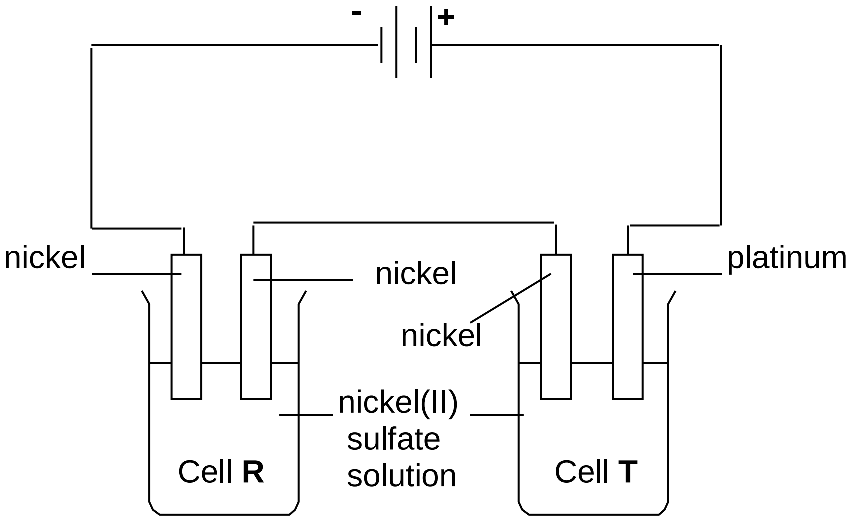
B 6 moles of lead ions (Pb^{2+}) in the electrolysis of molten lead(II) bromide

C 6 moles of silver ions (Ag^{+}) in the electrolysis of aqueous silver nitrate

D 12 moles of zinc ions (Zn^{2+}) in the electrolysis of molten zinc sulfate

23 A current is passed through two electrolytic cells, **R** and **T,** for some time. The electrolyte in both cells is green nickel(II) sulfate solution of the same concentration. Cell **R** has two nickel electrodes, while Cell **T** has a nickel and a platinum electrode.

The results are summarised in the table below.



Cell	Cathode	Anode
R	4.0 g of nickel is deposited.	Nickel dissolves.
T	Nickel is deposited.	Oxygen evolved.

Which statement about the reactions above is **not** true?

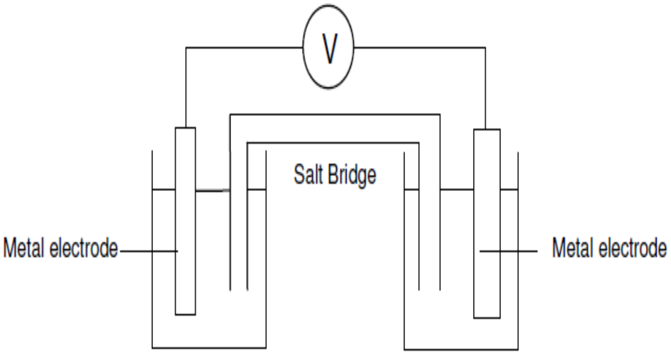
A The oxygen evolved at the anode of Cell **T** burns the platinum.

B The cathode in Cell **R** increases in mass by 4.0 g.

C The concentration of the nickel(II) sulfate solution in Cell **R** remains the same.

D The green colour of the nickel(II) sulfate solution in Cell **T** fades slowly and eventually disappears.

24 Four metals tin, ***x***, ***y*** and ***z*** were connected in pairs and the voltages were recorded.



The results obtained are shown in the table below:

negative terminal	positive terminal	Voltage **(V)**
tin	***y***	+ 1.10
x	tin	+ 0.90
z	tin	+ 2.50

What is the order of reactivity of the four metals with the most reactive first?

A ***x***, tin, ***y***, ***z***

B ***y***, tin, ***x***, ***z***

C ***z***, tin, ***y***, ***x***

D ***z***, ***x***, tin, ***y***

25 The table below shows the differences in the composition of the mixtures of exhaust gases from two cars, one fitted with a catalytic converter and one ithout.

	% by volume of nitrogen monoxide	% by volume of carbon dioxide	% by volume of water vapour
Car without catalytic convertor	67.60	12.00	11.00
Car with catalytic convertor	23.60	32.25	41.10

Which statement does **not** explain the differences in the data above?

A The percentage of nitrogen monoxide decreases as it is oxidised to form nitrogen in the catalytic converter.

B The percentage of nitrogen monoxide decreases as it is reduced to form nitrogen in the catalytic converter.

C The percentage of carbon dioxide increases as unburnt hydrocarbons undergo complete combustion in the catalytic converter.

D The percentage of water vapour increases as unburnt hydrocarbons undergo complete combustion in the catalytic converter.

26 To reduce atmospheric pollution, the following waste gases from a coal burning power station are passed through wet powdered calcium carbonate.

How many of the following waste gases will **not** be removed by the wet powdered calcium carbonate?

carbon monoxide
nitrogen monoxide
sulfur dioxide

carbon dioxide
nitrogen dioxide
phosphorus(V) oxide

A 1

B 2

C 3

D 4

27 The enthalpy of vaporization, (ΔH_{vap}) is the amount of energy absorbed to convert one mole of a liquid substance into a gas. The ΔH_{vap} for water is +40.7 kJ/ mol at 100°C and 1 atm.
Which of the following statements is true?

A The ΔH_{vap} for water is positive as energy is absorbed to break O-H bonds.

B 226 kJ of heat is absorbed to convert 100g of water into steam at 100°C and 1 atm

C Less than 226 kJ of heat is absorbed to convert 100g of water at 25°C into steam at 1 atm.

D Energy is absorbed to transform water molecules vibrating in fixed positions into molecules moving randomly at high speeds.

28 Which of the following processes are exothermic in nature?

I. Rusting of iron metal
II. Neutralisation of butanoic acid with alkali
III. Thermal decomposition of calcium carbonates
IV. Breaking down of hydrogen chloride into its constituent atoms
V. Combustion of sulfur to form an acidic gas

A I,II and III

B I, II and V

C I, II, III, IV

D All of the above

29 A piece of zinc foil dissolved completely in 20 cm^3 of a dilute sulfuric acid solution, and the volume of hydrogen evolved was noted at equal, short time intervals.

Another piece of zinc foil of the same surface area and mass was added to 40 cm^3 of the same solution of dilute sulfuric acid.

How will the initial rate of reaction and the total volume of hydrogen evolved in this second experiment compare to the first experiment?

	initial rate of reaction	**total volume of hydrogen evolved**
A	no change	Increase
B	no change	no change
C	increase	no change
D	increase	increase

30 When sodium thiosulfate reacts with dilute hydrochloric acid, a fine suspension of sulfur is formed.

An experiment was carried out at various temperatures and the time taken for the suspension to appear was recorded in the table below.

Temperature / °C	**Time taken / s**
30	97
35	52
40	42
50	24

Which one of the following conclusions about the experiment can be drawn from the above table?

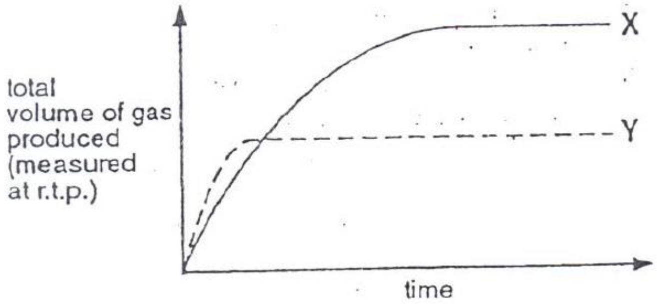
A The shorter the time taken, the higher the temperature rise of the reaction.

B The longer the time taken, the lower the temperature rise of the reaction.

C The higher the temperature, the lower the rate of formation of sulfur.

D The higher the temperature, the higher the rate of formation of sulfur.

31 In the graph shown below, curve **X** represents the result of the reaction between 2.5g of magnesium ribbon and 50 cm^3 of 1 mol/dm^3 sulfuric acid at 50°C.



Which reaction could produce curve **Y**?

- **A** 2.5g of magnesium powder at 50°C
- **B** 2.5g of magnesium ribbon at 60°C
- **C** 12.5 cm^3 of 2 mol/dm^3 sulfuric acid at 60°C
- **D** 25 cm^3 of 2 mol/dm^3 sulfuric acid at 50°C

32 Which statement about speed of reaction is correct?

- **A** Increasing the concentration of a reactant increases the speed because there are more rapidly moving particles.
- **B** Increasing the size of particles of a solid increases the speed because there are more particles.
- **C** Increasing temperature increases the speed because it increases the number of particles.
- **D** Increasing temperature increases the speed because there are more collisions.

33 Why is it wasteful to add ammonium nitrate fertiliser to soil which has recently been treated with slaked lime?

A Ammonium nitrate can be easily decomposed.

B Ammonium nitrate will react with slaked lime and ammonia is released into the air.

C Slaked lime has made the soil too basic for ammonium nitrate to be useful.

D The percentage by mass of nitrogen in ammonium nitrate is low.

34 Which of the following statements about alkanes and alkenes is true?

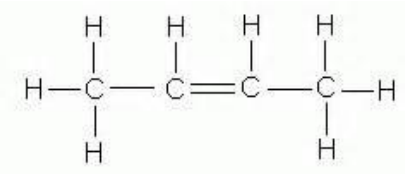
A Alkanes are unsaturated but alkenes are saturated.

B Alkanes undergo substitution while alkenes undergo addition.

C Alkanes and alkenes belong to the same homologous series.

D Alkanes have a higher percentage composition of carbon than the corresponding alkene.

35 The structure of but-2-ene is as shown. But-2-ene undergoes an addition reaction with hydrobromic acid, HBr in a similar way that it reacts with bromine.



Which of the following statements is true about the reaction between but-2-ene and HBr?

A The product is a mixture of two structural isomers

B Both the reactants and products are unsaturated.

C The product has a higher boiling point than the reactant.

D The product can undergo addition reaction with hydrogen.

36 An open can of beer is left exposed to the air for several days and was found to acquire a sour taste. Which of the following statements best explains this phenomenon?

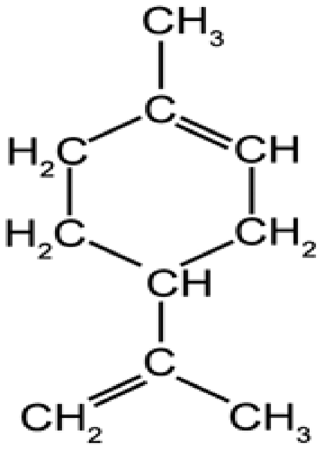
A The fermentation of glucose takes place in the can of beer.

B The oxidation of ethanol occurs to form ethanoic acid.

C The decomposition of carbohydrates in the beer occurs to form ethanoic acid.

D Carbon dioxide from the fermentation reacts with water to form carbonic acid.

37 The smell in citrus fruits is due to an organic compound, limonene, found in them. Which of the following statements apply to limonene?



I. Limonene undergoes addition polymerisation.
II. Limonene decolourises brown bromine water.
III. Limonene is saturated hydrocarbon.
IV. Limonene reacts with excess hydrogen gas to form a saturated product.
V. Limonene reacts with steam under suitable conditions to form an acid.

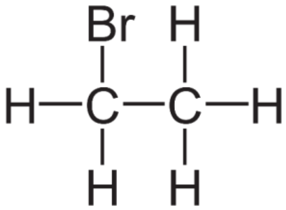
A **I, II, IV**

B **II,IV, V**

C **I,II, III, V**

D All of the above.

38 Ethane undergoes substitution reaction with bromine gas under certain conditions to form bromoethane.



Which of the following statements about the above reaction is true?

A The reaction should be carried out at room temperature in darkness.

B The side product of this reaction is hydrogen bromide, HBr.

C There are two possible isomers of bromoethane.

D A suitable solvent for the reactant mixture is water.

39 Which of the following physical property of the alcohols increases when the number of carbon atoms increases?

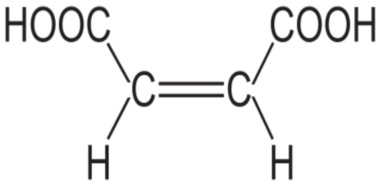
A Boiling Point

B Fluidity

C Flammability

D Water solubility

40 The structure shown below is maleic acid. It can be used as a monomer to make polymers. Which of the following statements is true?



A It can undergo addition polymerisation with $HN_2CH_2CH_2NH_2$.

B It can undergo condensation polymerisation with $HOCH_2CH_2OH$.

C When maleic acid undergoes addition polymerisation, it loses water molecules.

D When maleic acid undergoes condensation polymerisation, polymaleic acid is formed.

NAME: ________________________________ ( ) **CLASS:** ______________

ST JOSEPH'S INSTITUTION

PRELIMINARY EXAMINATION 2017
SECONDARY 4 ('O' Level Programme)

CHEMISTRY 5073 / 02

Paper 2 **15 Aug 2017**

Candidates answer on the Question Paper. **1 hour 45 minutes**
1100 – 1245h

Additional materials: NIL

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.

You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions in the spaces provided.

Section B
Answer **all three** questions, the last question is in the form either / or.
Answer **all** questions in the spaces provided.

At the end of the examination, hand in
Sections A and B SEPARATELY.

The number of marks is given in brackets [ ] at the end of each question or part question.
Electronic calculators may be used in this paper.
A copy of the Periodic Table is found on page 2.

This question paper consists of **23 printed pages** including the Cover Sheet.
[Turn over]

DATA SHEET
The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 **H** Hydrogen 1										4 **He** Helium 2
7 **Li** thium	9 **Be** Beryllium 4											11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
23 **Na** odium	24 **Mg** Magnesium 12											27 **Al** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulfur 16	35.5 **Cl** Chlorine 17	40 **Ar** Argon 18
39 **K** assium	40 **Ca** Calcium 20	45 **Sc** Scandium 21	48 **Ti** Titanium 22	51 **V** Vanadium 23	52 **Cr** Chromium 24	55 **Mn** Manganese 25	56 **Fe** Iron 26	59 **Co** Cobalt 27	59 **Ni** Nickel 28	64 **Cu** Copper 29	65 **Zn** Zinc 30	70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **As** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
85 **Rb** bidium	88 **Sr** Strontium 38	89 **Y** Yttrium 39	91 **Zr** Zirconium 40	93 **Nb** Niobium 41	96 **Mo** Molybdenum 42	**Tc** Technetium 43	101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47	112 **Cd** Cadmium 48	115 **In** Indium 49	119 **Sn** Tin 50	122 **Sb** Antimony 51	128 **Te** Tellurium 52	127 **I** Iodine 53	131 **Xe** Xenon 54
133 **Cs** esium	137 **Ba** Barium 56	139 **La** Lanthanum 57 *	178 **Hf** Hafnium 72	181 **Ta** Tantalum 73	184 **W** Tungsten 74	186 **Re** Rhenium 75	190 **Os** Osmium 76	192 **Ir** Iridium 77	195 **Pt** Platinum 78	197 **Au** Gold 79	201 **Hg** Mercury 80	204 **Tl** Thallium 81	207 **Pb** Lead 82	209 **Bi** Bismuth 83	**Po** Polonium 84	**At** Astatine 85	**Rn** Radon 86
Fr ncium	226 **Ra** Radium 88	227 **Ac** Actinium 89 †															

-71 Lanthanoid series

-103 Actinoid series

140 **Ce** Cerium 58	141 **Pr** Praseodymium 59	144 **Nd** Neodymium 60	**Pm** Promethium 61	150 **Sm** Samarium 62	152 **Eu** Europium 63	157 **Gd** Gadolinium 64	159 **Tb** Terbium 65	162 **Dy** Dysprosium 66	165 **Ho** Holmium 67	167 **Er** Erbium 68	169 **Tm** Thulium 69	173 **Yb** Ytterbium 70	175 **Lu** Lutetium 71
232 **Th** Thorium 90	**Pa** Protactinium 91	238 **U** Uranium 92	**Np** Neptunium 93	**Pu** Plutonium 94	**Am** Americium 95	**Cm** Curium 96	**Bk** Berkelium 97	**Cf** Californium 98	**Es** Einsteinium 99	**Fm** Fermium 100	**Md** Mendelevium 101	**No** Nobelium 102	**Lr** Lawrencium 103

a **X** b	a = relative atomic mass **X** = atomic symbol b = proton (atomic) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

Section A (50 marks)

Answer **ALL** the questions in this section in the spaces provided.

A1 10 cm^3 of ethanoic acid of unknown concentration is titrated with 0.10 mol/dm^3 of aqueous sodium hydroxide. It was found that 20 cm^3 of the sodium hydroxide solution was required for the neutralisation to be completed.

(a) **(i)** Write a balanced chemical equation for the reaction between ethanoic acid and sodium hydroxide.

……….…………………………………………………………………….[1]

(ii) Calculate the concentration of the ethanoic acid used in the above titration.

……….…………………………………………………………………..…….

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……….……………………………………………………………..……[2]

(iii) The formula to calculate the pH of a solution is:
pH = - lg [H^+]

pH is the negative logarithm to base 10 of the concentration of hydrogen ions.

For example, if the concentration of H^+ ions is 0.1 mol/dm^3,
Then pH = - lg [0.1]
= 1

It is found that the pH value of 0.1 mol/dm^3 ethanoic acid solution is higher than 1.

Using the information above, suggest a reason why the pH is more than 1.

………..……………………………………………………………..…….

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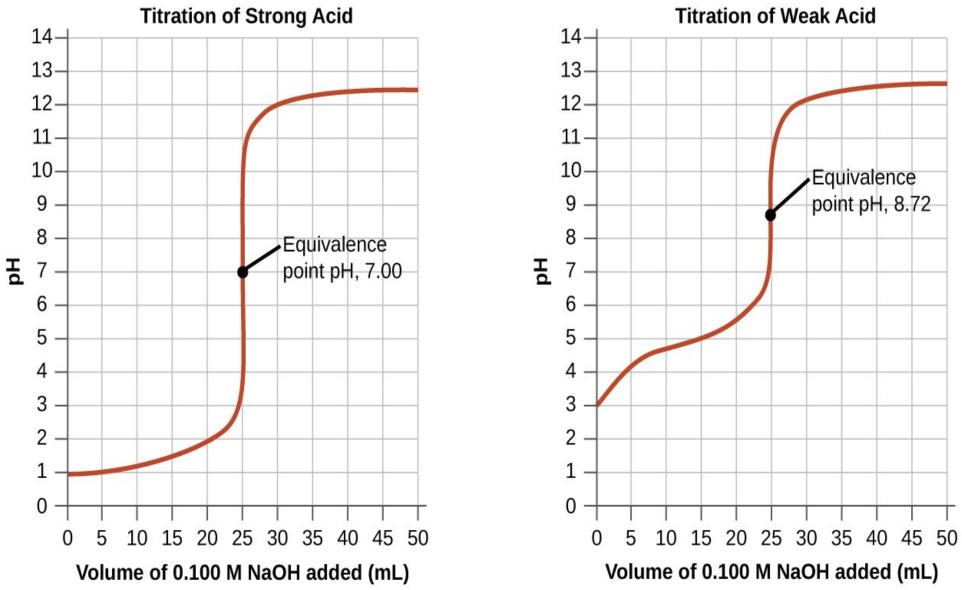
………..………………………………………………………..….[1]

(b) The titration curves below show the changes in pH that occurs when a strong acid and a weak acid is titrated with sodium hydroxide respectively.



(a) (b)

The **equivalence point** is the point where the acid is neutralised by the alkali.

(i) Describe **two key differences** in the two titration curves illustrated above other than the difference in the pH values at the equivalence point.

………..………..………………………………………………………

………..………..……………………………..……………………

…………………..……..…………………………………………………

…………………..………………………………………………[2]

(ii) What does the pH values at the equivalence points of the two titrations suggest about the nature of the salt formed in each of the two titrations?

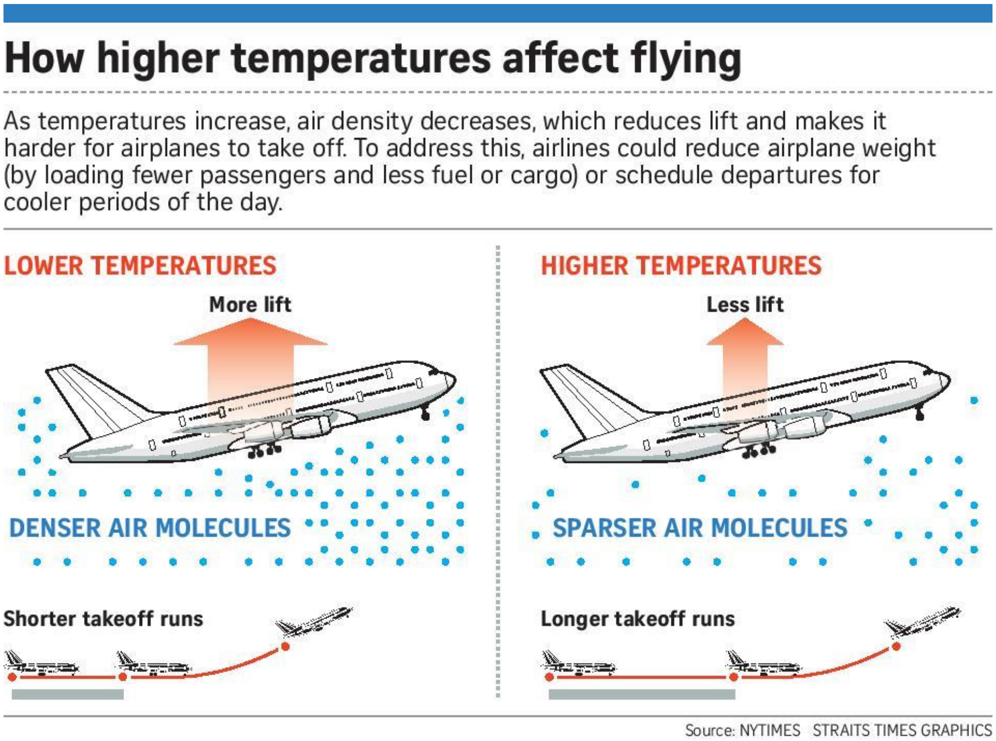
………..………..……………………………………………………………

………..………..…………………………………..……………………

…………………..……..……………………………………………...[1]

[Total : 7m]

A2 Michael read the following article featured in a newspaper recently. It is about increasing global temperatures due to global warming, grounding planes at the airport.



How higher temperatures affect flying

As temperatures increase, air density decreases, which reduces lift and makes it harder for airplanes to take off. To address this, airlines could reduce airplane weight (by loading fewer passengers and less fuel or cargo) or schedule departures for cooler periods of the day.

Source: NYTIMES STRAITS TIMES GRAPHICS

(a) Michael explained that the increase in temperature caused the air molecules to disintegrate leading to fewer molecules per unit volume.

Explain, using Kinetic Particle Theory,

(i) the correct reason for the sparser air molecules.

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………………………………………………………………………………[2]

(ii) how cooler periods of the day allow more lift for the airplane to take off.

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………………………………………………………………………………

………………………………………………………………………………[2]

(b) One other way of reducing airplane weight is to use carbon fibre (or graphite fibre) to make the wings, as the material could be moulded into a desirable shape.

Explain, using bonding and structure, why graphite can be easily moulded.

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………………………………………………………………………………

………………………………………………………………………………

………………………………………………………………………………[2]

(c) Environmental groups think that the shrinking of the ice caps is the result of global warming. Satellite images are used to show the area of Arctic sea ice as shown in the diagram below.

Photograph: National Snow and Ice Data Centre, Colorado.

(i) Give **one** consequence of the reduction of Arctic sea ice.

…………………………………………………………………………

…………………………………………………………………………[1]

(ii) Describe one possible source of global warming that has led to the reduction of Artic ice.

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…………………………………………………………………………[1]

(iii) Scientists are currently developing a process called **carbon capture and storage (CCS)**.

This will reduce the problem of global warming. There are three main steps to **CCS**. **Firstly, carbon** dioxide is trapped and separated from other gases produced in coal-powered electricity plants. The captured carbon dioxide is transported to a storage location. The carbon dioxide is then stored far away from the atmosphere (underground or deep in the ocean).

Suggest **one** reason why some scientists do not support the use of **CCS**. Use the information above to help you answer.

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……..…………………………………………………………………

……………………………………………………………………………[1]

[Total : 9m]

A3 The following equations show the reactions of some metals and aqueous metal ions.

$Mg + Fe^{2+} \longrightarrow Mg^{2+} + Fe$

$Fe + Ni^{2+} \longrightarrow Fe^{2+} + Ni$

$Zn + Fe^{2+} \longrightarrow Zn^{2+} + Fe$

$Mg + Zn^{2+} \longrightarrow Mg^{2+} + Zn$

(a) Place the metals in the order of decreasing reactivity.

………………………………..[1]

(b) Identify the strongest oxidising agent among the metals and aqueous metal ions shown in the equations. Explain your answer in terms of electrons.

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………………………………………………………………………………

………………………………………………………………………………[2]

(c) Name the type of reaction shown by the equations. State one observation for the reaction between zinc and aqueous iron(II) ions.

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……………………………………………………………………………...[2]

[Total : 5m]

A4 Dilute hydrogen peroxide, H_2O_2, decomposes to give oxygen and water when a catalyst is added.

$2\ H_2O_2\ (aq) \longrightarrow 2\ H_2O\ (l) + O_2\ (g)$ $\Delta H = -196$ kJ/mol

$2\ H_2O_2\ (aq) \longrightarrow 2\ H_2O\ (l) + O_2\ (g)$

(a) Which other method besides changing concentration, can increase the rate of decomposition of dilute hydrogen peroxide.

……………………………………………………………………………………[1]

(b) Explain, in terms of collision theory, how your answer in **(a)** increased the rate of decomposition of dilute hydrogen peroxide.

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……………………………………………………………………………………

……………………………………………………………………………………[2]

(c) Draw a fully labeled energy profile diagram to show the catalysed and uncatalysed decomposition of dilute hydrogen peroxide.

[3]

[Total : 6m]

A5 The chemical compound, hydrazine (N_2H_4) is used as a rocket fuel propellant. When burned, nitrogen and water are produced as shown in the following equation:

$$N_2H_4 + O_2 \rightarrow N_2 + 2H_2O$$

(a) Draw a 'dot and cross' diagram for hydrazine, showing only the valence shell electrons.

[2]

(b) Explain, using bonding and structure, why hydrazine exists as a liquid while water is in gaseous state at 100°C.

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……………………………………………………………………………...…[2]

(c) When 5 tonnes of hydrazine were burned in the rocket reaction chamber, 104000 kJ of energy were released. Calculate the enthalpy change per mole for this reaction.
(1 tonne = 1000 kg)

[2]

[Total : 6m]

A6 In the Haber process, the percentage of ammonia present at equilibrium at different temperatures and pressures is shown in the table below.

Ammonia present at equilibrium (%)

Temperature / **Pressure**	**100ºC**	**200ºC**	**300ºC**	**400ºC**	**500ºC**
10 atm	88.2	50.7	14.7	3.9	1.2
25 atm	91.7	63.6	27.4	8.7	2.9
50 atm	94.5	74.0	39.5	15.3	5.6
100 atm	96.7	81.7	52.5	25.2	10.6
200 atm	98.4	89.0	66.7	38.8	18.3
400 atm	99.4	94.6	79.7	55.4	31.9
1000 atm	99.9	98.3	92.6	79.8	57.5

Use information from the table to answer the following questions.

(a) Describe how the composition of ammonia varies with the conditions of pressure and temperature.

…………………………………………………………………………………

……………………………………………………………………………...[2]

(b) **(i)** State the temperature and pressure that will produce the highest percentage of ammonia at equilibrium.

……………………………………………………………………..…....[1]

(ii) Explain why these conditions are not used commercially in industries.

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…………………………………………………………………………......

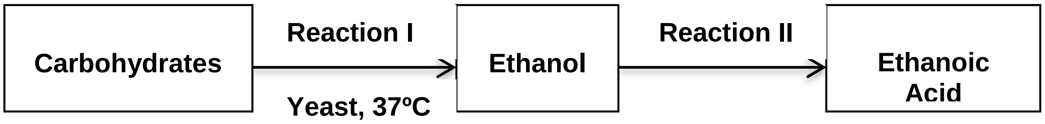
……………………………………………………………………….....[2]

(c) Calculate the mass of ammonia produced at equilibrium when 1 tonne of nitrogen was reacted with excess hydrogen at 200 atm and 400 ºC [1tonne = 1000kg]

[3]

[Total : 8m]

A7 **(a)** The flow chart below shows a series of reactions carried out to produce vinegar, ethanoic acid.



(i) State the name of Reaction **I**.

……..………………………………………………………………….[1]

(ii) Write a balanced chemical equation for Reaction **I**.

……..………………………………………………………………….[1]

(iii) State the reagents and conditions required in Reaction **II** to react with ethanol to form ethanoic acid.

....[1]

(iv) Methanoic acid reacts with ethanol to form a sweet-smelling compound, compound **Z**, when heated with concentrated sulfuric acid. State the name of compound **Z** and draw its full structural formula in the table below. Circle the functional group of compound **Z**. [3]

Name of Compound **Z**: Full structural formula:

(b) Ethanol is being increasingly used in many areas such as for beverages, fuel and solvents. Describe **two** disadvantages and **one** advantage of the manufacturing process of ethanol by fermentation over the addition reaction of ethene with steam.

NAME: ________________________________ (   ) **CLASS :** ______________

Section B (30m)

Answer all **three** questions from this section. The last question is in the form of an either / or and only **one** of the alternatives should be attempted.
Write your answers in the space provided.

B8 **Table 8.1** shows some information on the chlorides of elements in Period 3.

Proton number of element	**Formula of the chloride**	**Melting point of the chloride/ °C**	**Type of bonding in the chloride**
11	$NaCl$	801	Ionic
12	$MgCl_2$	714	Ionic
13	$AlCl_3$	193	Covalent
14	$SiCl_4$	–69	Covalent
15	PCl_3	–94	Covalent
16	S_2Cl_2	–80	Covalent
17	Cl_2	–102	Covalent

Table 8.1

(a) State the relationship between the proton number of the elements and the melting point of their chlorides.

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…………………………………………………………………………………..…[1]

(b) Explain your answer in **(a)** in terms of structure and bonding.

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……………………………………………………………………………………..[3]

(c) **Table 8.2** gives data about some physical properties of the elements calcium, iron and copper, found in Period 4 of the Periodic Table. **Use the data provided to answer the questions.**

Element / **Property**	**Calcium**	**Iron**	**Copper**
Proton number	20	26	29
Atomic radius/ nm	0.197	0.126	0.128
Ionic radius/ nm	0.114	0.075	0.087
Melting point/ °C	842	1538	1084
Density/ g cm^{-3}	1.54	7.86	8.92
Electrical conductivity/ 10^7 S m^{-1}	2.90	1.00	5.90

Table 8.2

(i) Explain in terms of the number of protons and electrons, why the ionic radius of the metal ion is always smaller than its atomic radius.

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………………………………………………………………………………..

……………………………………………………………………………...[2]

(ii) The high electrical conductivity of copper makes it a very useful element for making electrical components.
Apart from its high cost, suggest why copper is **not** usually used for overhead electrical cables.

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……………………………………………………………………………...[1]

(iii) Give one reason why the following metals are unsuitable material for making electrical wires.

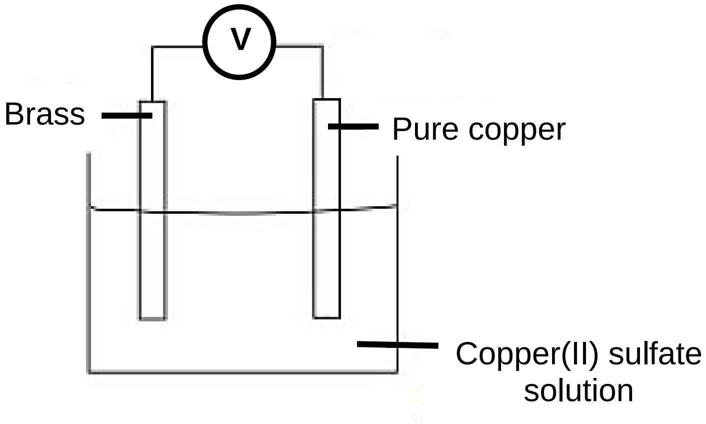
1. Calcium: ………………………………………………………………..

………………………………………………………………………………...

2. Iron: ……………………………………………………………………….

…………………………………………………………………………….….[2]

(d) The apparatus shown was used to determine the mass of zinc in brass (an alloy of zinc and copper).



(i) Use an arrow to show the direction of electron flow on the diagram. [1]

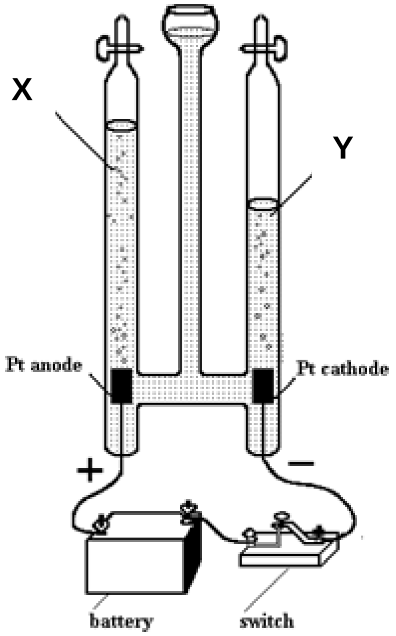
(ii) Write ionic equations for the reaction occurring at the negative and positive terminals.

…………………………………………………………………………………….

…………………………………………………………………………………….[2]

[Total : 10m]

B9 The follow apparatus can be used to carry out the electrolysis of dilute aqueous sulfuric acid.



Experiment I

(a) Write the balanced ionic equations for the anode and cathode reactions respectively.

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…………………………………………………………………………………………...............[2]

(b) Suggest one reason why platinum electrodes are preferred over graphite electrodes in this electrolysis.

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(c) Explain, with the help of the overall equation for this electrolysis, why the relative volumes of **X**:**Y** is approximately 1:2.

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……………………………………………………………………………………………….[2]

(d) In a separate experiment **II**, the same setup is used as experiment **I**, but concentrated hydrochloric acid is used as the electrolyte in place of dilute aqueous sulfuric acid.

State and explain **one similarity** and **two differences** in the observations made between experiments **I** and **II**.

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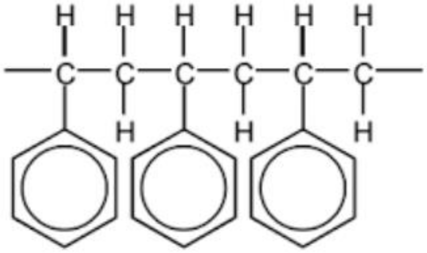
……………………………………………………………………………………………….[3]

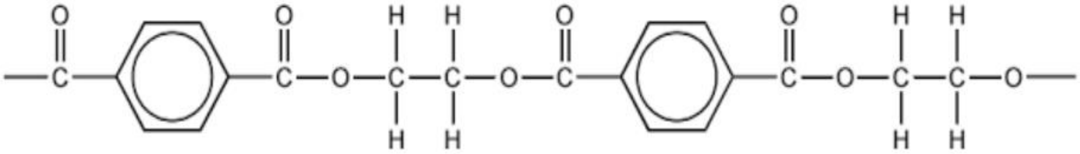
[Total : 8m]

Either

B10 Short sections of the structural formula of two polymers are shown below.



polymer **A**



polymer **B**

(a) Draw the structural formula of all the monomers that react to form the two polymers above and state the type of polymer that it is.

Monomer(s) from polymer **A**:

Type of polymer: ________________________

Monomer(s) from polymer **B**:

Type of polymer: ________________________ [4]

(b) **(i)** Polymer **B** was broken down into its respective monomers, which are miscible liquids. Describe the technique that can be used to separate the monomers of Polymer **B**.

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…………………………………………………………………………….....[2]

(ii) Describe chemical tests to identify the monomers present in Polymer **B**.

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(c) Describe a pollution problem that can be caused by the disposal of these polymers.

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…………………………………………………………………………………[2]

[Total: 10m]

OR

B10 The table below gives values for the energy change of combustion (**ΔH**) for some common alkanes and alcohols used as fuels :

Substance (fuel)	**Combustion Reaction**	**ΔH (kJ mol^{-1})**
ethane	$2C_2H_{6(g)} + 7O_{2(g)} \rightarrow 4CO_{2(g)} + 6H_2O_{(l)}$	ΔH = -1560
butane	$2C_4H_{10(g)} + 13O_{2(g)} \rightarrow 8CO_{2(g)} + 10H_2O_{(l)}$	ΔH = -2874
octane	$2C_8H_{18(g)} + 25O_{2(g)} \rightarrow 16CO_{2(g)} + 18H_2O_{(l)}$	ΔH = -5460
ethanol	$C_2H_5OH_{(l)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(l)}$	ΔH = -1368
butan-1-ol *(1-butanol)*	$C_4H_9OH_{(l)} + 6O_{2(g)} \rightarrow 4CO_{2(g)} + 5H_2O_{(l)}$	ΔH = -2671

(a) Using information from the table, describe the relationship between the number of carbon atoms in alkanes and enthalpy for the combustion.

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…………………………………………………………………………………….............

……………………………………………….……………………………………….....[2]

(b) Based on the information given in the above table, what conclusions can you draw about the enthalpy change of combustion for the alkanes and alcohols?

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……………………………………………….……………………………………….....[2]

(c) Explain, using bond breaking and bond formation, why the combustion of ethane is an exothermic reaction.

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…………………………………………….…………………………………..[2]

(d) Comparing butane and butan-1-ol, calculate which substance would give a better energy output when 10 kg of each fuel is used.

[3]

(e) State a reason for butan-1-ol as being a preferred fuel compared to butane.

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…………………………………………………………………………………....[1]

[Total : 10m]

SJI Chemistry 5073 2017
Marking Scheme:
Paper 1:

1	C	21	C
2	A	22	B
3	C	23	A
4	B	24	D
5	D	25	A
6	D	26	B
7	B	27	B
8	C	28	B
9	B	29	B
10	B	30	D
11	C	31	C
12	D	32	D
13	D	33	B
14	C	34	B
15	A	35	C
16	C	36	B
17	C	37	A
18	C	38	B
19	B	39	A
20	D	40	B

Paper 2:
Section A

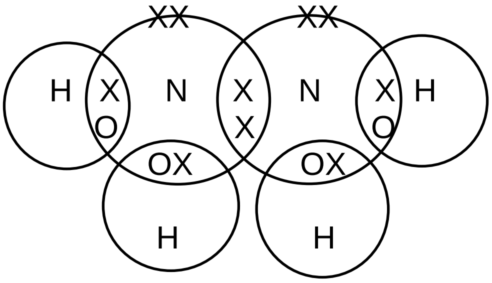
A1	**(a)**		
		(i)	$CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$
		(ii)	No of moles of NaOH = 10/1000 x 0.1 = 0.002 mol Mole ratio of ethanoic acid:NaOH = 1:1 Concentration of ethanoic acid = 0.002/ (10/1000) = 0.2 mol/dm^3
		(iii)	Ethanoic acid is a weak acid that dissociates partially in water to produce H+ ions in water with a concentration of lower than 0.1mol/dm^3. When –lg of a number lesser than 0.1 is calculated, the value is greater than 1.
	(b)	(i)	The vertical section in the titration curve at the equivalence point of the strong acid – strong alkali titration is longer than that of the weak acid- strong alkali titration. The starting pH of the strong acid solution is 1 while the starting pH of the weak acid solution is around 3. For a strong acid-strong base titration, pH increases steadily increases before the equivalence point, but pH rises faster at first but becomes more gentle as it gets closer to the equivalence for a weak acid strong base titration. Or For a strong acid-base titration, the pH increases at an increasing rate for the first 25 ml of NaOH added but for the weak acid strong base titration, the gradient increases at an increasing rate at first and then decreases in a decreasing rate until equivalence point.
		(ii)	The salt formed from a strong acid-strong alkali reaction is neutral. (pH7). The salt formed from a weak acid-strong alkali reaction is alkaline/basic. (pH= 8.5).

A2	**(a)**		
		(i)	As **heat is gained** by the molecules, they **move faster** and **further apart**
		(ii)	The molecules **lose energy** to the surroundings and slow down in their movement hence **coming closer together** making the air **more dense**.

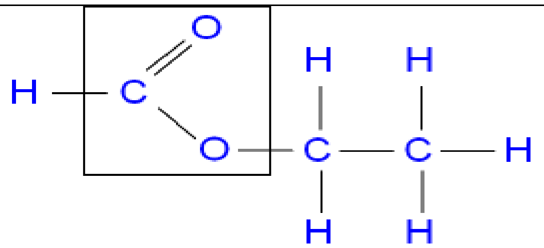
	(b)	Graphite has a **giant covalent structure with weak attractive forces between their layers**. **Little energy is needed** to overcome forces and this **allows the layers to slide over one another** making graphite easily moulded.	
	(c)	(i)	Flooding of low lying areas leading to catastrophes such as tsunamis and loss of crops/destruction of animal habitats.
		(ii)	Increase in usage of carbon containing fuels, Deforestation /higher usage or presence of cars
		(iii)	Any of of the following: CCS is expensive as it takes a lot of equipment to capture, purify, liquefy, transport and bury CO_2. Safety concerns because it is uncertain what the consequences will be if there is leakage of large amounts of CO_2. One might imagine that large amounts of CO_2 could escape and incapacitating humans and animals. CO_2 is a gas that occurs in nature, but can be dangerous in large concentrated quantities.

A3	**(a)**	Mg, Zn, Fe, Ni
	(b)	Ni^{2+} is the strongest oxidising agent. The strongest oxidising agent gains electrons most readily and gets reduced.
	(c)	Type of reaction: displacement reaction One observation: Zinc metal decreases in size/ dissolves or pale green solution turns paler/ colourless or grey deposits/ precipitate formed

A4	**(a)**	Increasing the temperature
	(b)	Increase the temperature: Particles gain kinetic energy and move faster/move at high speeds; more particles have the minimum energy required for reaction; increasing the frequency of effective collision
	(c)	Energy profile diagram showing reactants and products with correct ratio, correct axes and an exothermic reaction; label the activation energy of catalysed and uncatalysed reaction of which the E_a of catalysed reaction is lower than the uncatalysed reaction; ΔH of both reactions is labeled and indicated as the same value.

A5	**(a)**	
	(b)	Both have **simple molecular structure with weak intermolecular forces.** However the intermolecular forces are **more weak in water than in hydrazine** hence at 100°C, the **energy is sufficient to overcome the forces in water** but not in hydrazine.
	(c)	No of moles of hydrazine = $\frac{5 \times 10^6 \text{ g}}{32}$ = 156250 releases 104000 kJ Therefore, 1 mole releases =666 J

A6	**(a)**		The percentage of ammonia present at **equilibrium decreases with temperature** but **increases with pressure**.
	(b)	**(i)**	100 °C and 1000 atm
		(ii)	At 100 °C, the temperature is low causing the rate of reaction to be **slow**. At 1000 atm, the pressure is too high which makes **it costly** to maintain such a pressure.
		(iii)	1 mol $N_2 \rightarrow$ 2 mol NH_3 28 g of $N_2 \rightarrow$ 2(17) g NH_3 1 tonne of $N_2 \rightarrow$ 1/28 x 2(17) g = 1.214 tonne of NH_3 At 200 atm and 400 °C, percentage of ammonia is 38.8% Mass of ammonia produced at equilibrium = 1.214 x 38.8% = 0.471 tonne
A7	**(a)**	**(i)**	Fermentation
		(ii)	$C_6H_{12}O_6 \rightarrow 2CO_2 + 2C_2H_5OH$
		(iii)	Acidified potassium manganate(VII); heat
		(iv)	Ethyl methanoate

			
	(b)		**Advantages: (** Any one of the following) The cost for fermentation is lower as compared to hydration of steam. It uses renewable resources as glucose comes from sugar cane and corn which can be grown, ethene comes from petroleum which is a non-renewable resource. **Disadvantages:** (Any two of the following) The process takes a longer time. The yield is a lot lower than the hydration of steam. Ethanol needs to be separated from the liquid mixture by fractional distillation which is an additional process. Fermentation produces carbon dioxide gas, which contributes to global warming.

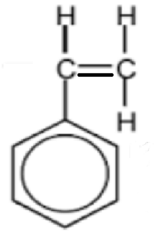
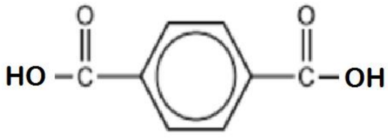
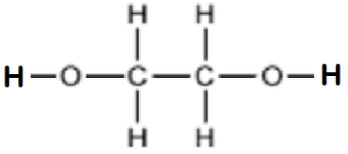
Section B

B8	**(a)**	As the proton number increases, the melting point of the chlorides decreases.	
	(b)	As proton number increases, the type of bonding in the chlorides changes from ionic to covalent. Their structures changes from giant ionic to simple molecular. More energy is needed to overcome strong electrostatic forces than the weak intermolecular forces.	
	(c)	**(i)**	There is lesser number of electrons than protons in the metal ion; giving rise to stronger attraction of the nucleus.
		(ii)	It is very heavy/ has high density.
		(iii)	For Calcium: electrical conductivity is low / its melting point is lower than copper. For iron: electrical conductivity is low.
	(d)	**(i)**	An arrow from brass to copper via the wire
		(ii)	Negative terminal: $Zn \longrightarrow Zn^{2+} + 2e^-$ Positive terminal: $Cu^{2+} + 2e^- \longrightarrow Cu$

B9	**(a)**	Anode: $4OH^- \rightarrow 2H_2O + O_2 + 4e$ Cathode: $2H^+ + 2e \rightarrow H_2$

	(b)	Graphite electrodes can react with the oxygen gas produced at the anode and become worn out while platinum electrodes do not react easily with oxygen gas.
	(c)	Overall equation: $2H_2O \rightarrow 2H_2 + O_2$ From the overall equation of the electrolysis, water is broken down to form 1 mole of oxygen and 2 moles of hydrogen gas at the anode (**X**) and cathode (**Y**) respectively. Hence, resulting in the relative volumes of **X**:**Y** to be 1:2.
	(d)	**Similarity** A colourless gas/ effervescence of colourless gas is observed at the cathode. **Reason:** Hydrogen ions are discharged at the cathode in both experiments to form hydrogen gas. **Differences:** A colourless gas is formed at the anode for experiment **I**, but a **yellowish green gas is formed at the anode** for experiment **II**. **Reason:** Unlike expt I where hydroxide ions are discharged to produce oxygen gas at the anode, in expt II, the high concentration of the chloride ions cause **Cl^- to be selectively/ preferentially discharged to form chlorine gas.** The relative volumes of **X:Y** in expt **II** is **1:1** instead of 1:2 in expt I. **Reason:** Hydrogen ions and chloride ions are discharged in a 1:1 mole ratio or at the same rate at the cathode and anode respectively to form hydrogen and chlorine gas.

EITHER

B9	**(a)**		Monomers from polymer A:  Addition Polymer Monomers from polymer B:   Condensation Polymer

	(b)	**(i)**	Separate the mixture of monomers using fractional distillation as they have different boiling points. The monomer with the lower boiling point will vapororise and condense first forming the distillate. The monomer with the higher boiling point will remain in the flask.
		(ii)	Add magnesium *(non group 1 metal and not Cu, Ag)* ribbon or a metal carbonate to the mixture, if effervescence of a colourless gas is produced, then the monomer contains the carboxyl group. Add acidified potassium manganate (VII) to the mixture, if it changes from purple to colourless, then the monomer/diol containing the hydroxyl groups is present.
	(d)		The polymers formed are **non-biodegradable**. They will take up space at land-fill sites which could be used for other purposes. OR When the polymers are burned, toxic gases like carbon monoxide may be released which when taken in by humans, causes death. OR When the polymers are disposed into the water bodies, they are consumed by fish and suffocate them to death.

OR

B9	**(a)**	As the number of carbon atoms increases in alkanes from 2 in ethane to 8 in octane,the enthalpy for the combustion increases from -1560 kJ / mol to -5460 kJ / mol.
	(b)	Enthalpy change of combustion for alkanes is greater than alcohols for the same number of carbon atoms. For both alkanes and alcohols, enthalpy change of combustion increases as number of carbon atoms increases.
	(c)	Energy **absorbed to break bonds in ethane and oxygen** is **less than** the energy **released in the formation of bonds in carbon dioxide and water**.
	(d)	10 000 g of butane, moles = 10000/58 Energy released = 2874x10000/58 = 495 517 kJ 10 000 g of butan-1-ol, moles = 10000/74 Energy released = 2671x10000/74 = 360 946 kJ As butane releases more energy, it is a better fuel.
	(e)	It is preferred as it is a renewable resource compared to butane which is a finite resource. OR Butan-1-ol burns with less oxygen than butane. It burns more cleanly than butane.

NAME		INDEX NO.

ST. PATRICK'S SCHOOL

PRELIMINARY EXAMINATIONS 2017

SUBJECT : **CHEMISTRY 5073 Paper 1** DATE : **25 Aug 2017**

LEVEL : **SECONDARY 4 EXPRESS** DURATION : **1 HOUR**

INSTRUCTIONS TO CANDIDATES:

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO.

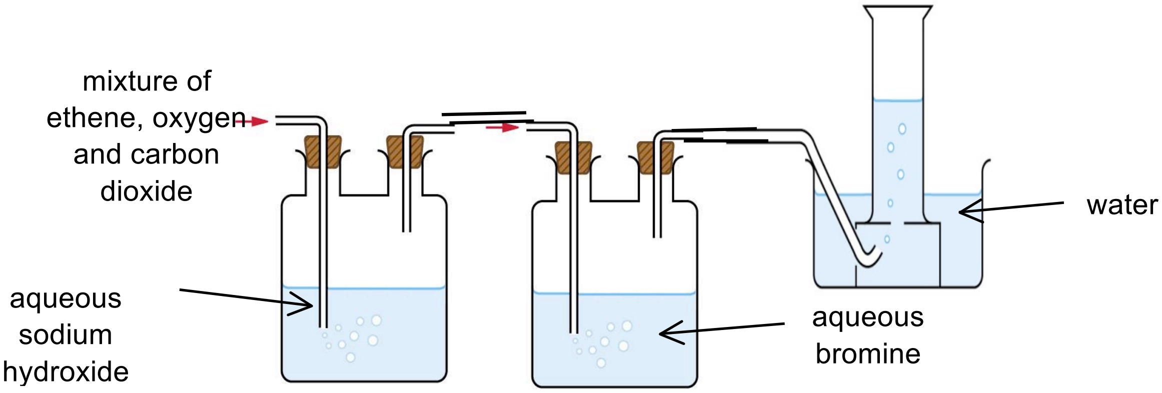
1. There are **forty** questions on this paper. Answer **all** questions.
2. For each question there are four possible answers **A**, **B**, **C** and **D**.
3. Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.
4. Answer **all** questions on the **Answer sheet** provided.

INFORMATION FOR CANDIDATES:

Each correct answer will score one mark. A copy of the Periodic Table is provided.

This question paper consists of 21 printed pages including the Periodic Table

1 A gaseous mixture of ethene, oxygen and carbon dioxide is passed through the apparatus shown. Only one of the gases is collected.



What is a property of the gas collected?

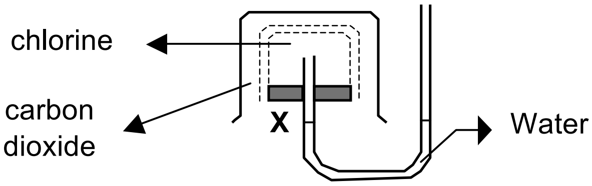
A gas extinguishes burning splint

B gas forms a white precipitate when bubbled through limewater

C gas relights a glowing splint

D gas turns acidified potassium manganate (VII) solution colourless

2 A porous pot contains chlorine gas.



What would happen to the water level at X when a beaker of carbon dioxide was inverted over the pot?

A **X** would fall only.

B **X** would rise only.

C **X** would fall, then rise after some time.

D **X** would rise, then fall after some time.

3 Deuterium is an isotope of hydrogen and has the symbol D.
Which formula is incorrect for a deuterium compound?

A BaOD

B CD_3CO_2D

C $C_2D_4Br_2$

D D_2O_2

4 Which one of the following represents the most likely structural formula for the covalent compound disulfur dichloride, S_2Cl_2?

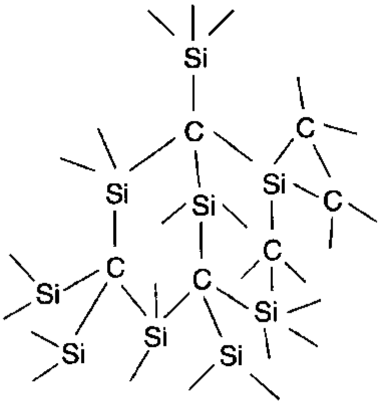
A Cl–S–S–Cl

B S–Cl–Cl–S

C S–Cl–S–Cl

D Cl=S–S=Cl

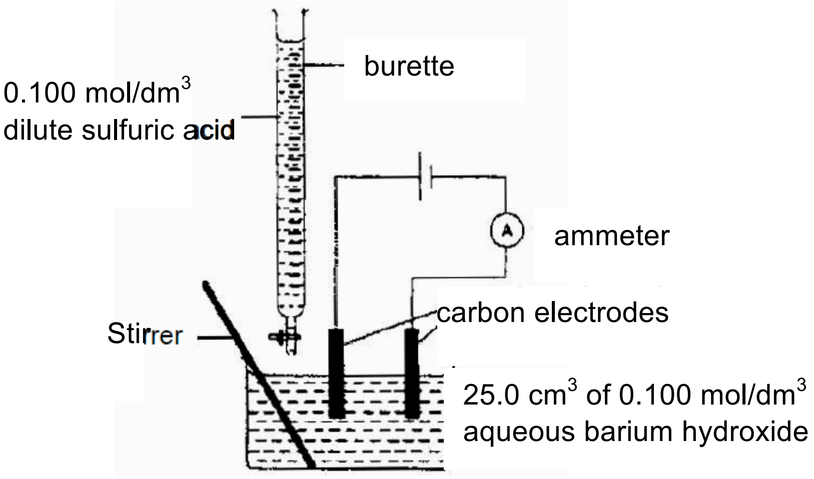
5 The diagram shows part of the structure of the compound silicon carbide.



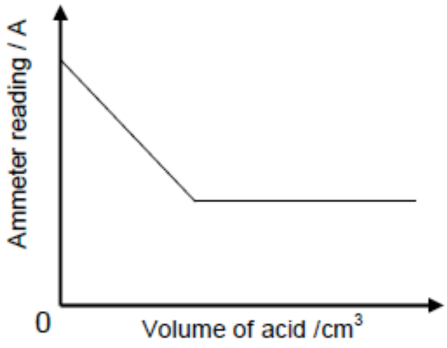
Which set of information about silicon carbide is correct?

	empirical formula	*when strongly heated in oxygen*
A	SiC	burns, giving a solid residue only
B	SiC	burns, giving a solid residue and a colourless gas
C	Si_2C	burns, leaving no solid residue
D	SiC_2	burns, giving a solid residue and a colourless gas

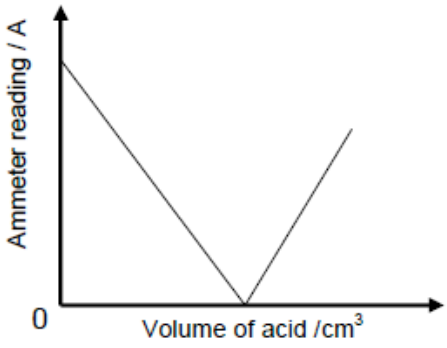
6 In an experiment, excess of 0.100 mol/dm^3 dilute sulfuric acid was added to 25.0 cm^3 of 0.100 mol/dm^3 aqueous barium hydroxide as shown in the diagram below.



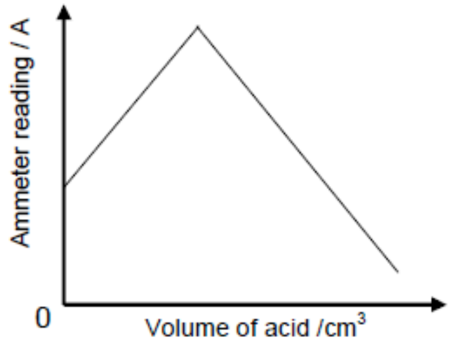
The acid was added from the burette in portions of 5 cm^3 until 40 cm^3 of the acid was added. After each addition, the solution was stirred and the ammeter reading was noted.
Which one of the following graphs correctly represents the relationship between the ammeter reading and the volume of acid added?



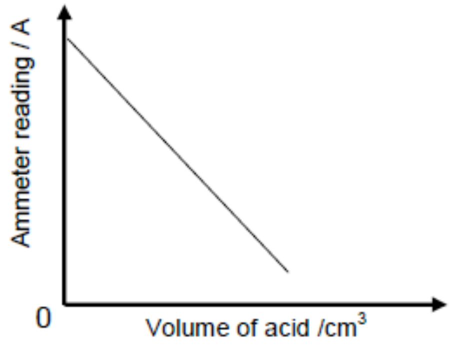
A



B



C



D

7 Naturally occurring iridium has a relative atomic mass of 192.2 and consists of two isotopes, ${}^{191}_{77}\mathrm{Ir}$ and ${}^{193}_{77}\mathrm{Ir}$. The percentage of the lighter isotope is

A 80%

B 60%

C 40%

D 20%

8 1 mole of an organic compound requires 3 moles of oxygen gas for complete combustion to form carbon dioxide and water.

What could be the formula of the compound?

A CH_3CHO

B CH_3CH_2OH

C CH_3CH_3

D CH_3CO_2H

9 20 cm^3 of an aqueous 1.0 mol/dm^3 solution of the hydroxide of metal X, exactly neutralises 40 cm^3 of aqueous 0.5 mol/dm^3 sulfuric acid.

What is the formula for the sulfate of X?

A $\mathbf{X}_2SO_4$

B $\mathbf{X}SO_4$

C $\mathbf{X}_2(SO_4)_3$

D $\mathbf{X}(SO_4)_2$

10 Zinc oxide is produced by heating zinc carbonate.

$$ZnCO_3 \rightarrow ZnO + CO_2$$

What is the percentage yield of zinc oxide if 125 g of zinc carbonate on heating produces 75 g of zinc oxide?

A $125 \times \frac{81}{75} \times 100$

B $125 \times \frac{75}{81} \times 100$

C $\frac{81}{75} \times 100$

D $\frac{75}{81} \times 100$

11 Rubidium, Rb, is an element in the same group of the Periodic Table as lithium, sodium and potassium.

Which statement about rubidium is likely to be correct?

A It forms a dichromate(VI) $Rb_2Cr_2O_7$.

B It forms an insoluble hydroxide.

C It is produced during the electrolysis of aqueous rubidium chloride.

D It reacts slowly with cold water.

12 When solid Y was added to dilute sulfuric acid, effervescence was observed and a colourless solution was obtained. When solid Y was warmed with aqueous sodium hydroxide and potassium nitrate, a pungent gas which turned damp red litmus blue was evolved. What could Y be?

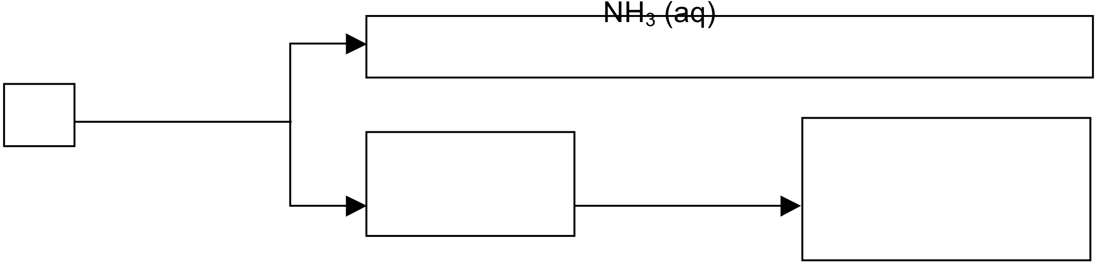
A Copper

B Zinc

C Aluminum

D Aluminium carbonate

13 The flow chart below shows the reaction of compound **X**.



What can compound **X** possibly be?

A aluminium carbonate

B calcium carbonate

C lead (II) sulfate

D zinc carbonate

14 Zinc is heated in oxygen. The product obtained is yellow when hot and white when cold.
Which of the following will neutralise the product?

I aqueous sodium hydroxide

II dilute hydrochloric acid

III dilute sulfuric acid

A I only

B II only

C II and III only

D I, II and III

15 A salt has the chemical formula $(NH_4)_2Fe(SO_4)_2.12H_2O$. Excess aqueous sodium hydroxide was added slowly, with shaking, to a hot aqueous solution of the salt in a boiling tube until there is no further reaction. The boiling tube was then left to stand for some time.

Which observation will **not** be observed?

A A green precipitate was produced.

B A precipitate formed which dissolved in excess aqueous sodium hydroxide.

C A strong smelling gas was produced which turned damp red litmus paper blue.

D The precipitate slowly turned brown.

16 The mass of an iron strip decreased from 10 g to 8 g after being placed in a beaker of solution X for some time. The mass of an identical iron strip remained the same after being placed in a beaker of solution Y for the same amount of time. Predict the identity of the solutions X and Y.

	X	**Y**
A	Copper(II) sulfate	Lead (II) nitrate
B	Calcium chloride	Zinc sulfate
C	Silver nitrate	Magnesium sulfate
D	Sodium chloride	Copper(II) chloride

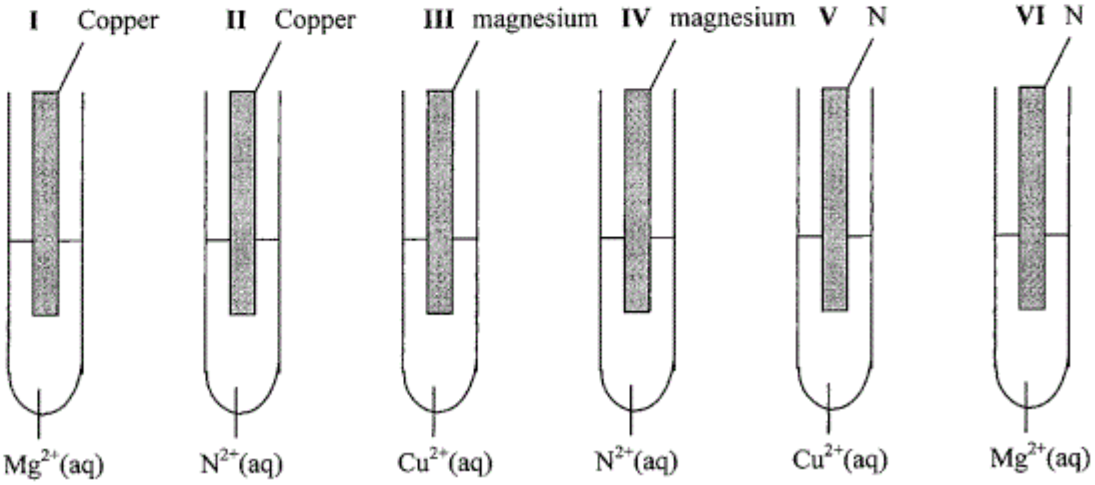
17 N is an unknown metal.

A student did the following experiments to compare the reactivity of magnesium, copper and metal N.

Six tubes were arranged as shown in the diagrams below. Each tube contained a piece of metal half immersed in an aqueous solution containing ions of one of the other two metals. The following observation were made:

There was a deposit seen in only three tubes including tube V.

There was no deposit in tube VI.



Which of the two tubes, besides tube V contain a deposit?

A **I** and **II**

B **II** and **III**

C **II** and **IV**

D **III** and **IV**

18 Which of following reactions does **not** occur in a blast furnace in the extraction of iron?

A $CaO + CO_2 \rightarrow CaCO_3$

B $CaO + SiO_2 \rightarrow CaSiO_3$

C $CO_2 + C \rightarrow 2CO$

D $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

19 Which of the following metals requires the **least** energy to be extracted from its ore?

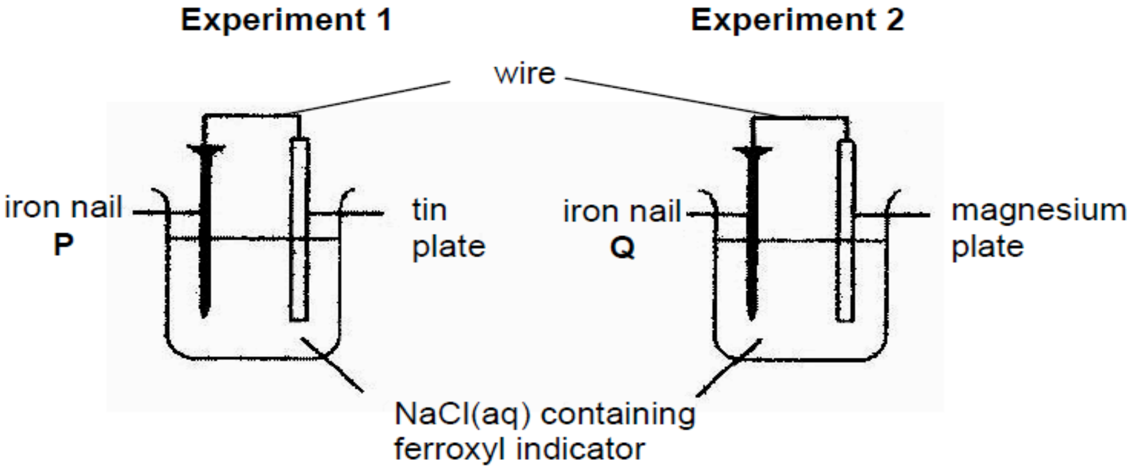
A copper

B iron

C lead

D zinc

20 A student carried out two experiments to investigate the rusting of iron. Ferroxyl indicator turns blue when Fe^{2+} ions are present.



After a short while, what would be observed?

A Blue colour does not appear at both **P** and **Q**.

B Blue colour appears around **Q** but not around **P**.

C Blue colour appears at both **P** and **Q**.

D Blue colour appears around **P** but not around **Q**.

21 Which one of the following changes is endothermic?

A $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

B $HCl + NaOH \rightarrow NaCl + H_2O$

C $CH_4 + 2O_2 \rightarrow 2H_2O + CO_2$

D $2H \rightarrow H_2$

22 Hydrogen reacts with chlorine according to the equation below.

$$H_2 + Cl_2 \rightarrow 2HCl \qquad \Delta H = -184 \text{ kJ/mol}$$

The H-H bond energy is 436 kJ/mol and the Cl-Cl bond energy is 242 kJ/mol.

What is the H-Cl bond energy?

A 862 kJ/mol

B 678 kJ/mol

C 431 kJ/mol

D 247 kJ/mol

23 In which reaction is the pressure **least** likely to affect the rate of the reaction?

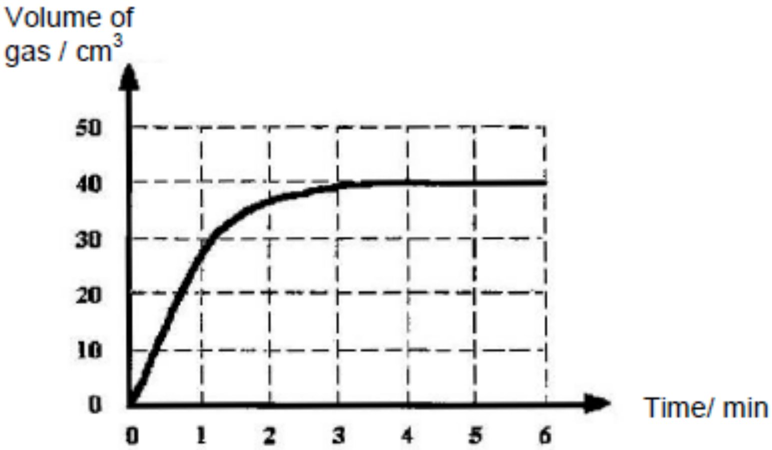
A $C(s) + CO_2(g) \rightarrow 2CO(g)$

B $2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$

C $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

D $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$

24 The rate of reaction between pieces of zinc and 1.0 mol/dm^3 hydrochloric acid was investigated. The total volume of gas produced every minute was recorded over a period of time. The zinc had completely reacted in the reaction and the results are shown in the graph below.



What would be expected if the experiment was repeated using the same mass of zinc and the same volume of 2.0 mol/dm^3 hydrochloric acid?

	Maximum volume of gas produced	Time at which maximum volume is obtained
A	40 cm^3	less than 4 minutes
B	40 cm^3	longer than 4 minutes
C	80 cm^3	less than 4 minutes
D	80 cm^3	longer than 4 minutes

25 The reaction represented by the equation below occurs by collisions between X_2 and Y_2 molecules.

$$X_2\,(g) + Y_2\,(g) \rightarrow 2XY\,(g)$$

Which of the following statement(s) is/are correct about this reaction?

I: All collisions between X_2 and Y_2 molecules produce XY molecules.

II: The frequency of collisions is increased by raising the concentration of X_2 and Y_2 molecules in the reaction mixture.

III: The frequency of collisions is unaffected by raising the pressure exerted on the reaction mixture.

IV: The frequency of collisions is increased markedly by even a small rise in the temperature of the reaction mixture.

A **IV** only

B **II** and **IV** only

C **I** and **III** only

D **I**, **II** and **III** only

26 Which statement best explain why coal dust forms an explosive mixture with air?

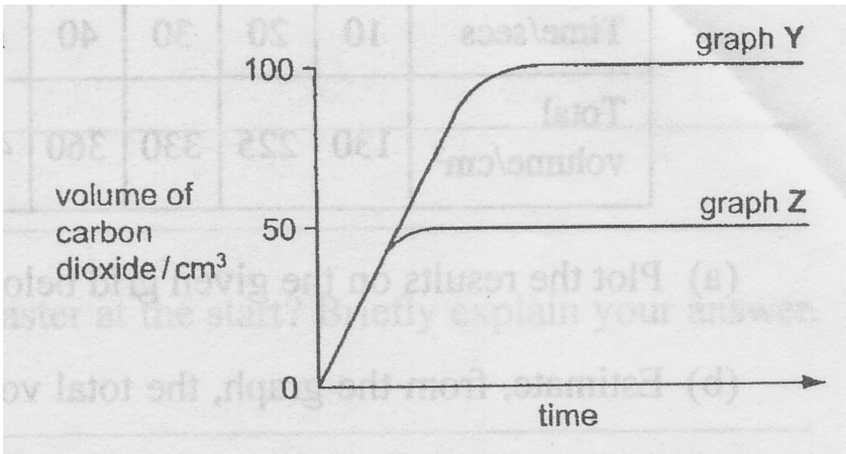
A Coal dust catalyse the explosion.

B Crushing coal breaks chemical bonds.

C Coal dust have a large surface area.

D Crushing coal releases hydrogen from compounds in coal.

27 Some crystals of sodium carbonate were added to an excess of sulfuric acid at room temperature. The volume of carbon dioxide produced was measured over a period of time. The results are shown in graph **Y**. The experiment was repeated and graph **Z** was obtained.



Which one of the following changes was made to obtain the results shown in graph **Z**?

A Acid of half the original concentration was used.

B A lower temperature was used.

C Half the amount of sodium carbonate was used.

D Larger crystals of sodium carbonate were used.

28 Which of the following pairs of compounds react together to produce ammonia?

1. solid calcium nitrate, solid lead(II) hydroxide and aluminium foil
2. solid calcium nitrate, aqueous sodium hydroxide and aluminium foil
3. solid ammonium sulfate and aqueous calcium hydroxide
4. solid ammonium sulfate and aqueous calcium nitrate

A 1 and 2 only

B 1 and 4 only

C 2 and 3 only

D 3 and 4 only

29 Which reaction does not involve oxidation and/or reduction?

A $Cl_2 + 2Br^- \rightarrow 2Cl^- + Br_2$

B $Ag^+ + Cl^- \rightarrow AgCl$

C $Mg + 2HCl \rightarrow MgCl_2 + H_2$

D $2Na + Cl_2 \rightarrow 2NaCl$

30 A portion of acidified potassium manganate (VII) solution was added to a sample of solution X.

Solution X decolourised the potassium manganate(VII) solution. The resulting solution Y was brown. When starch solution is added to a sample of solution Y, the solution turned dark blue.

What conclusion can be drawn about solution **X**?

A It is a reducing agent and it contains bromide ions.

B It is a reducing agent and it contains iodide ions.

C It is an oxidising agent and it contains bromide ions.

D It is an oxidising agent and it contains iodide ions.

31 When dilute aqueous sodium chloride is electrolysed between platinum electrodes,

A sodium is produced at the cathode.

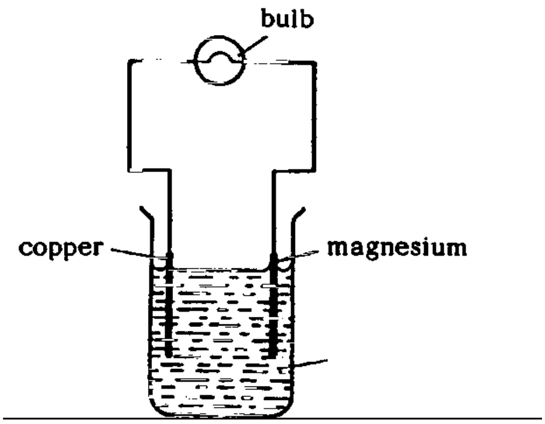
B the mass of the anode decreases.

C the concentration of sodium chloride increases.

D the pH of the electrolyte decreases.

Dilute sulfuric acid

32 The apparatus shown in the diagram below was set up.



Which one of the following represents the correct half equation taking place at the positive and negative electrode respectively for the above set up?

	Positive Electrode	**Negative Electrode**
A	$2H^+ + 2e \rightarrow H_2$	$Mg \rightarrow Mg^{2+} + 2e$
B	$Cu^{2+} + 2e \rightarrow Cu$	$Mg \rightarrow Mg^{2+} + 2e$
C	$4OH^- \rightarrow 2H_2O + O_2 + 4e$	$Mg^{2+} + 2e \rightarrow Mg$
D	$Cu \rightarrow Cu^{2+} + 2e$	$2H^+ + 2e \rightarrow H_2$

33 The following quantities of ions were discharged during electrolysis. Which of the following options required the passage of the largest quantity of electricity?

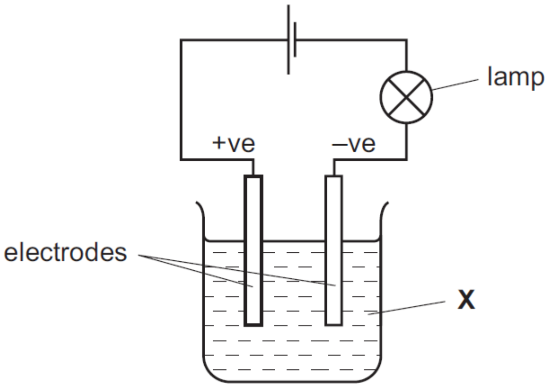
A 1 mole of Cu^{2+} ions

B 2 moles of Al^{3+} ions

C 2 moles of Br^- ions

D 4 moles of OH^- ions

34 In the following experimental set up, the lamp lights up, but there are no decomposition products at the electrodes.



What is **X**?

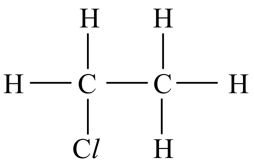
A aqueous sodium chloride

B bromine

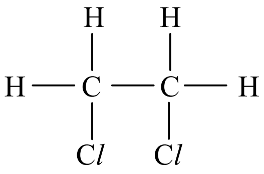
C molten sodium chloride

D mercury

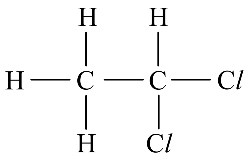
35 The structures of three compounds are shown below.


$H-C(H)(Cl)-C(H)(H)-H$

1


$H-C(H)(Cl)-C(H)(Cl)-H$

2


$H-C(H)(H)-C(H)(Cl)-Cl$

3

Which compound(s) can be product(s) of addition reaction of ethene with chlorine?

A 1 only

B 2 only

C 2 and 3 only

D 1, 2 and 3

36 The general formula for alkene is C_nH_{2n}.

Which physical property does **not** increase as n increases?

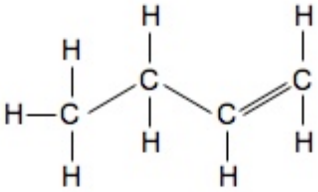
A boiling point

B density

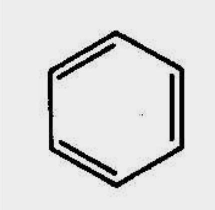
C percentage of carbon by mass

D viscosity

37 The diagram below shows how the structural formula of butene can be simplified:

Usual structural formula of butene	**Simplified version**
	

The simplified structural formula of benzene is shown below:



What is the empirical formula of benzene?

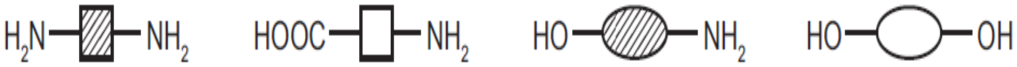
A CH

B CH_2

C CH_3

D CH_4

38 The diagrams show four monomers.



How many of the monomers above would react with the molecule below to form a polymer?

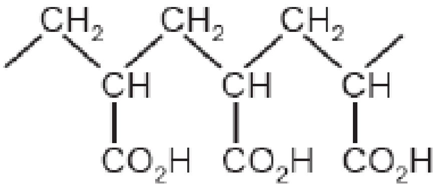
A 1

B 2

C 3

D 4

39 The absorbent material in babies' disposable nappies is made from the polymer shown.



From which monomer could this polymer be obtained?

A $H_2C{=}CHCO_2H$

B $HO_2CCH{=}CHCO_2H$

C $HOCH_2CH_2CO_2H$

D $CH_3CH_2CH_2CO_2H$

40 A food chemist wants to create the fragrance of pineapples for a product. An ester with this fragrance has the formula $C_3H_7CO_2C_2H_5$.

Which pair of reactants would produce this ester?

A propanoic acid and propanol

B ethanoic acid and butanol

C propanoic acid and ethanol

D butanoic acid and ethanol

-----end of paper-----

The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 H hydrogen 1										4 He helium 2
7 Li lithium 3	9 Be beryllium 4											11 B boron 5	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	20 Ne neon 10
23 Na sodium 11	24 Mg magnesium 12											27 Al aluminium 13	28 Si silicon 14	31 P phosphorus 15	32 S sulfur 16	35.5 Cl chlorine 17	40 Ar argon 18
39 K potassium 19	40 Ca calcium 20	45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	55 Mn manganese 25	56 Fe iron 26	59 Co cobalt 27	59 Ni nickel 28	64 Cu copper 29	65 Zn zinc 30	70 Ga gallium 31	73 Ge germanium 32	75 As arsenic 33	79 Se selenium 34	80 Br bromine 35	84 Kr krypton 36
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	– Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54
133 Cs caesium 55	137 Ba barium 56	139 La lanthanum 57 *	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80	204 Tl thallium 81	207 Pb lead 82	209 Bi bismuth 83	– Po polonium 84	– At astatine 85	– Rn radon 86
– Fr francium 87	– Ra radium 88	– Ac actinium 89 †															

*58-71 Lanthanoid series
†90-103 Actinoid series

140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	– Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	162 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
232 Th thorium 90	– Pa protactinium 91	238 U uranium 92	– Np neptunium 93	– Pu plutonium 94	– Am americium 95	– Cm curium 96	– Bk berkelium 97	– Cf californium 98	– Es einsteinium 99	– Fm fermium 100	– Md mendelevium 101	– No nobelium 102	– Lr lawrencium 103

Key

a X b	a = relative atomic mass X = atomic symbol b = proton (atomic) number

NAME	CLASS	INDEX NO.

ST. PATRICK'S SCHOOL
PRELIMINARY EXAMINATIONS 2017

SUBJECT	:	CHEMISTRY 5073 Paper 2	DATE	:	21 Aug 2017
LEVEL	:	SECONDARY 4 EXPRESS	DURATION :		1 HOUR 45 MIN

INSTRUCTIONS TO CANDIDATES:

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO.

1. This paper consists of **Two Sections**: **Section A and Section B.**
2. Answer **all** questions in **Section A** in the spaces provided.
3. Answer all **three** questions in **Section B, the last question is in the form either/or.** Answer **all** questions in **Section B** in the spaces provided.

INFORMATION FOR CANDIDATES:

The number of marks is given in brackets [ ] at the end of each question or part question. A copy of the Periodic Table is provided.

FOR MARKER'S USE ONLY:

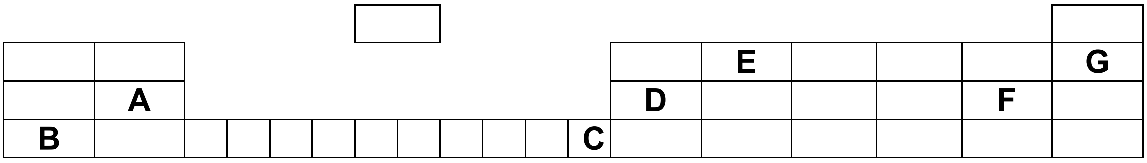
For Examiner's Use Only						
Paper 1 (40 m)	A (50 m)	B (30 m)	Total (120 m)	Percentage	Grade	Target Grade
Teacher's Comments, if any: Parent's Signature						

This question paper consists of 21 printed pages including the Periodic Table.

Section A [50 marks]

Answer all questions in the spaces provided.

A1 The positions of six elements, represented by letters, **A**, **B**, **C**, **D**, **E**, **F** and **G** are shown in the Periodic Table below. These letters **A**, **B**, **C**, **D**, **E**, **F** and **G** **are not** symbols of elements in the Periodic Table.



Use the letters **A**, **B**, **C**, **D**, **E**, **F** and **G** to answer the following questions. You may use each letter once, more than once or none at all.

(a) An element which combines with **F** to form a very volatile compound. [1]

____

(b) An element which has an insoluble hydroxide that is soluble in excess sodium hydroxide to form a colourless solution. [1]

____

(c) An element which is the strongest reducing agent. [1]

____

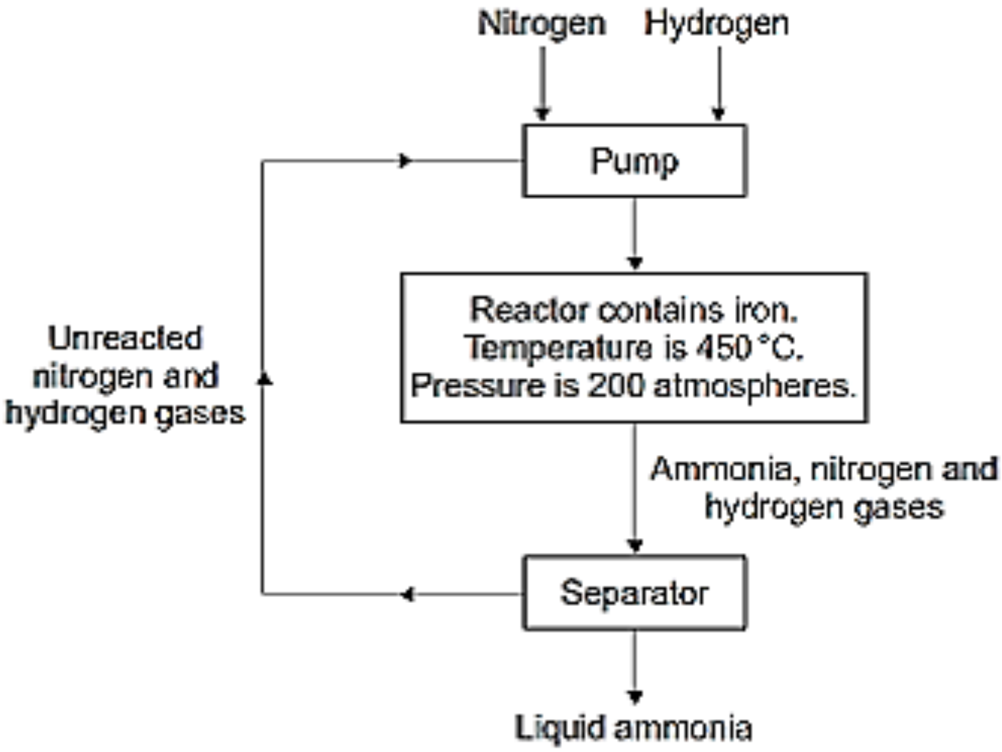
(d) An element which is chemically unreactive. [1]

____

(e) An element that can be obtained by heating its oxide with coke. [1]

____

A2 The figure below shows how ammonia is manufactured by the Haber process.



(a) Complete the table below about the gases used in the Haber Process. [2]

Gas	source	obtained by
nitrogen		fractional distillation
hydrogen	crude oil	

(b) Ammonia is used to produce nitrogenous fertilisers such as ammonium nitrate which is a source of nitrogen needed by the crops. Fertilisers like ammonium nitrate are added to the soil to increase crop yield.

Read the information given below on how to increase the crop yield with respect to using ammonium nitrate.

- Calcium carbonate may be added to reduce the acidity of a fertilised soil.
- Avoid adding calcium hydroxide to recently fertilised soil.

Explain why calcium carbonate may be added to fertilised soil to reduce the soil's acidity but adding calcium hydroxide to recently fertilised soil to reduce the soil's acidity should be avoided. [2]

A3 The reactivity of metals can be compared by their reactions with water, steam and displacement reactions. Some data of the experiments are recorded in table below.

metals	**displacement reactions**	**reaction with water and steam**	**observations during reaction with steam**
mercury	mercury does not displace any of the other metals	has no reaction with steam	silvery metal remains unchanged
magnesium	$Mg + Zn(NO_3)_2 \rightarrow Mg(NO_3)_2 + Zn$	reacts slowly with cold water but burns in steam	grey solid turns white
nickel	$Ni + Hg(NO_3)_2 \rightarrow Ni(NO_3)_2 + Hg$	has no reaction with water, reacts slowly with steam	silvery solid turns green
zinc	$Zn + Ni(NO_3)_2 \rightarrow Zn(NO_3)_2 + Ni$	has no reaction with water, reacts slowly with steam	grey solid turns yellow when hot

(a) From table above, arrange the metals in ascending order of their chemical reactivity. [1]

____

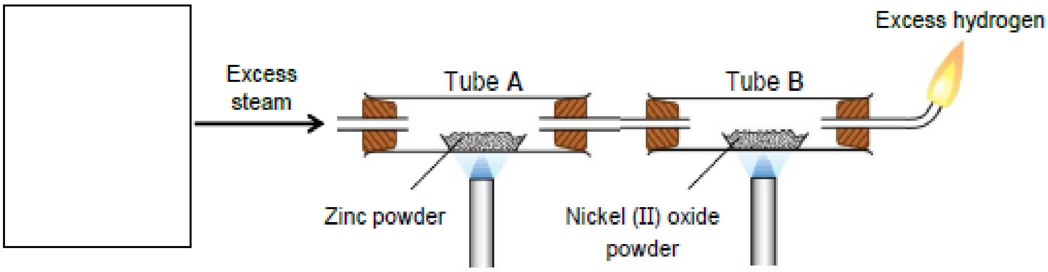
(b) **(i)** Solutions containing nickel(II) ions are usually green. What would you expect to see if magnesium is added to nickel(II) nitrate solution? [1]

____

(ii) Write an ionic equation, with state symbols, for the reaction in **(b)(i)**. [2]

____

(c) The figure below shows an apparatus set up where steam was first passed into tube A and zinc and the nickel(II) oxide were then heated.



(i) Write a balanced chemical equation with state symbols, for the reaction that occurs in tube **A**. [2]

____

(ii) Nickel lies in between iron and lead in the reactivity series. What would you observe in tube **B**? Explain your answer. [2]

____

____

____

A4 Haematite is an iron ore which is mainly made up of iron(III) oxide. The process of extracting iron from haematite occurs in a blast furnace.

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

(a) 2000 g of haematite was used to produce 1300 g of iron. Find the percentage purity of iron(III) oxide in haematite. [2]

(b) There are a number of reactions occuring in the blast furnace. Write a balanced chemical equation with state symbols, for the reaction which is a thermal decomposition reaction. [2]

____

(c) State the **chemical name** of the main molten waste product from the extraction of iron from haematite. [1]

____

A5 A toilet detergent contains the acid salt - sodium dihydrogen phosphate, NaH_2PO_4. Sodium dihydrogen phosphate can be made by reacting sodium hydroxide solution with dilute phosphoric acid, H_3PO_4.

(a) Explain why sodium dihydrogen phosphate is both an 'acid' and a salt. [2]

____

____

____

____

(b) Suggest the chemical formula of another possible salt formed from sodium hydroxide solution and dilute phosphoric acid. [1]

____

A6 A student found a solid sample of ammonium carbonate in a laboratory. The following steps were carried out. Record the observations in the table below including the test for gas (if any). [5]

Step	Observations and test for gas (if any)
1. Aluminium foil and aqueous sodium hydroxide were added to an aqueous solution of the solid sample and warmed.	
2a. Excess hydrochloric acid was added to the solid sample to form solution G.	
2b. Silver nitrate solution was added to a portion of solution G.	

A7 A student carried out an experiment to investigate the relationship between the mass of zinc used in a reaction and the volume of hydrogen gas liberated.
In the experiment he added pieces of zinc to 50 cm^3 of hydrochloric acid and recorded the volume of the gas collected. The table shows the student's results.

mass of zinc /g	volume of hydrogen collected / cm^3
0.1	33
0.2	66
0.3	99
0.4	132
0.5	165
0.6	198
0.7	225
0.8	225

The reaction of zinc and hydrochloric acid is

$$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$$

(a) **(i)** Using the equation, calculate the theoretical volume of hydrogen liberated when 0.5 g of zinc was used. [2]

(ii) Using information from the table, suggest why the answer in **a (i)** is different from the one obtained in the experiment assuming that there is no loss in gas collected. [1]

____

____

(b) Suggest why the volume of the hydrogen collected is different for 0.1 g to 0.6 g of zinc but remains the same for 0.7 g and 0.8 g. [2]

____

____

____

____

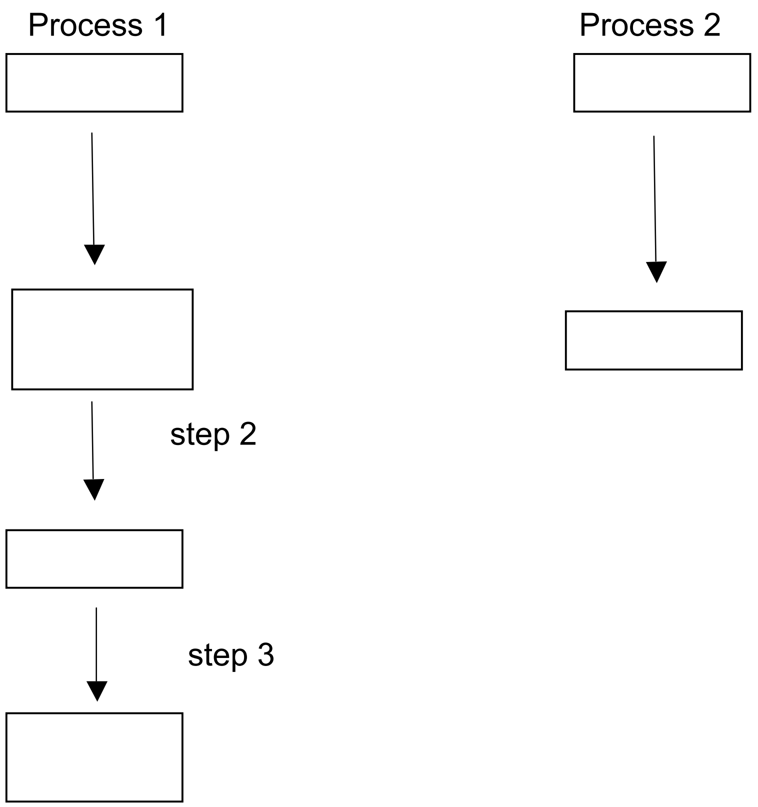
(c) Using information from the table, calculate the concentration of the acid used in this experiment. [3]

(d) The experiment was repeated using hydrochloric acid which was warmed to 60ºC. Using the collision theory explain why a shorter time was observed to collect the hydrogen gas. [2]

ethanol
petroleum
petroleum Step 1
fractions fractional
distillation

glucose fermentation
ethanol

A8 Ethanol can be manufactured by two processes. The flowcharts outline the sequence of steps for producing ethanol.



(a) Name the process in step 2 [1]

____

(b) State 2 conditions for step 3. [2]

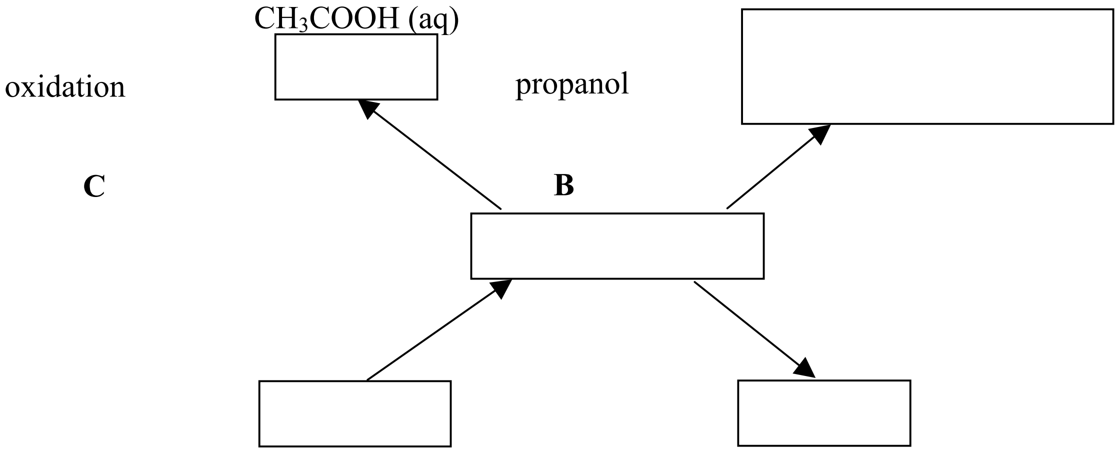
____

____

D CH_3COONa (aq) +
H_2O(l) + CO_2 (g)

NaOH(aq) **A**

A9 Four reactions of ethanoic acid CH_3COOH, are shown below.



(a) Name substance **A** that is added to ethanoic acid. [1]

____

(b) Name substance **B** and the catalyst in the spaces below. [2]

Substance B ____

Catalyst____

(c) Name substance **C**, and state the reagents and/or condition(s) for the oxidation reaction that **C** undergoes in the laboratory to form ethanoic acid. [2]

____

____

(d) Write the balanced chemical equation, including state symbols, for the formation of substance **D**. [2]

____

End of Section A

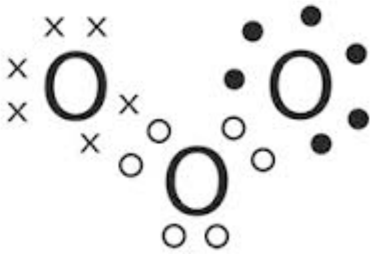
Section B (30 marks)

Answer **ALL 3** questions from this section.

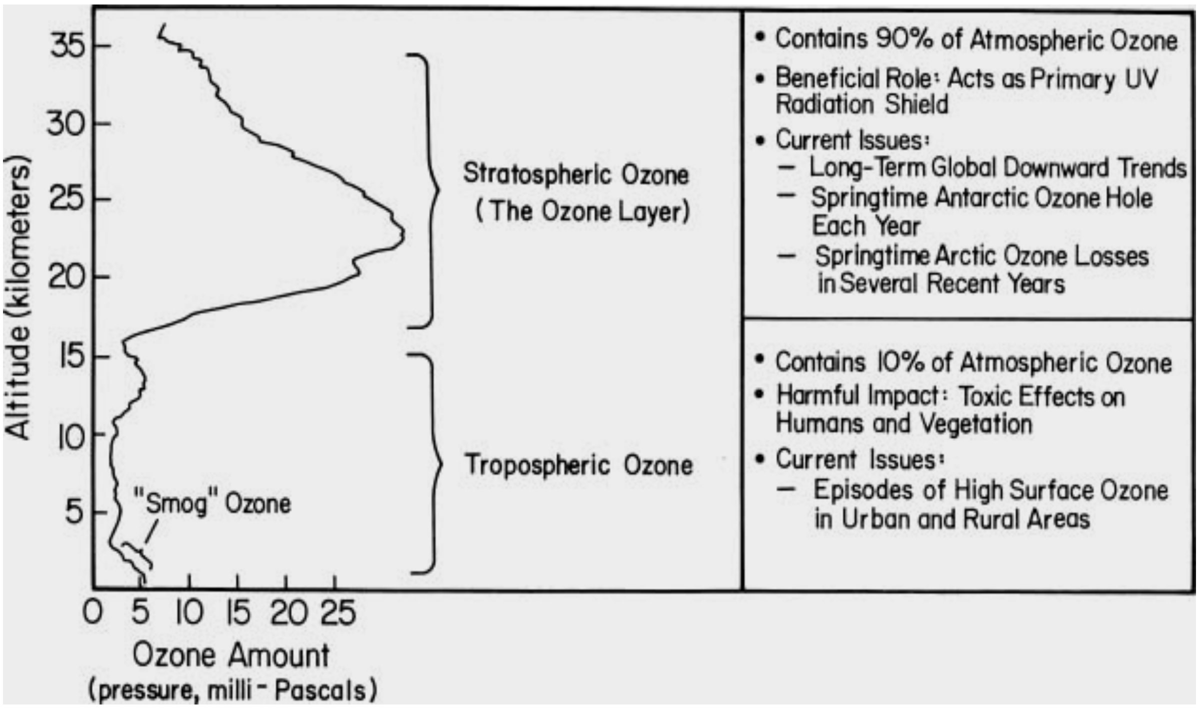
The last question is in the form of an either/or and only one of the alternatives should be attempted.

B10 Ozone, O_3 is a much less stable triatomic form of oxygen.

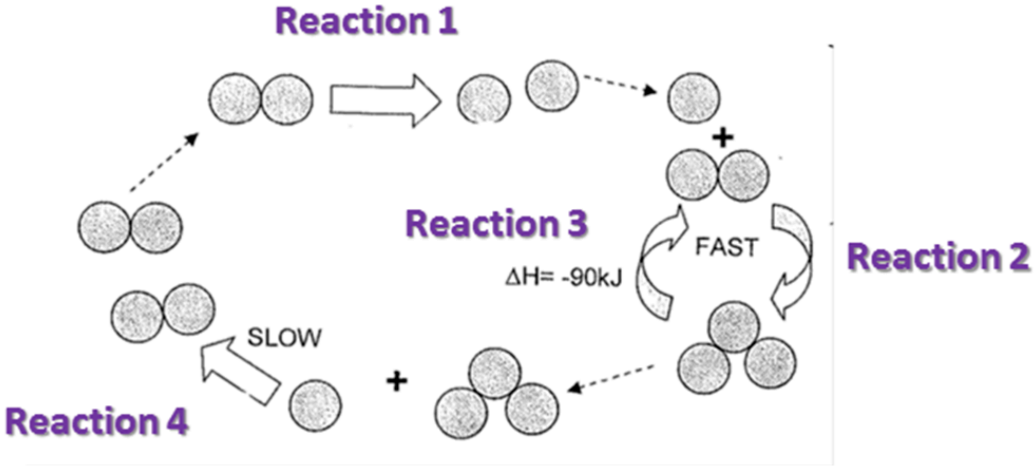
The diagram below shows the bonding in ozone molecules.



It is a pale blue gas present at low concentrations throughout the atmosphere (around 0.375 parts per million for O_3 compared to 21% for O_2).
In the troposphere, ozone is an air pollutant which can damage the respiratory systems of humans and other animals. The ozone in the stratosphere however is beneficial.
The diagram below shows how the concentration of ozone varies in the troposphere and stratosphere.



Ozone is formed as part of a natural cycle similar to nitrogen and carbon cycle. The first step in the formation of ozone is the decomposition of an oxygen molecule into two atoms by low energy ultraviolet (UV) light (reaction 1). The higher the altitude, the faster is this reaction. Each of these oxygen atoms can combine with another oxygen molecule to form an ozone molecule (reaction 2). The rate of reaction 2 is faster where the pressure is higher. The ozone molecule formed absorbs UV radiation and splits to form an oxygen atom and oxygen molecule which produces a lot of heat (reaction 3). For every mole of ozone that splits up, 90 kJ of energy is given off. Reactions 2 and 3 rapidly interconvert oxygen atoms and ozone. There is another slow reaction, though, which is known to destroy both oxygen atoms and ozone (reaction 4).
Reactions 1 to 4 are summarised in the figure below.



dotted arrow ------> indicates a molecule or an atom from one reaction goes on to take part in another reaction
solid arrow ⟹ indicates reactions
● - indicate one oxygen atom

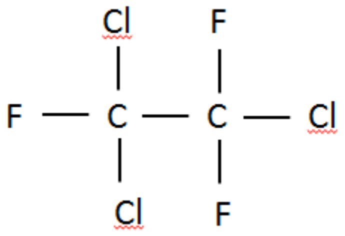
Chlorofluorocarbons, CFCs, destroy ozone in the upper atmosphere. Once the CFC vapour reaches the upper atmosphere the following reactions occur in order.

Reaction 5: CFC + UV light → CFC fragment + Cl

Reaction 6: $Cl + O_3 \rightarrow ClO + O_2$

Reaction 7: $ClO + O \rightarrow Cl + O_2$

One example of CFC is the compound CFC 113. CFC 113 is an inert, synthetic compound used in the electronics industry. The figure shows the structure of CFC 113 below.



$$F - \underset{Cl}{\overset{Cl}{C}} - \underset{F}{\overset{F}{C}} - Cl$$

Some data about the bond strength in these molecules are given below.

Bond	bond strength/ kJ per mole
C – Cl	330
C – C	346
C – F	450
C – H	412

(a) Calculate the percentage of ozone in the atmosphere. [1]

(b) At which altitude is the rate of ozone formation maximum? [1]

____

(c) With the help of information provided, suggest why the stratosphere is a warmer layer than the troposphere. [2]

____

____

____

____

(d) Which two reactions, 5, 6 or 7, when taken together are equivalent to reaction 4 which destroys the ozone and oxygen atoms? [1]

____

(e) The energy of the UV light is equivalent to 400 kJ per mole.

(i) When CFC 113 is decomposed by UV light, are chlorine atoms or fluorine atoms formed? Explain. [2]

____

____

____

____

(ii) Suggest a further bond change you would expect to occur in CFC 113 molecule. [1]

____

____

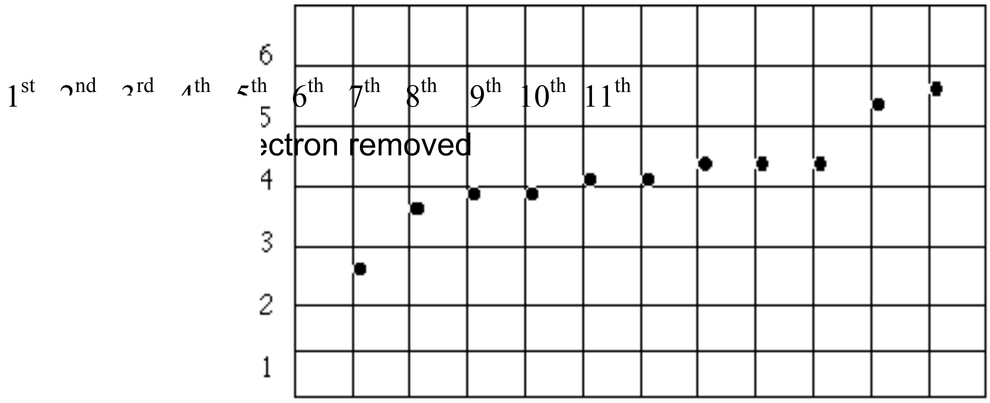
(f) The formation of ozone in the upper atmosphere can be represented by a single equation shown below. [1]

$$3O_2\,(g) \rightarrow 2O_3\,(g)$$

What is the value for enthalpy change for the reaction shown?

(g) Draw the full structural formula for ozone molecule. [1]

B11 **(a)** The ionization energy of an atom describes the minimum amount of energy required to remove an electron (to infinity) from an atom.
The data below shows a plot of ionisation energy against the number of the electron removed for sodium.



Use the information above to explain the trend in ionisation energy for sodium with reference to its electronic structure. [3]

____

____

____

____

____

____

(b) The table below shows the first ionization energy (energy required to remove the first electron from the atom) of elements in Period 3.

element	Na	Mg	Al	Si	P	S	Cl	Ar
first ionisation energy/ kJ /mol	496	738	577	786	1060	1000	1256	1520
formula of the hydride of the element	NaH	MgH_2	AlH_3			H_2S	HCl	

(i) Complete the table above by filling in the formulae of the 2 hydrides. [1]

(ii) Explain why there is a great difference in the first ionization energy of sodium and argon. [2]

____

____

____

____

(iii) Draw a 'dot and cross' diagram to show the bonding in sodium hydride. You need to show **all** the electrons. [2]

(iv) Suggest one similarity and one difference in physical property between sodium hydride and hydrogen chloride. [2]

Similarity:____

____

____

Difference:____

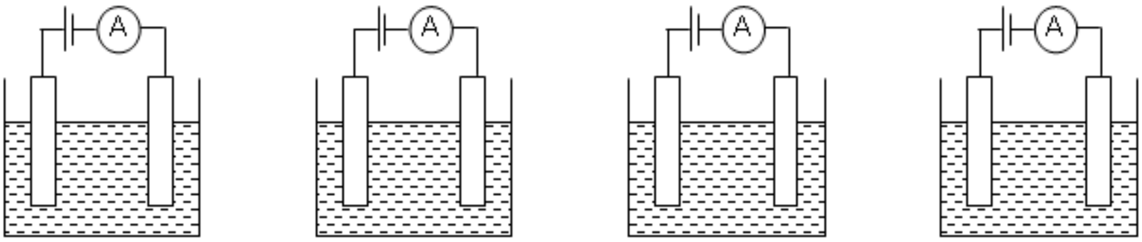
____

____

Cell 1	Cell 2	Cell 3	Cell 4
molten sodium chloride	concentrated sodium chloride solution	dilute sodium chloride solution	dilute copper(II) chloride solution

EITHER

B12 The diagrams show the electrolysis of four different electrolytes, using graphite electrodes.



(a) Explain why sodium metal can be extracted from molten sodium chloride solution using **Cell 1**. [1]

____

____

(b) The gases produced at the electrodes in **Cell 2** and **Cell 3** are collected and their volumes are measured.

(i) Name the gas formed at the anode of **Cell 3** and describe a test to identify the gas. [1]

____

____

____

(ii) Explain why the gases collected at the anode in **Cells 2** and **Cell 3** are different. [2]

____

____

____

____

____

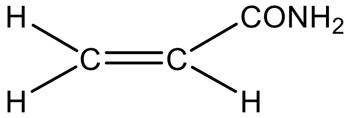
(iii) The volume of gas collected at the cathode in **Cell 3** is twice the volume of gas collected at the anode. By giving equations for the reactions that take place at the two electrodes, explain why this is so. [2]

(c) **(i)** Explain what happens to the ions as they arrive at the cathode in **Cell 4**. [2]

(ii) Explain why the reading of the current meter in **Cell 4** decreases when a few drops of lead (II) nitrate solution were added to the electrolyte. [2]

OR

B12 In 2002, Swedish scientists found high levels of acrylamide in starchy foods that had been cooked above 120 °C. Acrylamide, which is thought to be toxic to human health, has the following structure as shown in the figure below.



(a) Acrylamide polymerises to polyacrylamide. Interestingly, polyacrylamide is non-toxic and is used as an ingredient in a variety of cosmetic and beauty products, including skin cleansers, moisturisers, lotions and creams. Small polyacrylamide beads may also be used in skin cleansing products as an abrasive.

(i) Draw the structure of polyacrylamide. [1]

(ii) What type of polymerisation is this? [1]

____

(iii) Calculate the maximum mass of polyacrylamide that can be made from 13 000 moles of acrylamide. [2]

(iv) A student comments that the percentage by mass of nitrogen in acrylamide is the same as that in polyacrylamide. [2]
Explain why the student is correct.

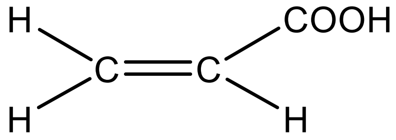
____

____

____

____

(b) Acrylamide reacts with water to form acrylic acid and ammonium ions. The structural formula of acrylic acid is shown in the figure below. It forms compounds called acrylates.



(i) Acrylic acid is a weak acid. [1]
How can Universal Indicator show that acrylic acid is a weak acid?

____

____

(ii) Acrylic acid reacts with ethanol to make an ester. [1]
Draw the structure of this ester.

(iii) Deduce the name of this ester. [1]

____

(iv) Acrylic acid reacts with aqueous bromine. [1]
Draw the structural formula of the product of this reaction.

End of Section B

-----END OF PAPER-----

The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 H hydrogen 1										4 He helium 2
7 Li lithium 3	9 Be beryllium 4											11 B boron 5	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	20 Ne neon 10
23 Na sodium 11	24 Mg magnesium 12											27 Al aluminium 13	28 Si silicon 14	31 P phosphorus 15	32 S sulfur 16	35.5 Cl chlorine 17	40 Ar argon 18
39 K potassium 19	40 Ca calcium 20	45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	55 Mn manganese 25	56 Fe iron 26	59 Co cobalt 27	59 Ni nickel 28	64 Cu copper 29	65 Zn zinc 30	70 Ga gallium 31	73 Ge germanium 32	75 As arsenic 33	79 Se selenium 34	80 Br bromine 35	84 Kr krypton 36
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	– Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54
133 Cs caesium 55	137 Ba barium 56	139 La lanthanum 57 *	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80	204 Tl thallium 81	207 Pb lead 82	209 Bi bismuth 83	– Po polonium 84	– At astatine 85	– Rn radon 86
– Fr francium 87	– Ra radium 88	– Ac actinium 89 †															

*58-71 Lanthanoid series

†90-103 Actinoid series

140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	– Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	162 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
232 Th thorium 90	– Pa protactinium 91	238 U uranium 92	– Np neptunium 93	– Pu plutonium 94	– Am americium 95	– Cm curium 96	– Bk berkelium 97	– Cf californium 98	– Es einsteinium 99	– Fm fermium 100	– Md mendelevium 101	– No nobelium 102	– Lr lawrencium 103

Key

a X b

a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

ST. PATRICK'S SCHOOL
PRELIM EXAMINATIONS 2017

SUBJECT : **CHEMISTRY** **DATE** :

LEVEL : **SECONDARY 4 EXPRESS** **DURATION :**

PAPER 1

1	2	3	4	5	6	7	8	9	10
C	C	A	A	B	B	C	B	B	D

11	12	13	14	15	16	17	18	19	20
A	C	A	D	B	C	D	A	A	D

21	22	23	24	25	26	27	28	29	30
A	C	D	A	B	C	C	C	B	B

31	32	33	34	35	36	37	38	39	40
C	A	B	D	B	C	A	C	A	D

(deduct ½ for wrong unit / not in 3 sig fig – deduct only once per part of a question)

PAPER 2 Section A

					ttl
A1	a		E	1	**5**
	b		C OR D	1	
	c		B	1	
	d		G	1	
	e		C	1	

<table>
<tr><td>A2</td><td>a</td><td></td><td><table><tr><th>gas</th><th>Source</th><th>obtained by</th></tr><tr><td>Nitrogen</td><td>(liquid) air [1]</td><td>fractional distillation</td></tr><tr><td>Hydrogen</td><td>crude oil</td><td>Cracking [1]</td></tr></table></td><td>2</td><td>4</td></tr>
</table>

	b		Calcium carbonate does not react with ammonium nitrate. [1] Calcium hydroxide reacts with ammonium nitrate to produce ammonia which results in the loss of nitrogen. [1]	2	

A3	a		Mercury, nickel, zinc, magnesium	1	**8**
	b	i	Green solution turns colourless OR Silvery solid forms OR Grey magnesium dissolves	1	
		ii	$Mg (s) + Ni^{2+} (aq) \rightarrow Mg^{2+} (aq) + Ni (s)$	2	
	c	i	$Zn(s) + H_2O (g) \rightarrow ZnO (s) + H_2 (g)$	2	
		ii	Silvery solid coated on green solid [1] Green nickel (II) oxide has been reduced by hydrogen to form silvery nickel metal. [1]	2	

A4	a		No of moles of Fe produced: 1300/56 = 23.2 mol moles of Fe : moles of Fe_2O_3 2 : 1 No of moles of Fe_2O_3= 23.2/2 = 11.6mol [1] % purity of Fe_2O_3=[(56 x 2 + 16 x 3) x 11.6]/2000 x 100% = 1856/2000 = 92.8% [1]	2	**5**
	b		$CaCO_3 (s) \rightarrow CaO (s) + CO_2 (g)$	2	
	c		Calcium silicate *(NOT: slag)*	1	

A5	a		It is an acid as it can produce hydrogen ion, H^+, when dissolved in water [1] It is a salt as it is a compound formed from the reaction of an acid and a base [1].	2	**3**
	b		Na_2HPO_4 or Na_3PO_4	1	

A6	Step	Observations and test for gas (if any)	5	**5**
	1. Aluminium foil and aqueous sodium hydroxide were added to an aqueous solution of the solid sample and warmed.	Effervescence/bubbles[0.5] Gas turned damp [0.5]red litmus blue [0.5]		
	2a. Excess hydrochloric acid was added to the solid sample to form solution G	Effervescence/bubbles[0.5] Gas pass through limewater [1] White ppt [1]		
	2b. Silver nitrate solution was added to a portion of solution G.	White ppt [1]		

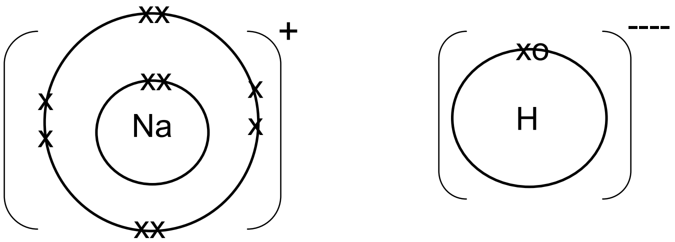
A7	a	i	Moles of 0.5 g of zinc = $\frac{0.5}{65}$ = 0.007692 Mole ratio: 1mole Zn:1 mole H_2 Moles of H_2 = 0.007692 [1] Volume of H_2 = 0.007692 x 24000 = 184.6 cm^3 = 185 cm^3[1] or 0.185 dm^3 (3 sf)	2	**10**
		ii	The zinc samples are impure.	1	
	b		In the experiments when 0.1 g to 0.6 g of zinc were used , zinc is the limiting reagent. Or HCL is in excess[1] From 0.7 g of zinc, HCl is the limiting reagent. Or zinc is in excess [1]	2	
	c		Moles of H_2 = $\frac{225}{24000}$ = 0.009375 [1] Moles of HCl = 0.009375 x 2 = 0.01875 [1] Concentration of HCl = $\frac{1000}{50}$ x 0.01875 = 0.375 mol/dm^3 [1]	3	
	d		increase in frequency of effective collisions [1] increase in kinetic energy/move faster/ more particles that possess the minimum activation energy[1]	2	

A8	a		cracking	1	**3**
	b		heat, 60 atmospheric pressure and phosphoric (V) acid any 2 (1m each)	2	

A9	a		sodium carbonate/sodium hydrogencarbonate	1	**7**
	b		propyl ethanoate [1] concentrated sulfuric acid [1]	2	
	c		Ethanol [1] add acidified potassium manganate(VII),[0.5] reflux/heating [0.5]	2	
	d		$CH_3COOH(aq) + NaOH(aq) \rightarrow CH_3COONa(aq) + H_2O(l)$	2	

PAPER 2 Section B

B10	a		0.375 / 1000 000 x 100 % = 0.0000375 %	1	**10**
	b		23 km (accept 22 to 24)	1	
	c		Energy produced by splitting of ozone [1] Comparison of stratosphere and troposphere – higher conc of ozone, UV shield, faster reaction 3 as pressure lower at higher altitude [1]	2	
	d		Reactions 6 and 7 (both correct)	1	
	e	i	Chlorine atoms [1] The UV light has sufficient energy to break the C-Cl bond(330 kJ/mol) but not able to break the C-F bond (450 kJ/mol) [1]	2	
		ii	The C – C bond will also break.	1	
	f		2 x 90 kJ/ mol = +180 kJ/mol	1	
	g		**O = O – O**	1	

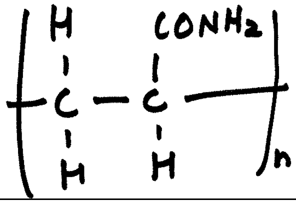
<table>
<tr><td>B11</td><td>a</td><td></td><td>Increase in ionisation energy [1]
Decreasing Distance/shell [1]
Increasing charge [1]</td><td>3</td><td>10</td></tr>
<tr><td></td><td>b</td><td>i</td><td><table><tr><td>Formula of the hydride of the element</td><td></td><td></td><td></td><td>SiH_4</td><td>PH_3</td><td></td><td></td><td>-----</td></tr></table>0.5 mark each</td><td>1</td><td></td></tr>
<tr><td></td><td></td><td>ii</td><td>3rd shell same [0.5]; decreasing atomic radius [0.5]; closer nucleus and electron [0.5]; stronger electrostatic force of attraction for argon [0.5]</td><td>2</td><td></td></tr>
<tr><td></td><td></td><td>iii</td><td>

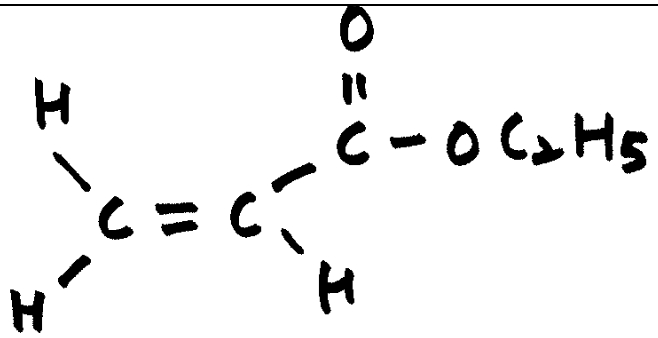
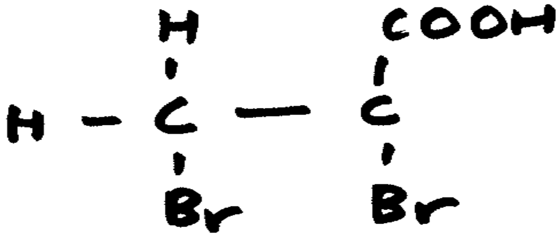
sodium hydride</td><td>2</td><td></td></tr>
<tr><td></td><td></td><td>iv</td><td>Similarity: NaH and HCl are both soluble in water.c [1]
Difference: NaH has high melting point and boiling point/solid
HCl has low melting and boiling point/gas [1]
Must have correct comparison to earn the mark</td><td>2</td><td></td></tr>
</table>

EITHER

B12	a		The molten sodium chloride contains **Na^+ ions** [½],which are the only cations present, and will **accept electrons/be discharged**[½] at the cathode of Cell 1.	1	**10**
	b	i	Oxygen gas [½]. It relights a glowing splint [½].	1	
		ii	Cell 2 contains concentrated sodium chloride. The **chloride ions will be preferentially discharged** [½] as **chlorine gas** [½], instead of the hydroxide ions. Cell 3 contains dilute sodium chloride and the **hydroxide ions are preferentially discharged** [½] instead, forming **oxygen gas** [½].	2	
		iii	Cathode: $2H^+(aq) + 2e \rightarrow H_2(g)$ or $4H^+(aq) + 4e \rightarrow 2H_2(g)$ [½] Anode $4OH^-(aq) \rightarrow 2H_2O(l) + O_2(g) + 4e$ [½] For the same number of electrons [½], the volume of hydrogen gas produced is twice the volume of oxygen gas produced. [½]	2	
	c	i	**H^+ and Cu^{2+} ions** [½] both arrive at the cathode in Cell 4. Since **copper is less reactive than hydrogen in the reactivity series** [½], it will be **preferentially discharged** [½] instead at the cathode, forming **copper metal** [½].	2	
		ii	An insoluble salt of $PbCl_2$ [1] is formed It does not contain delocalised ions [1] to conduct electricity. OR it removes Cl^- ions [1]	2	

OR

B12	a	I		1	**10**
		ii	Addition Polymerisation	1	
		iii	Mr of acrylamide = 12x3 + 5x1 + 16 +14 = 71 [1] Mass of 13 000 moles of acrylamide = maximum mass of polyacrylamide that can be formed = 13 000 x 71 = 923 000 g [1]	2	

		iv	The calculation for both the monomer and polymer is based on the formula of the monomer, same empirical formula [1] There are no other molecules being eliminated or produced OR All the elements in the monomers become the polymer product. [1]	2	
	b	i	When it shows colours of yellow and orange	1	
		ii		1	
		iii	Ethyl acrylate	1	
		iv		1	

XINMIN SECONDARY SCHOOL
新民中学
SEKOLAH MENENGAH XINMIN

Preliminary Examination 2017

CANDIDATE NAME	
CLASS	
INDEX NUMBER	

CHEMISTRY 5073/01

Paper 1 Multiple Choice **28 August 2017**

Secondary 4 Express **1 hour**

Setter: Mr. Kuo Yu Hsuan
Vetter: Mrs. Annie Ng

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, class and index number on the Question Paper and Answer Sheet in the spaces provided.

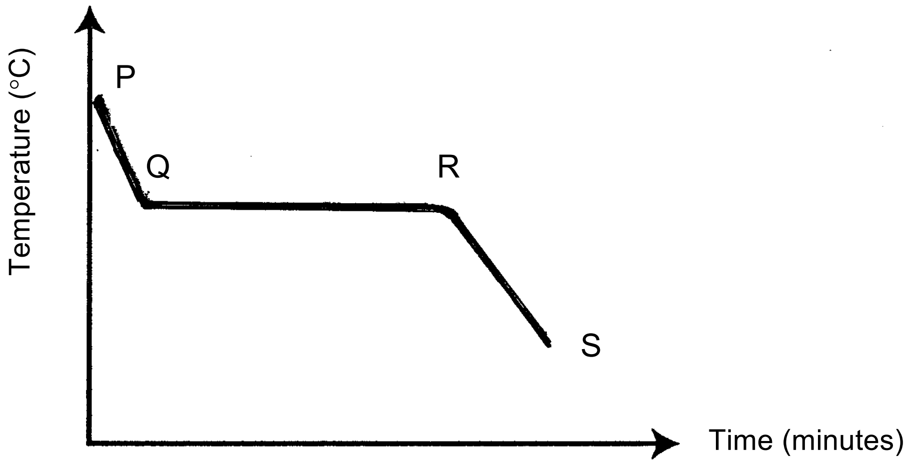
There are **forty** questions in this paper. Answer **all** questions. For each question, there are four possible answers, **A**, **B**, **C**, **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

For Examiner's Use	
Total	/40
Parent's Signature	

1 A sample of solid **X** was heated until it was completely melted. The graph shows how its temperature varies with time as molten **X** is cooled.

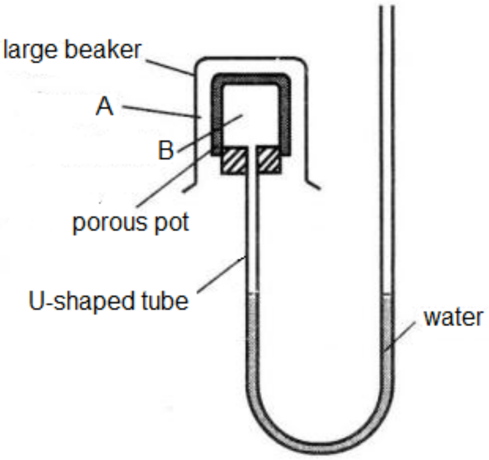


Which of the following statements are **true** about the particles in **X**?

I They are closer to each other at stage RS than at stage PQ.
II The forces of attraction are stronger at stage P than at stage S.
III The arrangement is more orderly at stage RS than at stage PQ.
IV Their total energy content at stage QR is lower than at stage RS.

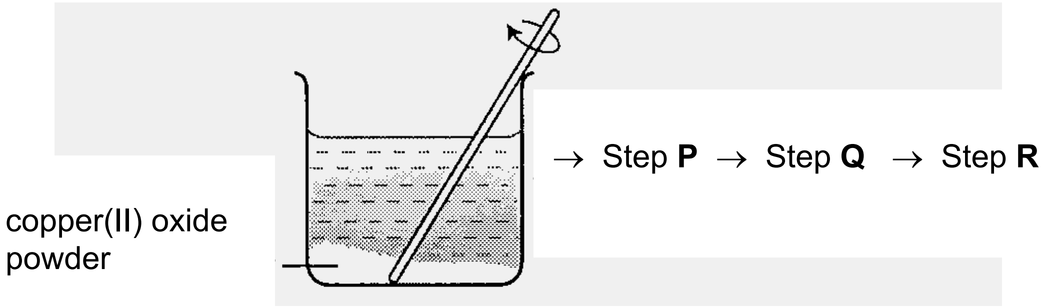
A I and II only are correct.
B I and III only are correct.
C II and III only are correct.
D II and IV only are correct.

2 The following diagram shows a set up. Which pair of gases would cause a fall in the water level at the right side of the U-shaped tube?



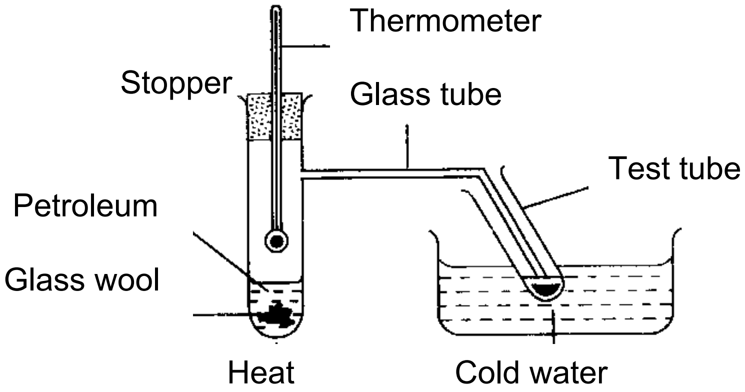
	Gas A	Gas B
A	Nitrogen dioxide	Chlorine gas
B	Carbon Monoxide	Nitrogen gas
C	Oxygen gas	Neon
D	Fluorine gas	Argon

3 The figure below shows excess copper(II) oxide powder after it has dissolved in dilute sulfuric acid. Starting from the beaker, which is the **correct** set of steps to obtain copper(II) sulfate crystals?



	Step **P**	Step **Q**	Step **R**
A	filtration	evaporation	cooling
B	cooling	filtration	evaporation
C	evaporation	cooling	filtration
D	filtration	cooling	evaporation

4 The diagram below shows the experimental set-up for fractional distillation of petroleum. However, there is an error in the set-up.



What is the error?

A The thermometer should be placed at the junction of the glass tube.
B The test-tube should be placed higher up from the cold water.
C The glass wool should be placed above the petroleum.
D The stopper should be removed to prevent pressure from building up.

5 Which of the following statements concerning molecules is **not** correct?

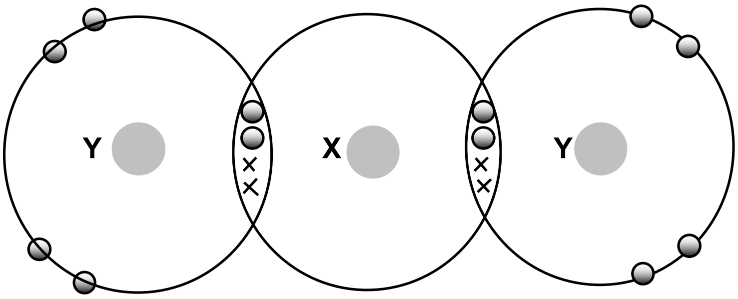
A A molecule can be attracted to another separate molecule with intermolecular forces.
B A molecule always contains two or more atoms from different elements.
C The atoms in a molecule achieve stable valence electron configurations by sharing of electrons.
D Molecules by themselves do not conduct electricity.

[Turn over

6 When magnesium reacts with oxygen to form magnesium oxide, which of the following is **not** true?

A A magnesium atom loses two electrons.
B An oxygen atom gains one electron.
C Forces of attraction between ions of magnesium and oxygen are strong.
D The chemical formula of the compound is MgO.

7 The figure shows the electron arrangement of a molecule of compound **XY**$_2$. (Only the valence electrons are shown).



What are the possible identities of **X** and **Y**?

	X	**Y**
A	carbon	chlorine
B	carbon	oxygen
C	carbon	hydrogen
D	oxygen	carbon

8 Chlorine and oxygen react to form a compound. The compound formed

A has the formula OCl_2.
B will be able to conduct electricity by itself.
C is insoluble in organic solvent.
D has a high melting point.

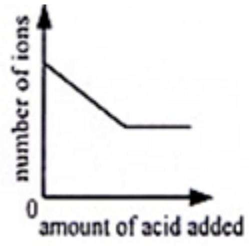
9 A hydrocarbon compound contains 86% carbon and 14% hydrogen by mass. The likely molecular formula is

A CH_4
B C_4H_8
C C_6H_6
D C_8H_{18}

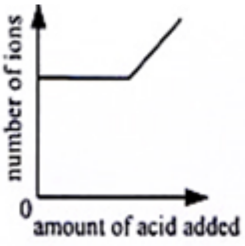
10 If **x** electrons are needed to deposit 108 g of silver from a solution containing silver ions, how many electrons are needed to deposit 27 g of aluminium from a solution containing aluminium ions?

A **x**
B 2**x**
C 3**x**
D 4**x**

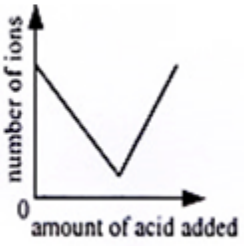
11 Dilute sulfuric acid was added to aqueous barium hydroxide until the acid was in excess. Which graph best represents the variation in the *total number of ions in solution?*



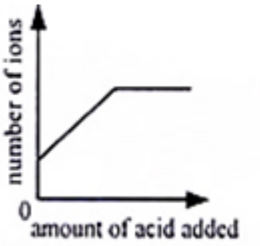
A



B

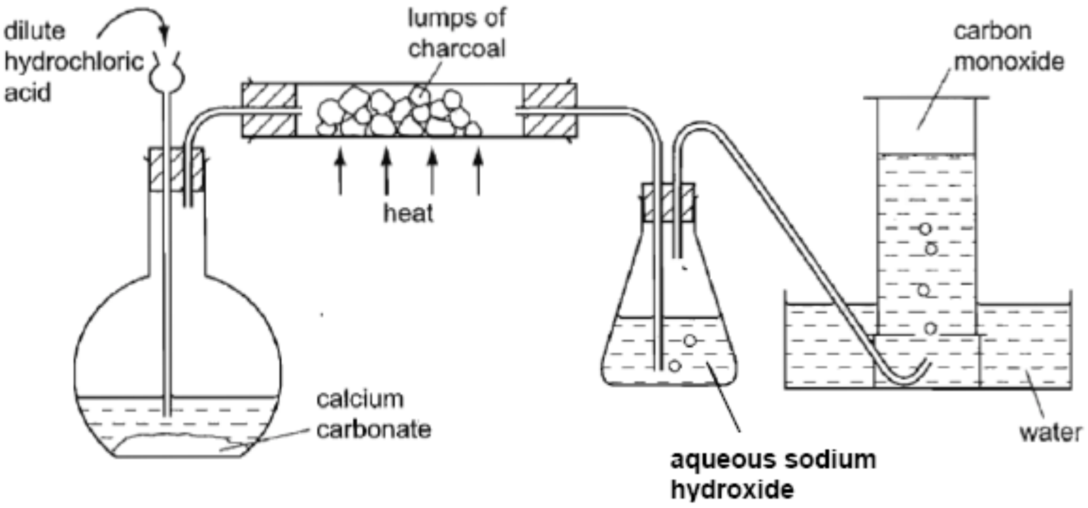


C



D

12 The diagram below is a set-up used to obtain carbon monoxide.



What is the main purpose of the charcoal?

A To remove the oxygen present
B To remove the excess acid
C To reduce the carbon dioxide present
D To remove moisture from the carbon monoxide

13 Substance **X** is mixed with ammonium chloride and heated. The equation below represents part of the reaction.

X + ammonium chloride → ammonia gas

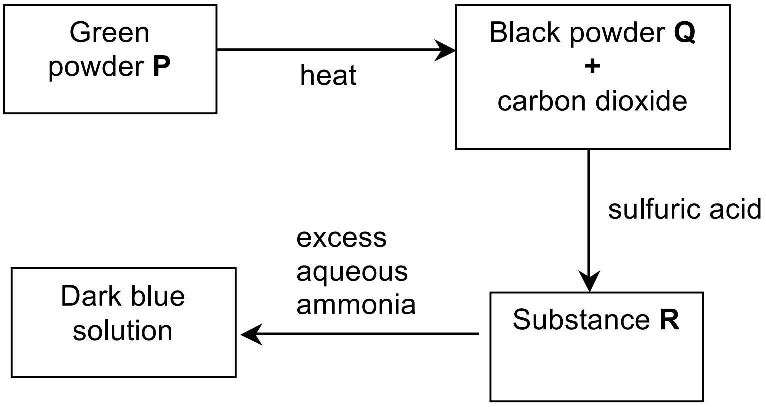
Substance **X** could be:

A sodium metal.
B zinc carbonate.
C calcium hydroxide.
D sulfuric acid.

14 The best substance that can be used to differentiate hydrochloric acid and nitric acid solutions is

A zinc metal.
B barium nitrate solution.
C silver nitrate solution.
D sodium carbonate solution.

15 The diagram below shows a series of tests starting with substance **P**.



Which of the following statements is **true**?

A **P** can react directly with dilute sulfuric acid to give **R**.
B **Q** reacts with acids to liberate hydrogen gas.
C Substance **R** is also green in colour
D **R** forms a green precipitate with aqueous sodium hydroxide.

16 The equation shows the reaction between copper(II) oxide and carbon.

$$2\,CuO\,(s) + C\,(s) \rightarrow 2\,Cu\,(s) + CO_2\,(g)$$

What is the function of the copper(II) oxide in the reaction?

A catalyst
B oxidising agent
C reducing agent
D dehydrating agent

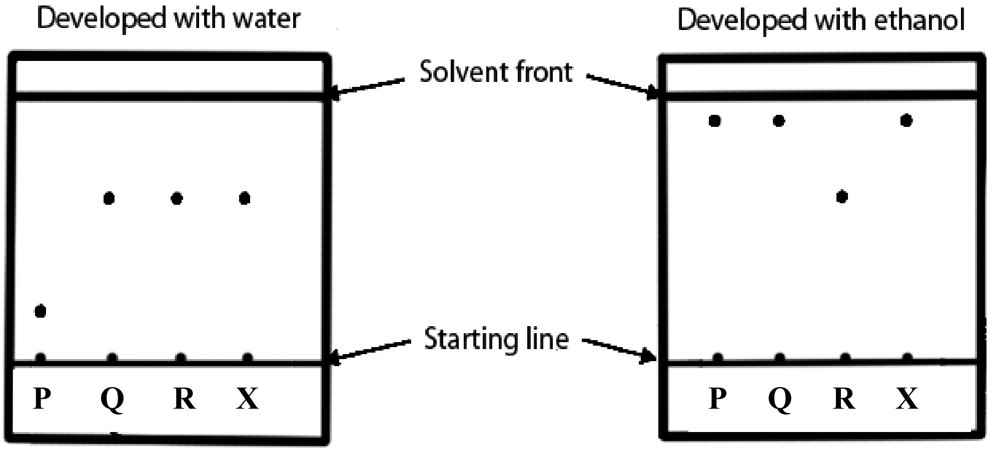
17 Small portions of aqueous potassium iodide and acidified potassium manganate(VII) solution were added to four solutions. The colour changes are seen as shown in the table.

solution	potassium iodide	potassium manganate (VII)
1	colourless to brown	purple to colourless
2	colourless to brown	no change
3	no change	purple to colourless
4	no change	no change

Which solution/s contain/s an oxidising agent **only**?

A 1
B 2
C 2 and 4
D 1 and 3

18 Chromatography was used to identify four substances. The solvent used for one of the chromatography was water while the other was ethanol. Which substances are the same?



A P and Q
B Q and X
C Q, R and X
D P, Q and X

19 $A + B \rightleftharpoons C + D$

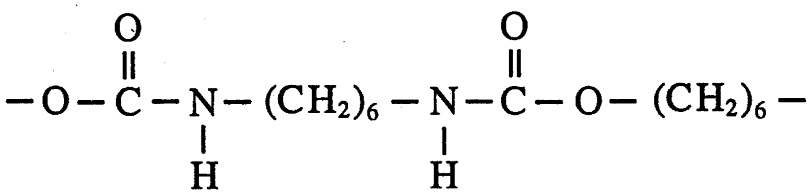
The equation above represents a certain type of chemical reaction. Which of the following is true regarding this reaction?

A The reaction produces heat and light when **C** and **D** are formed.
B As **C** and **D** are formed, they will react to produce **A** and **B**.
C **A** and **B** require a large amount of activation energy to produce **C** and **D**.
D The rate of reaction to give **C** and **D** will be very slow.

20 To reduce the effect of acid rain, the best way is to

A introduce more ammonia into the atmosphere.
B ensure all power stations using fossil fuels adopt flue gas desulfurisation.
C stop using fossil fuels.
D enforce a total ban coal-firing power stations.

21 The diagram shows the structure of a synthetic polymer **P**.



$$-O-\overset{\overset{O}{\|}}{C}-\underset{\underset{H}{|}}{N}-(CH_2)_6-\underset{\underset{H}{|}}{N}-\overset{\overset{O}{\|}}{C}-O-(CH_2)_6-$$

Which of the following air pollutants could be released when polymer **P** is burnt in air?

A sulfur dioxide
B soot particles and methane
C nitrogen dioxide and carbon monoxide
D carbon monoxide, oxygen and hydrogen gas

22 Going down Group I from lithium to caesium,

A the reactivity decreases.
B the number of electron shells increases.
C the number of valence electrons increases.
D the melting point increases.

23 The table below represents 8 elements **P**, **Q**, **R**, **S**, **T**, **U**, **V** and **W** across Period 2 of the Periodic Table.

P	**Q**	**R**	**S**	**T**	**U**	**V**	**W**

Which of the following is **correct**?

A The chloride of **T** has a high melting point whereas the chloride of **P** has a low melting point.
B The oxide of **S** is alkaline whereas the oxide of **Q** is acidic.
C **P** and **Q** are metals whereas **V** and **W** are non-metals.
D Element **W** forms the most stable compounds.

24 In the fractional distillation of crude oil, bitumen is collected at the bottom of the fractionating column. This is because

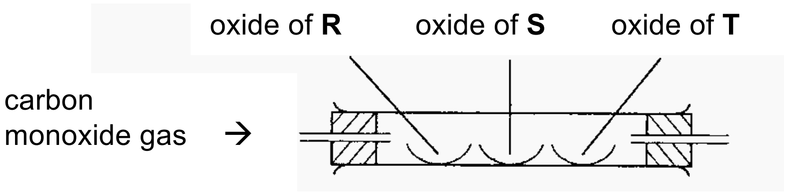
A it is the first substance to condense from a gas to a liquid in the column.
B it was never vaporized in the heating chamber.
C bitumen is a substance that has little or no commercial value.
D bitumen is not flammable.

25 Steel is harder than iron because steel has

A larger atoms.
B atoms that are more closely arranged.
C atoms of different sizes.
D stronger bonds between the atoms.

26 Three metallic oxide powders containing metals **R**, **S** and **T** are heated strongly in a hard glass tube as shown below. At the same time carbon monoxide gas is directed through the tube.

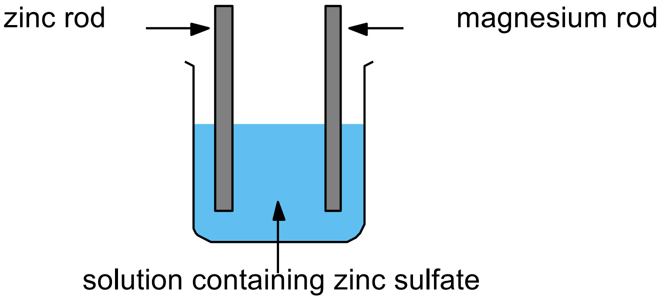
Oxide of **R** reacts slowly, oxide of **T** glows strongly while oxide of **S** does not undergo any changes.



Based on these observations, arrange **R**, **S**, **T** and carbon in descending order of reactivity (most reactive first) is

A **R**, **S**, **T**, carbon
B **T**, **R**, carbon, **S**
C **S**, carbon, **R**, **T**
D **T**, carbon, **R**, **S**

27 The table below shows an experimental set-up.

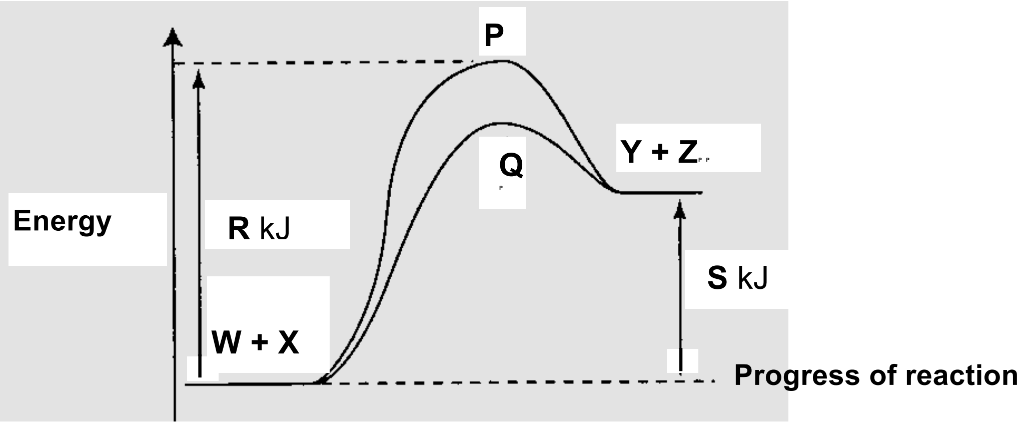


Which of the following correctly describes the experimental setup?

A If a wire is connected between the magnesium and zinc rods, electrons will flow from zinc to magnesium.
B Bubbles of a colourless gas will appear next to the magnesium rod.
C The concentration of the zinc ions in the solution will increase.
D Greyish deposits can be immediately observed at the zinc rod.

28 The diagram shows different energy paths, **P** and **Q**, and energy levels for a reaction represented by the following equation :

$$\mathbf{W + X \rightarrow Y + Z}$$



Which of the following conclusions can be made based on the diagram?

A the temperature of the surrounding increases when **Y** and **Z** are formed
B enthalpy change of the reaction equals (**R** – **S**) kJ/mol
C more products **Y** and **Z** are formed through path **Q** than through path **P**
D the pathway **Q** is achieved by using a catalyst

29 Hydrogen reacts with oxygen forming water according to the equation :

$$2H_2 + O_2 \rightarrow 2H_2O$$

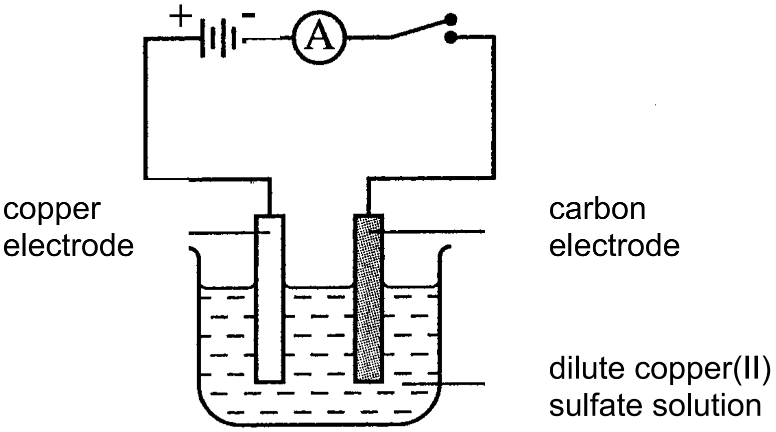
Using the bond energies given below, calculate ΔH of the reaction.

Chemical Bond	Bond Energy, kJ/mol
O – H	110
O = O	142
H - H	104

The enthalpy change for the reaction is:

A –440 kJ/mol
B +90 kJ/mol
C –350 kJ/mol
D –90 kJ/mol

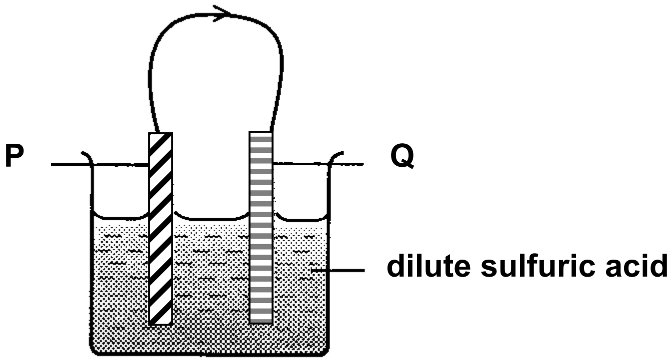
30 The figure below shows the set-up of an electrolytic process.



What is the half-equation for the reaction at the anode?

A $4OH^- (aq) \rightarrow O_2 (g) + 2 H_2O (l) + 4e$
B $2 H^+ (aq) + 2e \rightarrow H_2 (g)$
C $Cu^{2+} (aq) + 2e \rightarrow Cu (s)$
D $Cu (s) \rightarrow Cu^{2+} (aq) + 2e$

31 The diagram below shows a simple electrochemical cell.



Which of the following electrodes will give the smallest potential difference (voltage) for this electric cell?

	P	Q
A	magnesium	copper
B	zinc	silver
C	zinc	copper
D	lead	silver

32 When concentrated sodium chloride solution is electrolysed, gas **X** is formed at the anode followed by gas **Y**. Identify gas **X** and gas **Y**.

	gas **X**	gas **Y**
A	chlorine	oxygen
B	oxygen	chlorine
C	hydrogen	oxygen
D	oxygen	hydrogen

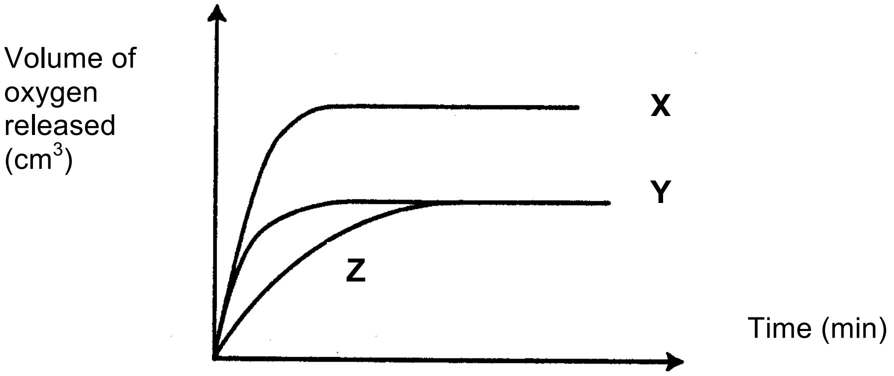
33 Which statement about the characteristic of catalysts is **not** true?

A Catalysts increase the rate of a reaction.
B The effect of catalysts depends on the amount of the catalyst used.
C The mass of catalysts does not change after a reaction.
D Catalysts increase the final amount of products of a reaction.

34 The rate of reaction increases as the temperature increases. Which of the following statements provides the **best** explanation for this?

A At lower temperatures, the proportion of particles having sufficient energy to react is greater.
B At higher temperatures the particles move faster and collide less often.
C Increasing the temperature increases the number of moving particles, so they collide more often.
D Increasing the temperature allows more particles to possess the minimum activation energy required when they collide.

35 The graph below shows the rate of decomposition of potassium chromate(V) to release oxygen gas using copper (II) oxide as a catalyst. There were three experiments conducted (I, II and III).



I adding copper(II) oxide powder to 10 cm^3 of 2.0 mol/dm^3 potassium chromate(V) solution
II adding copper(II) oxide pieces to 20 cm^3 of 1.0 mol/dm^3 potassium chromate(V) solution
III adding copper(II) oxide powder to 20 cm^3 of 2.0 mol/dm^3 potassium chromate(V) solution

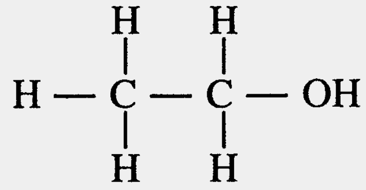
with decane ($C_{10}H_{22}$) ceramic catalyst

Which of the curves, **X**, **Y**, **Z** in the graph are associated with experiments I, II and III?

	I	II	III
A	X	Z	Y
B	X	Y	Z
C	Y	Z	X
D	Z	Y	X

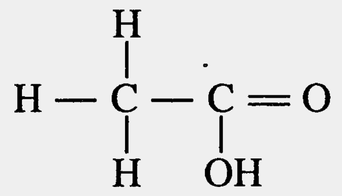
36 A neutral organic liquid is burnt in air completely, producing carbon dioxide and water. Which of the following is most likely to be that liquid?

A



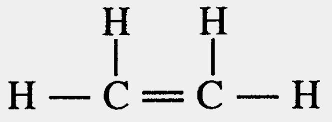
$$\begin{array}{ccccccc} & & H & & H & & \\ & & | & & | & & \\ H & - & C & - & C & - & OH \\ & & | & & | & & \\ & & H & & H & & \end{array}$$

B



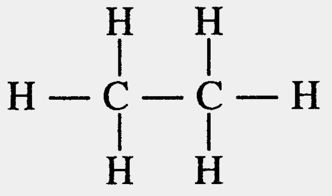
$$\begin{array}{ccccccc} & & H & & & & \\ & & | & & & & \\ H & - & C & - & C & = & O \\ & & | & & | & & \\ & & H & & OH & & \end{array}$$

C



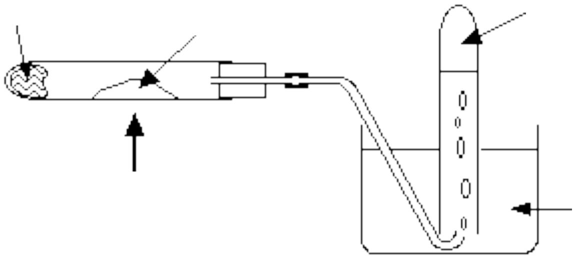
$$\begin{array}{ccccccc} & & H & & H & & \\ & & | & & | & & \\ H & - & C & = & C & - & H \end{array}$$

D



$$\begin{array}{ccccccc} & & H & & H & & \\ & & | & & | & & \\ H & - & C & - & C & - & H \\ & & | & & | & & \\ & & H & & H & & \end{array}$$

37 The diagram below shows the apparatus set-up used to produce gas **Z**.



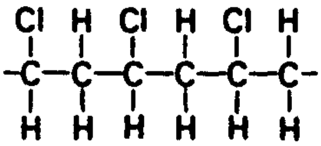
Which of the following is a property of the gas **Z**?

A reacts with ethanol to form an ester
B soluble in water
C forms white precipitate with limewater
D decolourises bromine water

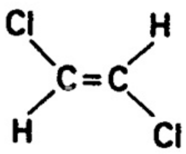
38 What is the formula of the ester formed when propanoic acid reacts with ethanol?

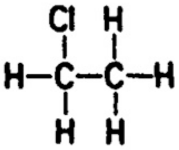
A $CH_3CO_2C_3H_7$
B $C_2H_5CO_2C_2H_5$
C C_4H_9COOH
D C_5H_9OH

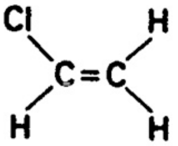
39 A polymer formed by addition polymerisation has the following structure:

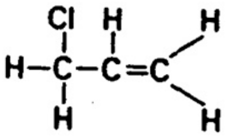


What is the structure of the monomer?

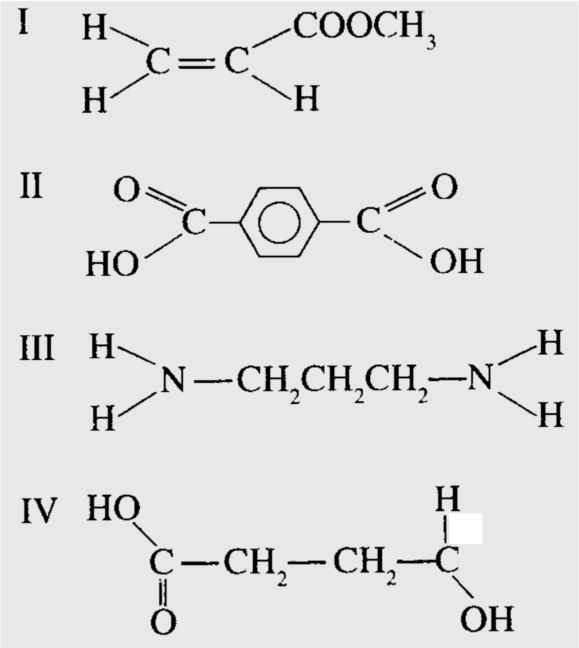
A


B


C


D


40 The following are monomers of a few compounds. Which of them can be used to produce a polymer via condensation polymerisation?



A I and III only
B II and IV only
C I, II and IV only
D II, III and IV only

End of Paper

XINMIN SECONDARY SCHOOL
新民中学
SEKOLAH MENENGAH XINMIN

Preliminary Examination 2017

CANDIDATE NAME				
CLASS			INDEX NUMBER	

CHEMISTRY 5073/02

Paper 2 **17 August 2017**

Secondary 4 Express **1 hour 45 minutes**

Setter: Mrs. Annie Ng
Vetter: Mr. Kuo YH & Mr. Lim BP

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions in the spaces provided.

Section B
Answer all **three** questions, the last question is in the form either/or.
Answer **all** questions in the spaces provided.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page 2.
The use of an approved scientific calculator is expected, where appropriate.

For Examiner's Use	
Section A	50
Section B	30
Total	80
Parent's Signature	

This document consists of **22** printed pages.

Section A

Answer **all** questions in this section in the spaces provided.
The total mark for this section is 50.

A1 Magnesium is best known for burning with a characteristic brilliant white light. The metal itself was first produced by Sir Humphry Davy in 1808 by the electrolysis of a molten mixture of magnesia (MgO) and mercury oxide. Mercury oxide was added as an impurity to lower the melting point of magnesia, and inert electrodes were used during the electrolysis.

(a) **(i)** Davy obtained magnesium at the cathode.
Write an ionic equation to show how magnesium was formed at the cathode.
Suggest a reason why the magnesium was obtained as a mixture at the cathode.

ionic equation …………………………………………….

reason ………………………………………………………………………… [2]

(ii) What product did Davy obtain at the anode?
Write an ionic equation for the reaction at the anode.

product …………………………………………….

ionic equation ……………………………………………………………………. [2]

(b) Table 1.2 below lists the natural abundances for the three stable isotopes of magnesium.

Table 1.2

isotope	^{24}Mg	^{25}Mg	^{26}Mg
natural abundance (%)	78.99	10.00	

(i) Calculate and complete Table 1.2 with the natural abundance of ^{26}Mg. [1]

(ii) Using the values in the Table 1.2, calculate the average relative mass for an atom of magnesium. Leave your answer in 3 significant figures.

[2]

[Total 7 marks]

A2 **X**, **Y** and **Z** are organic compounds from three homologous series.

X can be converted to **Y** by oxidation.
Z and water are produced when **X** and **Y** react together.
Z is an isomer of ethanoic acid.

M_r of compound **X** = 32

M_r of compound **Y** = 46

M_r of compound **Z** = 60

(a) Using the information provided, complete the boxes by drawing the structures of **X**, **Y** and **Z**. [3]

(b) Suggest a reagent in the laboratory that can be used to convert compound **X** to compound **Y**.

……………………………………………………………………………………………………. [1]

(c) Draw a 'dot-and-cross' diagram for compound **X**. Show the outer shell electrons only.

[2]

(d) The reaction mole ratio for **X** : **Y** : **Z** = 1 : 1 : 1.

Calculate the mass of **Z** produced when 100 kg of **X** reacts with 100 kg of **Y**.

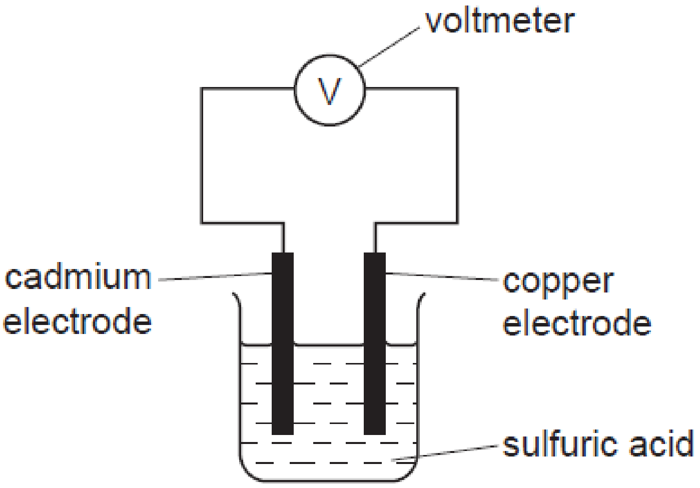
[3]

[Total 9 marks]

A3

(a) A reactivity series can be established by measuring the voltage of simple cells.

The diagram shows a simple cell.



Results from cells using the metals tin, cadmium, zinc and copper are given in the table.

cell	electrode 1 (–)	electrode 2 (+)	voltage / volts
1	cadmium	copper	0.74
2	tin	copper	0.48
3	zinc	copper	1.10

(i) What is a simple cell?

……………………………………………………………………………………………...

……………………………………………………………………………………………..
[2]

(ii) Place the four metals in order of increasing reactivity and explain how you used the data in the table to arrive at this order.

least reactive …………………………………………

…………………………………………

…………………………………………

most reactive …………………………………………

……………………………………………………………………………………………...

……………………………………………………………………………………………..

……………………………………………………………………………………………...

……………………………………………………………………………………………..
[3]

(b) Cadmium is in the same group of the Periodic Table as zinc. Cadmium carbonate is insoluble in water and reacts in the same way as zinc carbonate with dilute acids. Cadmium sulfate is soluble in water.

Describe how you would prepare a pure, dry sample of cadmium carbonate, starting from cadmium sulfate.

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……………………………………………………………………………………………..
[4]

[Total 9 marks]

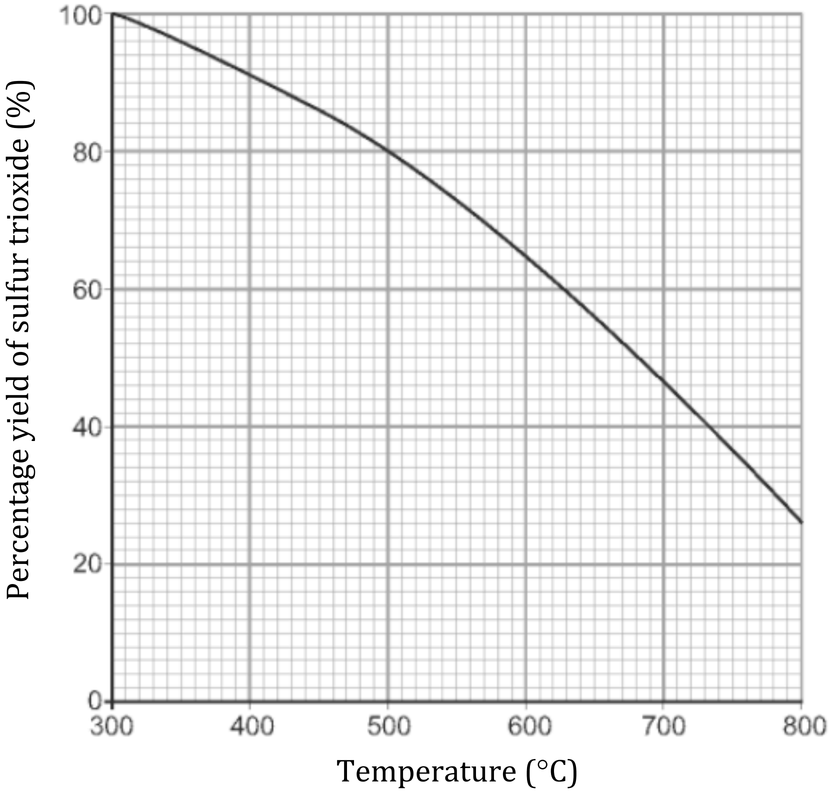
A4 One of the main stages in the manufacture of sulfuric acid is the reaction between sulfur dioxide and oxygen to produce sulfur trioxide, SO_3. The reaction is reversible.

(a) Write a balanced chemical equation for this reaction.

…………………………………………………………………………………………………..
[2]

(b) The percentage yield of sulfur trioxide against temperature is shown in Graph 4.1.

Graph 4.1



(i) Using information from the graph, describe how the percentage **yield** of sulfur trioxide changes with temperature.

…………………………………………………………………………………………...

…………………………………………………………………………………………..
[1]

(ii) Using ideas about collisions between particles, explain how the **rate** of sulfur trioxide production changes with temperature.

…………………………………………………………………………………………...

…………………………………………………………………………………………...

…………………………………………………………………………………………...
[3]

(c) The enthalpy change of reaction (ΔH) for the conversion of sulfur dioxide to sulfur trioxide is '– 196 kJ / mol'.

(i) Use ideas about breaking and forming bonds to explain why the value is negative.

…………………………………………………………………………………………...

…………………………………………………………………………………………...

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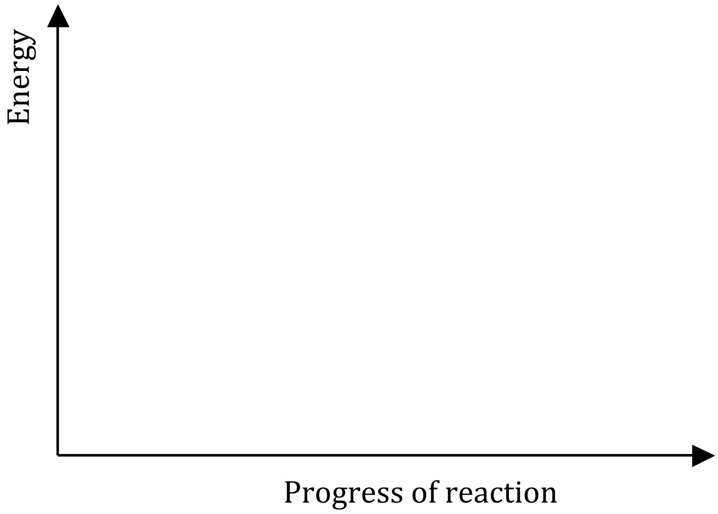
…………………………………………………………………………………………...

[3]

(ii) Draw the energy profile diagram for this reaction, clearly indicating the **formulae** of the reactants and products, and the *enthalpy change* and a*ctivation energy* in your diagram.

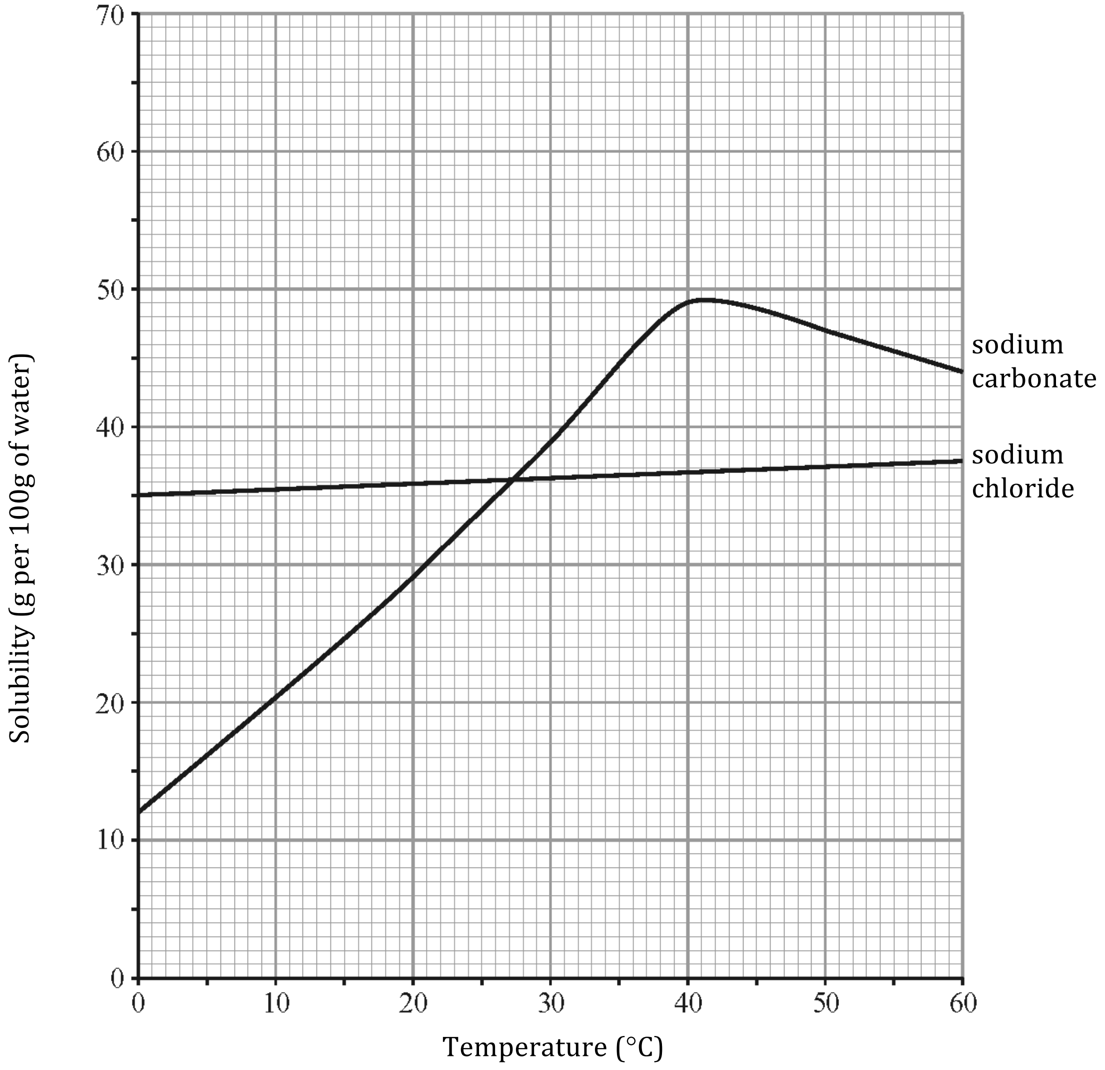


[3]

[Total 12 marks]

A5 Graph 5.1 shows the solubility of sodium carbonate and sodium chloride in water at different temperatures.

Graph 5.1



The table gives the solubility data of sodium bromate in water at different temperatures.

Temperature (°C)	0	10	20	30	40	50	60
Solubility (g per 100g of water)	25	29	35	41	48	55	64

(a) Use the information from the graph and the table to answer the following questions.

(i) Determine the order of solubility of the three sodium compounds in water at temperatures below 20 °C.

most soluble ……………………………………………………

……………………………………………………

least soluble …………………………………………………… [1]

(ii) A student makes a comment about the solubilities.
'Between room temperature and 60 °C, the solubility of all three sodium compounds increases with temperature.' Explain whether the student is correct.

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……………………………………………………………………………………………

……………………………………………………………………………………………
[2]

(b) Aqueous sodium carbonate and aqueous sodium chloride are both colourless solutions. An unlabelled bottle of a colourless solution has been found. You are told that the bottle contains either sodium carbonate or sodium chloride.

Describe a chemical test you can perform to identify the contents of the bottle, stating clearly the reagent(s) used and giving an equation for any reaction that occurs.

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……………………………………………………………………………………………

[3]

[Total 6 marks]

A6 Oxides of nitrogen in the upper atmosphere cause damage to the ozone layer.

Nitrogen monoxide, NO, damages the ozone layer by reacting with ozone in a two-step reaction.

$NO + O_3 \rightarrow NO_2 + O_2$ step 1

$NO_2 + O_3 \rightarrow NO + 2O_2$ step 2

(a) Use oxidation states to identify which element is **oxidised** in step 1.

element ……………………………………………

change in oxidation state …………………………………………… [2]

(b) One nitrogen monoxide molecule can destroy thousands of ozone molecules.
Use the equations for steps 1 and 2 to explain why.

………………………………………………………………………………………………………

………………………………………………………………………………………………………

………………………………………………………………………………………………………

………………………………………………………………………………………………………

………………………………………………………………………………………………………
[2]

(c) Using the equations for steps 1 and 2, derive the equation for the **overall** reaction.

………………………………………………………………………………………………………
[1]

(d) Oxides of nitrogen are removed from car exhaust emissions by catalytic converters.
In a converter, the oxides of nitrogen react with carbon monoxide.
Nitrogen and carbon dioxide are produced and released into the atmosphere.

Suggest **two** potential environmental hazards that may arise from the car exhaust emissions, should the catalytic converters fail to work.

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………………………………………………………………………………………………………

………………………………………………………………………………………………………

………………………………………………………………………………………………………
[2]

[Total 7 marks]

Section B

Answer all **three** questions from this section.
The last question is in the form of an either/or and only one of the alternatives should be attempted.

B7 Ionisation energy is the amount of energy needed to remove an electron from an atom or ion. It is usually measured in kilojoules (kJ). The closer the electron to be removed is to the nucleus, the higher the ionisation energy.

The ionisation energies for sodium are listed in Table 7.1.

Table 7.1

Ionisation energy number	Energy needed (kJ)
1st	495.8
2nd	4562
3rd	6910.3
4th	9543
5th	13354
6th	16613
7th	20117
8th	25496
9th	28932
10th	141362
11th	159075

Source: https://www.webelements.com/sodium/atoms.html

Typically, the *n*th ionisation of an atom or ion (**X**) can be expressed as:

$$\mathbf{X}^{n\text{-}1} \rightarrow X^{n+} + e$$

where *e* represents electron removed

Thus for the 1st ionisation of sodium:

$Na \rightarrow Na^{+} + e$ energy needed = 495.8 kJ

2nd ionisation of sodium:

$Na^{+} \rightarrow Na^{2+} + e$ energy needed = 4562 kJ

3rd ionisation of sodium:

$Na^{2+} \rightarrow Na^{3+} + e$ energy needed = 6910.3 kJ

(a) The electronic configuration for a sodium atom may be written as 2,8,1.

State, in a similar way, the electronic configuration for a

- Na^+ ion ………………………………..
- Na^{2+} ion ………………………………..

[1]

(b) Based on your understanding of ionisation energy and electronic configurations, suggest why the value for the 2nd ionisation energy of sodium is much higher than the 1st.

……………………………………………………………………………………………

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……………………………………………………………………………………………

[2]

(c) **(i)** Write an expression for the **10th** ionisation of sodium, in a manner similar to the first three ionisations of sodium as shown in the given data.

……………………………………………………………………………………….

[1]

(ii) By considering the location of the electron to be removed, explain why the value for the 10th ionisation energy for sodium is much higher than the 2nd to 9th ionisation energies.

……………………………………………………………………………………….

……………………………………………………………………………………….

……………………………………………………………………………………….

……………………………………………………………………………………….

……………………………………………………………………………………….

……………………………………………………………………………………….

[2]

For Examiner's Use

Table 6.2 lists the 1st ionisation energy (in kJ) for the first twenty elements in the Periodic Table.

Table 6.2

H 1312							**He** 2372
Li 520	**Be** 900	**B** 801	**C** 1087	**N** 1402	**O** 1314	**F** 1681	**Ne** 2081
Na 496	**Mg** 738	**A*l*** 578	**Si** 787	**P** 1012	**S** 1000	**C*l*** 1251	**Ar** 1521
K 419	**Ca** 590						

Source: http://www.sciencegeek.net/tables/IonisationNRG.pdf

(d) Describe the trends in the 1st ionisation energy **across a period** and **down a group** in the Periodic Table.

(i) Across a period:

……………………………………………………………………………………………..

(ii) Down a group:

……………………………………………………………………………………………..

[2]

(e) Explain why the 1st ionisation energy is generally higher for non-metals than metals.

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……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

[2]

[10 marks]

B8 Aspirin is a medicine that is used as a painkiller. It is made from salicylic acid.

(a) A student makes a sample of aspirin. He thinks it contains some impurities.

(i) The student tests the melting point of his sample of aspirin.

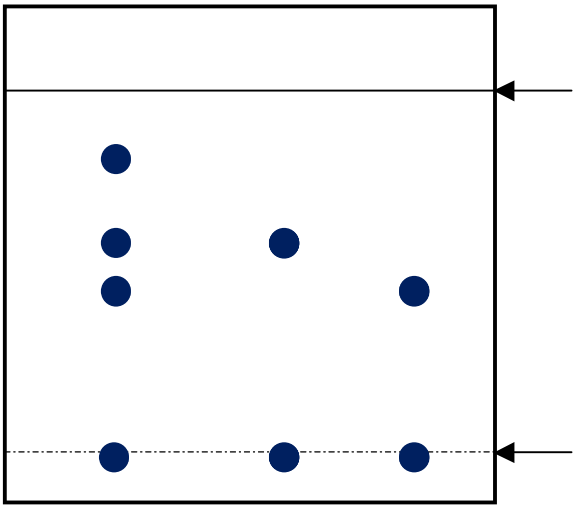
Explain how he can use the result of the test to find out whether his sample contains impurities.

……………………………………………………………………………………………..

……………………………………………………………………………………………..

[2]

(ii) The student uses chromatography to produce a chromatogram.
He uses his own aspirin and pure samples of aspirin and salicylic acid.
The diagram shows his chromatogram.



Is the student's sample of aspirin pure? Explain your answer.

……………………………………………………………………………………………..

……………………………………………………………………………………………..

……………………………………………………………………………………………..

……………………………………………………………………………………………..

[2]

COOH COONa COOH

(iii) In another chromatography using pure samples of aspirin and salicylic acid, the solvent was allowed to travel 9 cm from the start line.

Table 8.1

Substance	aspirin	salicylic acid
R_f values	0.56	0.654

Using the R_f values provided in Table 8.1, calculate the distance travelled by aspirin.

[1]

(b) The student tests some aspirin tablets bought from a store.
He performs a titration using a crushed tablet and aqueous sodium hydroxide.

The formula for aspirin can be represented as . The equation for the reaction between aspirin and aqueous sodium hydroxide is shown below.

+ NaOH → + H_2O

Table 8.2 shows the results of the student's titration.

Table 8.2

concentration of aqueous NaOH used	0.10 mol/dm^3
volume of aqueous NaOH needed for neutralisation	15.90 cm^3
relative molecular mass of aspirin	180

(i) Calculate the mass of aspirin, **in mg**, in one tablet. Leave your answer in 3 significant figures. (1 g = 1000 mg)

[3]

(ii) Some tablets that contain aspirin also contain citric acid.
The student does another titration using one of these tablets.
Explain why the mass of aspirin he calculates from his titration results is incorrect.

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……………………………………………………………………………………………...

……………………………………………………………………………………………...

……………………………………………………………………………………………...

[2]

[10 marks]

EITHER

B9 A student carried out some experiments to place four metals, **V**, **W**, **Y** and **Z** in order of reactivity.

Table 9.1 shows the results.

Key ✓ shows a reaction happened
× shows no reaction happened
– shows the experiment was not performed

Table 9.1

	metal **V**	metal **W**	metal **Y**	metal **Z**
solution of **V** nitrate	–	×	×	×
solution of **W** nitrate	✓	–	✓	✓
solution of **Y** nitrate	✓	×	–	✓
solution of **Z** nitrate	✓	×	×	–

(a) Place the metals in order of reactivity, starting with the most reactive.

………………………………………………………………………………………………………

[2]

(b) Metal **Z** reacts with nitric acid.
What would you **see** when metal **Z** reacts with nitric acid?
Explain your reasoning.

………………………………………………………………………………………………………

………………………………………………………………………………………………………

………………………………………………………………………………………………………

………………………………………………………………………………………………………

[2]

(c) The student carried out further experiments to place metal **N** in the list.
She used dilute nitric acid and samples of the metals.
She found out that metal **N** is the second most reactive metal.
Describe the experiments that the student carried out. Your answer should include

- the experiments that she carried out using dilute nitric acid and the samples of the metals,
- the measurements that she made,
- how the results showed that metal **N** is the second most reactive metal.

………………………………………………………………………………………………………

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……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

[3]

(d) The five metals, **V**, **W**, **Y**, **Z** and **N** are extracted from their ores in three different ways.
Two of the metals are extracted from their ores by electrolysis.
Two of the metals are extracted by heating their ores with carbon.
One of the metals occurs uncombined.

(i) Suggest which metal occurs uncombined. Explain your answer.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

[2]

(ii) Suggest the name of metal **Z**. ………………………………………………..

[1]

[10 marks]

OR

B9 Polystyrene and Kevlar are examples of useful synthetic polymers.

Polystyrene is an addition polymer used as a foam material.

Kevlar is a condensation polymer used to make bullet proof vests.

(a) Describe the differences between addition polymers and condensation polymers.

……………………………………………………………………………………………………….........

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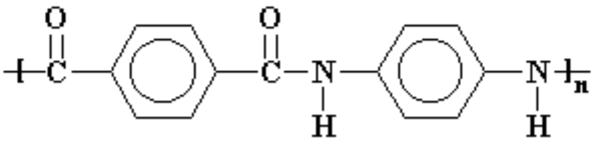
[3]

(b) Diagram 9.1 shows the repeating unit of Kevlar.

Diagram 9.1



Source: http://web.mit.edu/3.082/www/team2_f01/chemistry.html

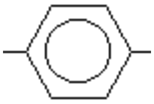
(i) Draw the structures of the **two** monomers that react to form Kevlar.

monomer 1

monomer 2

[2]

(ii) During the manufacturing process, the chain length of Kevlar is controlled so that the Kevlar polymer molecules have an average relative molecular mass in the range of 12 000 to 20 000.

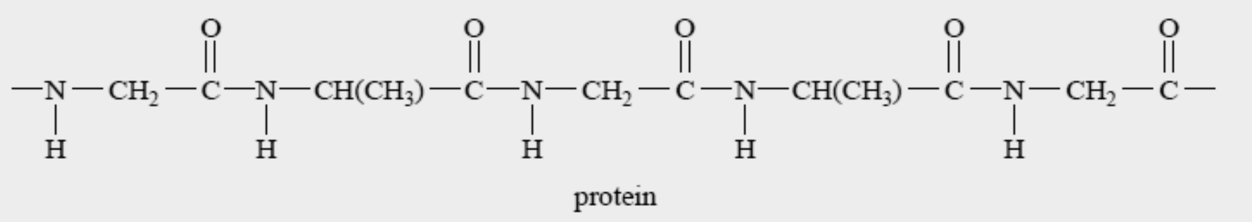
Each  (known as a benzene ring) is made up of 6 carbon atoms and 6 hydrogen atoms.

What is the range of the average number of repeating units in the Kevlar molecules? Show your working.

[2]

(c) Proteins are also condensation polymers.
Diagram 9.2 shows the structure of a protein, which is made from two monomers.

Diagram 9.2



$$-\underset{\underset{H}{|}}{N}-CH_2-\overset{\overset{O}{\|}}{C}-\underset{\underset{H}{|}}{N}-CH(CH_3)-\overset{\overset{O}{\|}}{C}-\underset{\underset{H}{|}}{N}-CH_2-\overset{\overset{O}{\|}}{C}-\underset{\underset{H}{|}}{N}-CH(CH_3)-\overset{\overset{O}{\|}}{C}-\underset{\underset{H}{|}}{N}-CH_2-\overset{\overset{O}{\|}}{C}-$$

protein

(i) Draw the structure for **one** of the monomers of the protein in diagram 9.2.

[1]

(ii) Give one similarity and one difference between the structures of Kevlar (diagram 9.1) and protein (diagram 9.2).

one similarity ……………………………………………………………………………

………………………………………………………………………………………………..

………………………………………………………………………………………………..

one difference ……………………………………………………………………………

………………………………………………………………………………………………..

………………………………………………………………………………………………..

[2]

[10 marks]

******************* ***End of Paper*** *******************

Answers and Marking Scheme
Preliminary Examination 2017
Secondary 4 Express / **5073** Chemistry (SPA) / **Paper 2** (as at 17 Aug)

A1 (a)(i) $\mathbf{Mg^{2+} + 2e \rightarrow Mg}$ [1]

Mercury was obtained with the magnesium [1]

(ii) oxygen [1]

$\mathbf{2O^{2-} \rightarrow O_2 + 4e}$ [1]

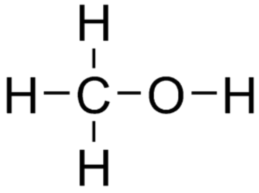
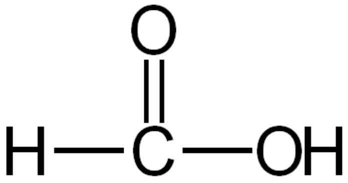
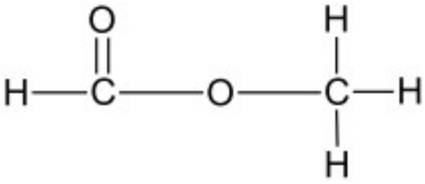
(b) (i) **11.01%** (exact) or **11.0%** (to 3 s.f.) [1]

(ii)
$$\frac{(78.99\times24)+(10.00\times25)+(11.01\times26)}{100} \approx \mathbf{24.3} \text{ (to 3 s.f.)}$$

Award 1m for correct method.
Award 1m for answer correctly left in 3 s.f. [2]

[7 marks]

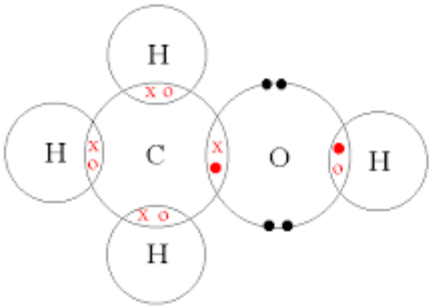
A2 (a) Structural formula for

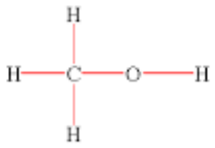
<table>
<tr>
<td>compound X (methanol)
</td>
<td>compound Y (methanoic acid)
</td>
</tr>
<tr>
<td colspan="2">compound Z (methyl methanoate)
</td>
</tr>
</table>

Award 1m for each correct structural formula drawn.
*Naming of compound **X**, **Y** and **Z** is not required.* [3]

(b) *Award 1m for any oxidising agent found in chemistry lab.*
E.g. acidified potassium manganate(VII) / acidified potassium dichromate (VI) / hydrogen peroxide [1]

A2 (c) 'Dot-and-cross' diagram for X: [2]





Award 1m for correct pairs of shared electrons.
Award 1m for octet for O atom.

(d) 100 kg of **X** = 3.125 × 10^3 moles
100 kg of **Y** = 2.174 × 10^3 moles
Limiting reagent is **Y** (or that **X** is in excess)
Mass of **Z** produced = (2.174 × 10^3) × 60 = **130 kg** (to 3 s.f.)

Award 1m for calculating number of moles in 100 kg of ***X*** *or* ***Y****.*
*Award 1m for correctly identified which reagent (****X*** *or* ***Y****) is in excess / is the limiting reagent.*
Award 1m for final answer. [3]

[9 marks]

A3

(a) (i) device which changes chemical energy [1] into electrical energy; [1]
OR
produces a voltage / potential difference / electricity [1] due to difference in reactivity of two metals; [1]
OR
produces a voltage / potential difference / electricity [1] by redox reactions [1]

(ii) Cu Sn Cd Zn (i.e. all 4 in correct order) [1]
relates order to voltage [1]
one relevant comment from: [1]
higher reactivity metals form the negative electrode or pole / copper is least reactive because it is the positive electrode or pole in all the cells / the bigger the difference in reactivity, the bigger the voltage / zinc has highest voltage because it is most reactive / more reactive metals give higher voltage

(b) 1. Add aqueous cadmium sulfate to aqueous sodium carbonate (or any soluble carbonate).
2. Filter the mixture to obtain the precipitate (cadmium carbonate).
3. Wash the residue.
4. Dry the residue (using sheets of filter paper). [4]

[9 marks]

A4 (a) $2SO_2 + O_2 \rightleftharpoons 2SO_3$ [2]

Award 1m for all correct symbols and balanced equation.

Award 1m for the '⇌' reversible arrow.

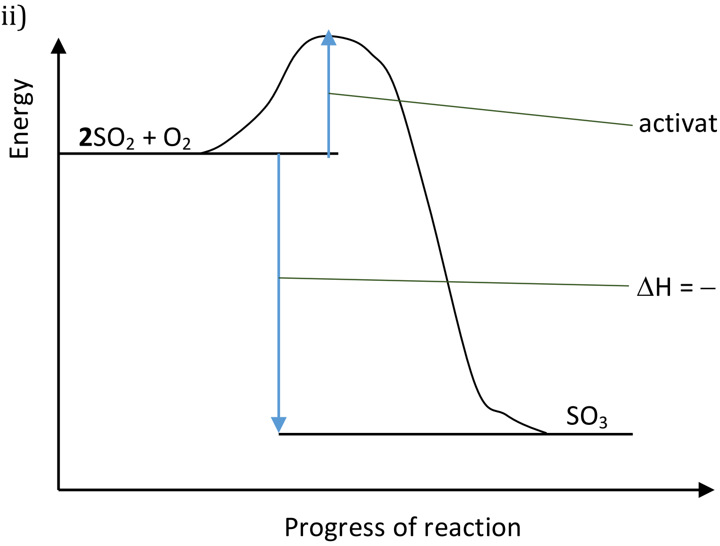
(b) (i) Percentage yield decreases as temperature increases. [1]

Accept any answers to the same effect.

(ii) Reacting particles have more energy and move faster /
More reacting particles have energy to overcome the activation energy [1]
Particles collide more frequently / Frequency of collision increases [1]
Rate of reaction increases / Reaction goes faster [1] [3]

(c) (i) Energy <u>absorbed</u> in breaking bonds is <u>less than</u> [1[the energy <u>released</u> [1] in forming bonds. Hence the reaction is <u>exothermic</u>. [1] [3]

(ii)



[3]

Award 1m for correct energy profile diagram.

Allow for ECF from (c)(i).

In event 'endothermic' reaction is stated in (c)(i), the profile for (ii) must match.

Award 1m for correctly labelling enthalpy change or ΔH (including ↓ arrow) and activation energy (including ↑ arrow).

Award 1m for correctly labelling reactants and products.

[12 marks]

A5 (a) (i) (most) sodium chloride, sodium bromate, sodium carbonate (least) [1]

(ii) Student is partially correct / incorrect (no mark)
While the solubility of sodium chloride and bromate increases [1], the solubility of sodium carbonate decreases after 40 °C [1] [2]

(b) <u>Method 1:</u>

- Add dilute hydrochloric acid (or any named acid) to a sample of the contents in the bottle. [1]
- If effervescence observed, the bottle contains sodium carbonate.
- If no effervescence observed, the bottle contains sodium chloride. [1]

$Na_2CO_3 + 2HCl \rightarrow 2NaCl + CO_2 + H_2O$ [1]

<u>Method 2:</u>

- Add <u>acidified</u> silver nitrate to a sample of the contents in the bottle. [1]
- If a white precipitate is seen, the bottle contains sodium chloride. [1]
- If no precipitate is seen, the bottle contains sodium carbonate.

$AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$ [1]

Note: Use of silver nitrate solution is not accepted as silver carbonate (also a white precipitate) will be produced with sodium carbonate solution.

[6 marks]

A6 (a) Nitrogen [1]; from +2 (in NO) to +4 (in NO_2) [1] [2]

(b) No loss in NO molecules. [1]
The NO molecules removed in step 1 (after reacting with ozone) are regenerated in step 2 (in reaction with more ozone). [1]

(c) $2O_3 \rightarrow 3O_2$ [1]

(d) *'Catalytic converters fail to work' means release of oxides of nitrogen and carbon monoxide into the atmosphere.*
Accept any valid health or environmental hazards due to oxides of nitrogen and carbon monoxide.

Suggested answers:

- Release of carbon monoxide poses danger of carbon monoxide poisoning. Inhalation of carbon monoxide prevents haemoglobin from absorbing oxygen and may lead to suffocation / organ failure / headaches. [1]
- Release of oxides of nitrogen may result in formation of acid rain, which leads to corrosion of buildings / structures. [1]

[7 marks]

B7 Compulsory Data-Based Question (10 marks)

(a) Na^+ ion : 2, 8 [½]
Na^{2+} ion : 2, 7 [½]

(b) 1st ionisation energy is the energy required for a sodium atom to lose 1 valence electron, and obtaining a stable octet / stable electronic structure. [1]
2nd ionisation energy is the energy required to remove an electron from the stable octet. This **disrupts the stable electronic configuration**. Hence more energy is needed. [1]

(c) (i) $Na^{9+} \rightarrow Na^{10+} + e$ [1]

(ii) The 10th ionisation energy involves the removal of an electron from the 1st shell
The 2nd to 9th ionisation energy involves removing electrons from the 2nd shell.
Electrons in 1st shell are closer to the positively charged nucleus than those in the 2nd shell;
Attraction (between electron and nucleus) is stronger;
A larger amount of energy is needed to remove that electron (in the 1st shell).
[2]

Award 1m for describing removal of electrons from 1st / 2nd shell.
Award 1m for stating being closer to nucleus requires larger amount of energy.
Allow 1m should student describe shielding effect instead of proximity to nucleus.

(d) (i) Increases across the period [1]
(ii) Decreases down the group [1]

(e) Metals tend to lose electrons (to gain stability with full most outer shell) and form positively charged ions (or cations);
non-metals tend to gain electrons and form negatively charged ions (or anions).
Removing electrons from an atom of non-metal makes its electronic structure less stable.
[2]

[10 marks]

B8

(a) (i) If his sample is pure, the melting point should be a fixed temperature. [1]

If his sample is not pure, the aspirin should melt over a range of temperatures. [1]

or

Look up the melting point of aspirin. [1]

If the melting points are the same, the sample is pure. / Impure aspirin would have a different (lower) melting point. [1] [2]

(ii) Sample is not pure. (no mark)

Sample contains **two** impurities. [1]

The impurities are salicylic acid and an unidentified/unknown substance. [1]

(iii) 0.56 × 9 = **5.04 cm** [1]

(b) (i) mole ratio of aspirin : NaOH = 1:1 (from equation)

Mass of aspirin $= \left(\frac{15.80}{1000} \times 0.10\right) \times \frac{1}{1} \times 180 = 0.286\text{ g} = \mathbf{286\text{ mg}}$

Award 1m for calculating number of moles of aspirin using 'M = C × V'.

Award 1m for calculating mass of aspirin using 'mass = molar mass × moles'.

Award 1m for giving final answer in mg and 3 s.f. [3]

(ii) Citric acid (in the tablets) will also **react with** / **be neutralised** by sodium hydroxide during the titration. [1]

Hence **more** sodium hydroxide would be used / the calculated mass of aspirin will be **greater** than actual. [1]

[10 marks]

EITHER B9

(a) (most reactive) **V**, **Z**, **Y**, and **W** [2]

Award 1m for at least 2 metals in correct order.

(b) Effervescence / Bubbling of gas seen. [1]

Z will displace / produce hydrogen from the acid. [1]

(c) [New order: **V**, **N**, **Z**, **Y**, and **W**]

Add a fixed mass of each metal sample to a fixed volume of HNO_3 (aq). [1]

Measure the volume of gas collected over regular time intervals (i.e. reaction rate). [1]

Rate of reaction of **N** with the acid should be slower than **V** but faster than **Z**. [1]

(d) (i) **W** [1]

W is the least reactive of the 5 metals. Unreactive metals are usually found uncombined. [1]

(ii) zinc / iron [1]

[10 marks]

OR B9

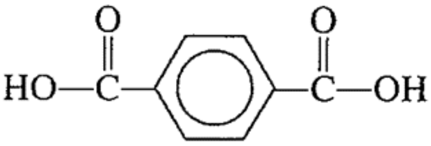
(a) *For clarity of marking scheme, the answer is presented in a table.*

Any 3 points

Addition polymer	**Condensation polymer**
Monomers must be unsaturated / contain C=C double bond. [1]	Monomers contain 2 functional groups (e.g. –COOH, –OH, $–NH_2$). [1]
No loss in atoms during polymerisation. [1] **or** Only 1 product is formed. [1]	Loss of small molecules (e.g. water) during polymerisation. [1] **or** 2 products formed (i.e. polymer and small molecules). [1]
Mass of addition polymer <u>equals</u> sum of its monomers' masses. [1]	Mass of condensation polymer is <u>less than</u> sum of its monomers' masses. [1]
Polymer contains C -C linkages. [1]	Polymer contains ester or amide linkages. [1]

[3]

(b) (i)

 [1]	 [1]

(ii) Formula of repeating unit for Kevlar = $C_{14}H_{14}N_2O_2$

M_r of repeating unit for Kevlar = (14 × 12) + (14 × 1) + (2 × 14) + (2 × 16) = **242**

Number of units if average mass is 12 000 = (12 000 ÷ 242) = 49.6 ≈ 50

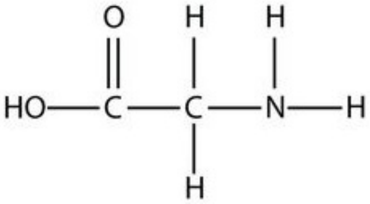
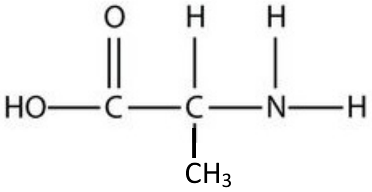
Number of units if average mass is 20 000 = (20 000 ÷ 242) = 82.6 ≈ 82

Range is <u>between 50 to 82</u> repeating units.

Working [1]

Answer [1] [2]

(c) (i) *Either one of the following monomers:*

[1]

(ii) Similarity – Both contain amide linkages. / Both are polyamides. [1]

Difference – Absence of benzene ring in protein. / Amide linkage is in the same order in protein but not in Kevlar. [1]

Vague answer such as 'The structures are different.' is not accepted.

[10 marks]

******************** **End of Answers and Marking Scheme** ********************