# 2016 Science Chemistry

| 1 | Anglo-Chinese School (Barker Road) |
|---|---|
| 2 | Maris Stella High School |
| 3 | Chung Cheng High School |
| 4 | CHIJ Katong Convent |
| 5 | St. Gabriel's Secondary School |
| 6 | Hua Yi Secondary School p1 and p2 |
| 7 | Queenstown Secondary School p1 and p2 |
| 8 | Saint Patrick's School |

| Exam Index |  |
|---|---|
| Number |  |

## Anglo-Chinese School (Barker Road)

### PRELIMINARY EXAMINATION 2016

SECONDARY FOUR (EXPRESS) /
SECONDARY FIVE (NORMAL ACADEMIC)

SCIENCE (CHEMISTRY)
5076/3

1 HOUR 15 MINUTES

**INSTRUCTIONS TO CANDIDATES**

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

Write your index number in the spaces provided at the top right hand corner of this page and on any separate answer paper used. Write in dark blue or black pen in the spaces provided on the Question Paper. You may use a pencil for any diagrams, graphs, or rough working.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer all questions in **Section A** and any **two** questions in **Section B**. In calculations, you should show all the steps in your working, giving your answer at each stage.

Enter the numbers of the **Section B** questions you have answered on the dotted grids.

A copy of the periodic table is printed on the last page of this booklet.

| | Total Marks | |
|---|---|---|
| Section A | | / 45 |
| Section B | ........... | |
| | ........... | |
| Total | | / 65 |

This paper consists of **18** printed pages inclusive of this page.

---

## Section A

Answer **all** the questions in the spaces provided.
The total mark for this section is 45.

1   The table shows the atomic structure of six particles, represented by the letters **A** to **F**. These particles are either atoms or ions, and the letters are **not** the symbols of the elements.

| particle | number of electrons | number of protons | number of neutrons |
|---|---|---|---|
| A | 6 | 6 | 6 |
| B | 2 | 2 | 2 |
| C | 12 | 12 | 12 |
| D | 10 | 12 | 12 |
| E | 6 | 6 | 8 |
| F | 10 | 7 | 14 |

(a)   Which two particles are an atom and an ion of the same element?

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

(b)   Which particle(s) is/are chemically unreactive?

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

(c)   Which two particles combine together to form a compound with a chemical formula which is in the form of $X_2Y_3$?

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

(d)   Which particles are elements in Group IV of the Periodic Table?

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

2   The chromatogram shows the dyes contained in three different sweets labelled **W**, **X** and **Y**. Yellow and blue dyes are harmful.
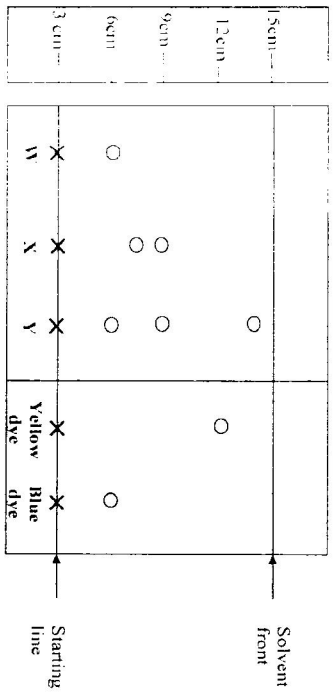


(a)   Which sweet(s) is/are harmful?

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

(b)   Explain why the starting line must not be submerged in the solvent during chromatography.

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

(c)   Explain why the result will be inaccurate if the solvent front stops at the 9 cm mark

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

(d)   The table below shows some information about the properties of three solids.

| substance | effect of heat | hot water |
| --- | --- | --- |
| solid **A** | no effect | very soluble |
| solid **B** | no effect | insoluble |
| solid **C** | sublimes | insoluble |

Solid **C** **sublimes** when heated strongly. Explain the meaning of this statement.

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

(e)   Using this information, explain how you would obtain a pure, dry sample of solid **B** given a mixture of all three substances.

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

3 (a) The box shows the names of some oxides.

| | | |
|---|---|---|
| aluminium oxide | carbon monoxide | nitrogen dioxide |
| sodium oxide | sulfur dioxide | zinc oxide |

(i) Which oxide(s) will react with hydrochloric acid but not with aqueous sodium hydroxide?

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

(ii) Which oxide(s) will react with both hydrochloric acid and aqueous sodium hydroxide?

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

(iii) Which oxide(s) will not react with hydrochloric acid or with aqueous sodium hydroxide?

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

(b) Two of the oxides are responsible for acid rain.

Identify the two oxides from the table above and state the cause of their presence in the atmosphere.

............................................................................................................

............................................................................................................

............................................................................................................

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

(c) Draw a 'dot and cross' diagram to show the bonding in sodium oxide. You only need to show the outer shell electrons.

[2]

4 Insoluble salts can be made by mixing solutions of two soluble salts.

A student mixed sodium carbonate solution with copper(II) sulfate solution.

(a) Construct a chemical equation for the reaction.

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

(b) Describe the method to separate the two products in (a)(i) completely.

............................................................................................................

............................................................................................................

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

3

5. The table six organic compounds, P, Q, R, S, T and U.

| P | Q | R |
|---|---|---|
| | | |
| S | T | U |

(a) Which compounds will decolourise aqueous bromine?

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

(b) Which compound is formed by the addition of hydrogen to R?

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

(c) Which compound, P or S, has a higher boiling point? Explain your answer.

................................................................

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

(d) Compound U can polymerise to form a large organic compound.

(i) Draw the structure of the product of polymerisation.

[1]

(ii) Name the compound you have drawn in (d)(i).

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

6. (a) Steel is an alloy containing iron.

The following are three differences between steel and aluminium.

* Steel can rust but aluminium resist corrosion.
* Steel has a higher density than aluminium.
* Steel is much stronger than aluminium.

(i) Use the information from the list to suggest why aluminium is the better material for making ladders.

................................................................

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

(ii) Use the information from the list to suggest why steel is the better material for making bridges.

................................................................

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

4

**(b)** The diagram shows how aluminium and iron(III) oxide react with each other.



magnesium ribbon

sand

mixture of aluminium powder and iron(III) oxide
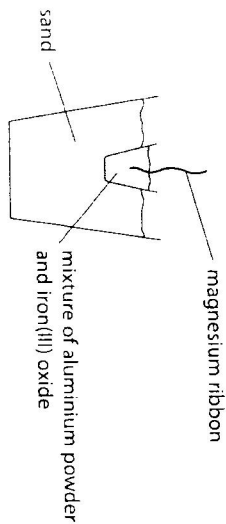
The magnesium ribbon is lit to ignite the reaction mixture. The reaction is highly exothermic.

The equation for the reaction is

$$2Al + Fe_2O_3 \rightarrow Al_2O_3 + 2 Fe$$

(i) Define the term 'exothermic'.

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

(ii) Explain how iron is produced in the above reaction.

..........................................................................................................

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

(iii) Which substance is oxidised in the reaction?

Explain your answer in terms of changes in the oxidation number.

..........................................................................................................

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

9

**(c)** The following diagram shows a chemical reaction between aluminium powder and iron (III) oxide, which is used to join together two railway lines.



railway line

mixture of aluminium powder and iron(III) oxide

mould

railway line
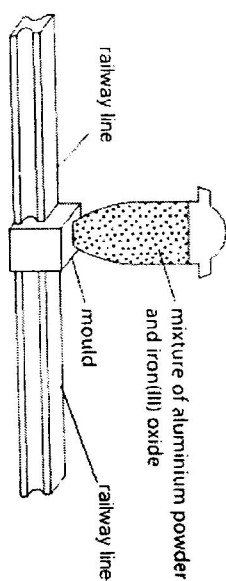
The mixture is ignited and molten iron is collected in the mould. The molten iron solidifies and creates a joint between the two rails. The mould is then removed.

Explain why the iron produced in the reaction is molten.

..........................................................................................................

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

10

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5

7   The graph shows the volumes of carbon dioxide given off when calcium carbonate lumps are reacted with hydrochloric acid, at room temperature and pressure, in five different experiments.
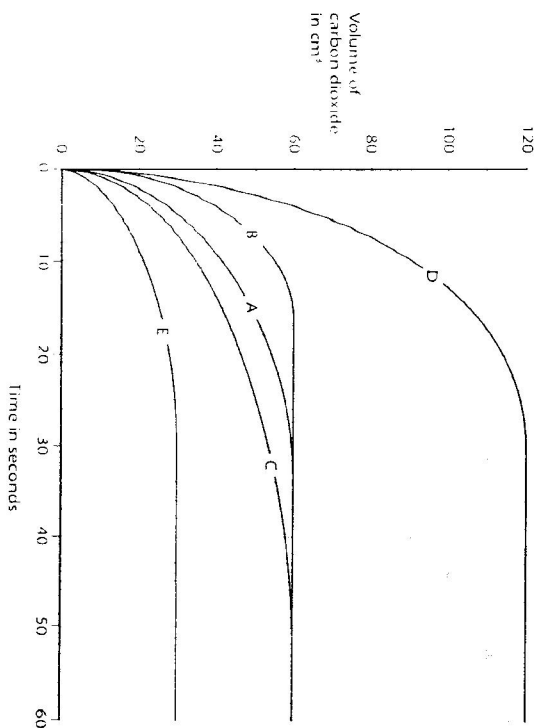


(a) Curve **A** shows the volume of carbon dioxide given off when some calcium carbonate lumps are reacted with an excess of $1.0 \ mol/dm^3$ hydrochloric acid.
The experiment that gave the results of Curve **A** was repeated a few times, each time with a different condition modified.

Complete the table below to identify the curve that corresponds each changed condition and explain your answer.

| modification | curve | reason |
|---|---|---|
| half the mass of calcium carbonate lumps | | |
| lower temperature | | |
| powdered calcium carbonate | | |

[6]

(b)   The equation for the reaction is

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$$

(i)   Calculate the number of moles of carbon dioxide produced in the experiment represented by Curve **A**.

[The volume of any gas is $24 \ dm^3$ at room temperature and pressure.]

[1]

(ii) Calculate the mass of calcium chloride produced in the experiment represented by Curve **A**.

[Relative atomic masses of Ca= 40, Cl= 35.5, C= 12, O= 16]

[2]

13

## Section B

Answer any **two** questions. Write your answers on the lined pages provided.
The total marks for this section is 20.

8   The alcohols form a homologous series. The first member of this homologous series is methanol.

(a) Describe the four characteristics of members of a homologous series, using alcohol as an example.

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[4]

(b) Propane and propene are both hydrocarbons. Using equations to support your answer, describe the similarities and differences in their reactions.

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..................................................................

[6]

14

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7

9  (a)  Magnesium sulfate can be made by reacting dilute sulfuric acid with either magnesium oxide or solid magnesium carbonate.

Describe the difference in observations between the two reactions, using equations to explain your answer.

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[5]

(b)  A student dissolved some salt crystals in water. He added sodium hydroxide to the solution until it was in excess.

(i)  Describe what the student would see if the salt contained lead(II) ions.

...................................................................................................................

...................................................................................................................

[5]

(ii)  Explain why the result you have described in (b)(i) does not confirm that the salt contains lead(II) ions. Describe an additional test the student could do that would prove the salt contains lead(II) ions.

...................................................................................................................

...................................................................................................................

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...................................................................................................................

[5]

10  The figure shows the structures of calcium chloride and chlorine.



calcium chloride
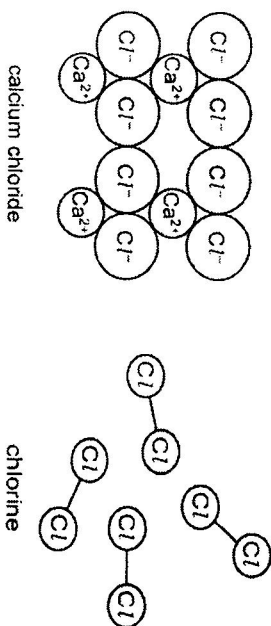
chlorine

(a)  Chlorine exists as two isotopes, $^{35}Cl$ and $^{37}Cl$.

Compare and contrast these two isotopes.

...................................................................................................................

...................................................................................................................

...................................................................................................................

...................................................................................................................

...................................................................................................................

[3]

8

(b) Calcium reacts with chlorine atoms to form calcium chloride. The following table shows the physical properties of calcium chloride and chlorine.

| | conductivity | boiling point/ °C |
|---|---|---|
| calcium chloride | conducts in molten state but not in solid state | 1935 |
| chlorine | does not conduct electricity | -34 |

(i) Explain how a calcium atom combines with chlorine atoms.

(ii) Explain the difference in properties of calcium chloride and chlorine shown in the table.

[7]

End of Paper

17

## 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 | | **Key** relative atomic mass atomic symbol name atomic number | | | | | | | | | | | 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 | 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| †90-103 Actinoid series | 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 |

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

18

9

Sec 4E/5N PRELIMINARY EXAMINATION 5076 2016
Science Chemistry P3
Marking Scheme

| | Answer | Marks | Remarks |
|---|---|---|---|
| 1(a) | C and D | 1 | |
| (b) | B | 1 | |
| (c) | D and F | 1 | |
| (d) | A and E | 1 (total 4) | |
| 2(a) | W and Y | 1, 1 | |
| (b) | This is to ensure that the dyes do not get washed off by the solvent, preventing a proper separation up the chromatogram | 1 | (b) accept answers that state/mean 'dyes dissolve into solvent' 'preventing a proper separation up the chromatogram' left out by most students |
| (c) | Spots will not be distinct as dyes are not completely separated | 1 | (c) most state 'yellow dye will not be if travel beyond the 9 cm mark'. Answers need to imply 'there will be no full separation of colours' |
| (d) | Its state changes from solid to gas correctly without going through the liquid state | 1 | (d) 'without going through liquid state' left out BOD |
| (e) | Dissolve the mixture in hot water and filter [1]. Heat the residue until all the solid C has sublimed / there is no further change in mass [1] | 1, 1 (total 6) | (e) no mark for first part if 'hot' water not mentioned |

| 3 | | | | Remarks |
|---|---|---|---|---|
| (a) | (i) | sodium oxide | 1 | Many still weak in this area. Need to revise types of oxides [1] [1] |
| | (ii) | aluminium oxide and zinc oxide | 1 | |
| (b) | | carbon monoxide | 1 | (b) Students misread 'cause of their presence' as 'harmful effects caused by gases'. Reject if merely state 'factories', without mentioning burning of fuels |
| | | Sulfur dioxide and nitrogen dioxide | 1 (no ½ mark) | |
| | | Sulfur dioxide is formed due to volcano eruptions / burning of fossil fuels/petroleum at the power stations / factories. | 1 | |
| | | Nitrogen dioxide is formed due to lightning / internal combustion in the car engines | 1 | |
| (c) | |  | 2 (total 8) | (c) Accept even if all shells drawn (BOD) Accept 2 [Na]+ instead of drawing 2 Na+ |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | correct charges & balancing [1]; no of electrons in ions [1] | | | | include charge one dot to cross for oxide ion on opposite side |
| 4 | (a) | (i) | Na₂CO₃(aq) + CuSO₄(aq) → CuCO₃(s) + Na₂SO₄ | | 1: 1 (state symbols) | (a) (i)Accept if no state symbols (since question did not ask for it) (BOD) |
| | | (ii) | Filter the mixture Rinse residue with **distilled water**, dry by pressing residue between 2 pieces of filter papers | | 1: 1: | (ii) "distilled/deionised water" needs to be mentioned |
| | | | | | (total: 4) | |
| 5 | (a) | | R and U | | 1: | |
| | (b) | | Q | | 1: | |
| | (c) | | S | | 1: 1: | |
| | | | **S** is a bigger molecule than **P**, therefore has stronger intermolecular forces of attraction and require more energy to overcome the forces. | | | |
| | (d) | (i) | [structure H–C–C–H] | | 1: | (d) few draw polyethene instead of polypropene. "n" has to be at right position. |

| | | | | | |
|---|---|---|---|---|---|
| 6 | (a) | (i) | polypropene | 1: (total:6) | (a) (i) "lighter" and "resist corrosion" both need to be mentioned/equivalent in meaning. "rusting" is rejected. |
| | | (ii) | Ladders made of aluminium are lighter and can resist corrosion/does not rust compared to steel | 1: | (ii) as long as "stronger" is mentioned/equivalent in meaning |
| | | | A steel bridge is stronger than aluminium, better able to withstand the weight of heavy objects | 1 | |
| | (b) | (i) | heat (energy) is given out to the surroundings | 1: | "heat/heat energy" accepted. reject "energy" |
| | | (ii) | aluminium is more reactive than iron; it displaces iron from its oxide; | 1:1 | |
| | | (iii) | Aluminium: The oxidation state of aluminium increases from 0 in Al to +3 in Al₂O₃; | 1:1 | (b) (iii) As long as student mentions oxidation increases from 0 to +3 |
| | (c) | | Heat is produced during the reaction. Resulting temperature is higher than the melting point of iron. | 1: | (c) "large amount of heat", "higher than mp" required. Reject if merely suggest "heat melts iron" |
| | | | | (total:8) | |

**(a)**

| Curve | reason |
|---|---|
| E | Half the mass of reacting particles of calcium carbonate + reactant calcium carbonate |
| C | Lower temperature reduces the kinetic energy of the reacting particles, leading to lower frequency of effective collision and decrease in speed of reaction + same yield |
| B | Powdered marble chips have smaller particle size, larger surface area exposed to collisions, leading to higher frequency of effective collisions and greater speed of reaction |

**(b) (i)**

Volume of $CO_2$ collected is 60 cm³

n₁o of mole of $CO_2$ = 60/24000
= 0.0025

**(ii)**

Mole ratio of $CO_2$ : $CaCl_2$ is 1:1
n₁o of mole of $CaCl_2$ = 0.0025

Mass of $CaCl_2$ = 40 + 2(35.5) times
0.0025

0.278g (to 3 sf)

---

**(a) Curve E** "no. of particles' halved/ 'yield' is halved to be suggested

**Curve C** 'lower temp resulting in "slower reaction" needs to be implied. No need to use collision theory to explain (BOD since question does not ask)

**Curve B** powdered marble chips have 'larger surface area' for reaction needs to be implied. No need to use collision theory. (BOD)

Each blank =1 mark
(total : 6)

**(b) (i)** Few did not convert 24 dm³ to 24000 cm³

**(ii)** error carried forward (ECF) using part (i) answer.

w/o 3 sf minus 1 mark
no units minus 1 mark

(total : 9)

---

**Section B**

**8 (a)**

1. Members have the same general formula of $C_nH_{2n+1}OH$    1:1:1:1

2. Members have the same functional group of –OH (or hydroxyl) and hence similar chemical properties

3. Each successive member increases by –$CH_2$

4. Physical properties (e.g. boiling points, flammability) show a gradual change as the number of C atoms increase

**(b)**

**Similarity**
Both react with oxygen completely to produce carbon dioxide and water
$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$    1:
$2C_3H_6 + 9O_2 \rightarrow 6CO_2 + 6H_2O$    1:

**Differences**
Propane undergoes addition reactions but propane undergoes substitution reaction.    1:

Substitution reaction:
$C_3H_8 + Cl_2 \rightarrow C_3H_7Cl + HCl$    1:

addition reactions (any 1)
- hydrogenation
  $C_3H_6 + H_2 \rightarrow C_3H_8$, nickel catalyst, 200 ºC
- bromination
  $C_3H_6 + Br_2 \rightarrow C_3H_6Br_2$

Well attempted by most.
(2) mentioning "–OH" crucial, reject if student merely state "similar chemical properties".
(3) mentioning "–$CH_2$" crucial
(4) allow of 'gradual' omitted (BOD)

Conditions not required (BOD)

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13

| | | | | |
|---|---|---|---|---|
| 9 | (a) | • hydration<br>$C_2H_4 + H_2O \rightarrow C_2H_5OH$<br>phosphoric acid catalyst, 300°C<br>• Addition polymerisation<br>$nC_2H_4 \rightarrow (C_2H_4)_n$ | 1 | |
| | | Little/no gas is observed when magnesium carbonate is added to the acid but no bubbling of gas when magnesium oxide was added | 1 | |
| | | MgO does not produce $CO_2$/gas when added to sulfuric acid<br>$MgO(s) + H_2SO_4(aq) \rightarrow MgSO_4(aq) + H_2O(l)$ | 1:1 | (a)State symbols not required (BOD) |
| | | $MgCO_3$ produces $CO_2$/gas when added to sulfuric acid<br>$MgCO_3(s) + H_2SO_4 \rightarrow MgSO_4(aq) + H_2O(l) + CO_2$ | 1:1 | |
| | (b)(i) | He would see a white precipitate, soluble in excess $NaOH(aq)$ to form a colourless solution | 1 | (b)(i) needs to mention "soluble in excess" |
| | (ii) | the ions would also produce the same result.<br>Additional test: add aqueous ammonia to the salt solution<br>$Al^{3+}$ ions would also produce the same result.<br>Additional test: add aqueous ammonia to the salt solution when it should be zinc ions.<br>No penalty if lead ions instead of lead(II) ions used | 1 | (ii) few get this correct. Some mentioned using additional test using an ammonia because aluminium ions have same result as lead(II) ions, when it should be zinc ions.<br>No penalty if lead ions instead of lead(II) ions used |
| 10 | (a) | Both have same number of protons of 17. | 1 | (a) Well answered by most |
| | | They have different number of neutrons/atomic mass | 1 | accept "2 more neutrons" |

| | | | | |
|---|---|---|---|---|
| | | $^{17}Cl$. Has 20 neutrons/mass number of 37 | 1 (both values calculated) | (b)(i) failure to give complete answer. Most stopped after describing how ions are formed attraction between +ve and –ve ions) (left out<br>However, accept if "ionic bonding" mentioned |
| (b) | (i) | Calcium atom has an electronic configuration of 2,8,8,2. It has 2 valence electrons. Chlorine has an electronic configuration of 2,8,7. It has 7 valence electrons.<br>Each calcium atom transfers two valence electrons to 2 chlorine atoms.<br>$Ca^{2+}$ and $Cl^-$ ions are formed which are attracted by electrostatic forces of attraction. | 1; | |
| | (ii) | When molten, calcium ions are free to move so they are able to carry electrical charges around.<br>In solid form, the ions are fixed in position so they are unable to carry the electrical charges around. | 1;<br>1; | (ii) accept as long as "mobile ions" implied in liquid state<br>most fail to mention "ions fixed in position" (BOD) as long "no mobile ions" implied |
| (b) | | $CaCl_2$ has strong electrostatic forces of attraction between its positive and negative ions which requires a large amount of energy to overcome. | 1; | both points have to be mentioned, "strong electrostatic force" and "large amount of energy" |
| | | Chlorine exists as small covalent molecules. It has weak intermolecular forces of attraction | 1 | |

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14

15

Class | | Index No. | | Name: | | Date:
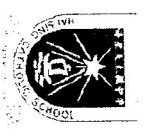
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**PRELIMINARY EXAMINATION TWO 2016**

**Secondary Four Express/Five Normal Academic**

5076/03 and 5078/03
13 September 2016
1 hour 15 minutes
1100 – 1215h

SCIENCE CHEMISTRY
Paper 3

Students 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.
You may use an HB pencil for any diagrams, tables or rough working.
Write in a dark blue or black pen.
Do not use staples, paper clips, highlighters, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your workings or if you do not use appropriate units.

**Section A**
Answer **all** questions
Write your answers in the spaces provided on the question paper.

**Section B**
Answer any **two** questions.
Write your answers in the spaces provided on the question paper.

A copy of the Data Sheet is printed on page 14.
A copy of the Periodic Table is printed on page 15

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

| FOR EXAMINER'S USE | |
|---|---|
| Section A | /45 |
| Section B | /20 |
| Total | /65 |

| Parent's Signature |
|---|
| |

HAI SING CATHOLIC SCHOOL

This question paper consists of **15** printed pages, including the cover page

---

2

**Section A**

Answer all the questions in the spaces provided

1  The table below gives the composition of six particles which are either atoms or ions

| particle | number of protons | number of neutrons | number of electrons |
|---|---|---|---|
| A | 33 | 40 | 33 |
| B | 19 | 20 | 18 |
| C | 34 | 45 | 36 |
| D | 33 | 42 | 33 |
| E | 13 | 14 | 13 |
| F | 24 | 28 | 21 |

(a) Which particles are atoms? Explain your choice.

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

(b) Which particle is a negative ion and why has this particle got a negative charge?

..........................................................................................................................

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

(c) Which particles are positive ions?

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

(d) Explain why particle **A** and particle **D** are isotopes.

..........................................................................................................................

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

2  The halogens are a group of elements showing trends in colour, state and reaction with other halide ions.

(a) (i) C omplete and balance the chemical equation for the reaction of chlorine with aqueous potassium bromide.

$Cl_2$  +  KBr  ⟶  ......................................... [1]
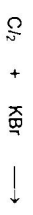
(ii) Describe what you would see when aqueous chlorine is bubbled into potassium bromide.

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

(iii) Explain why an aqueous solution of iodine does not react with potassium chloride.

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

(b) The table shows the properties of some halogens.

- Complete the missing spaces in the table.
- Suggest a value for the boiling point of bromine.

| halogen | state at room temperature | colour | boiling point/ °C |
|---|---|---|---|
| fluorine | gas | yellow | -188 |
| chlorine | | green | -35 |
| bromine | | | |
| iodine | solid | | 184 |

[3]

3  The head of a safety match contains potassium chlorate and antimony sulfide. The side of the matchbox contains red phosphorus.
When a match is struck on the side of the box, the friction produces enough heat to light the match.

(a)  The equation for this reaction is shown

$$5KClO_3 + 6P \rightarrow 5KCl + 3P_2O_5$$
potassium chlorate          phosphorus(V) oxide

Which substance is oxidised and which is reduced? Explain your answer in terms of oxygen gain or loss

substance oxidised .................... [1]

explanation ....................

substance reduced ....................

explanation .................... [1]

(b)  Phosphorus(V) oxide, $P_2O_5$, absorbs water from the air to form meta-phosphoric acid, $HPO_3$.

(i)  Write an equation for this reaction .................... [1]

(ii)  On addition of more water, phosphoric acid is formed. Phosphoric acid has typical acidic properties.

What would you observe when aqueous phosphoric acid is added to

aqueous sodium carbonate. ....................

blue litmus paper? .................... [2]

**[Turn over]**

4  Fig. 4.1 describes some of the reactions of calcium oxide.
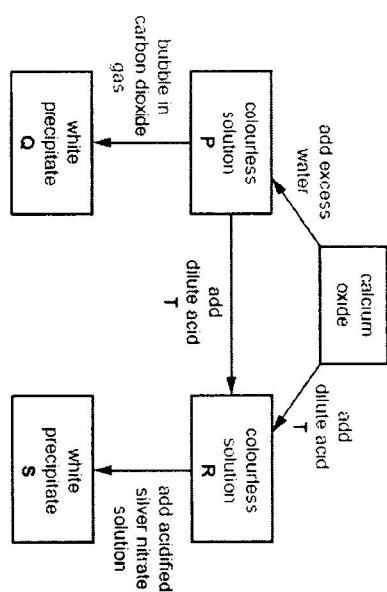


Fig. 4.1

(a)  Identify substances P, Q, R, S and T.

P ....................

Q ....................

R ....................

S ....................

T .................... [5]

(b)  Write a balanced equation for any one of the reactions in Fig. 4.1. .................... [1]

5  Carbon is an element in Group IV. Two of the oxides of carbon are carbon monoxide, CO and carbon dioxide, CO₂.

(a)  Draw the electronic structure of one molecule of carbon dioxide.
Show only the outer shell electrons.

[2]

(b)  Carbon monoxide is an air pollutant.

(i)  Give the source of this pollutant and describe one of its harmful effects.

...........................................................................................

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

(ii)  Carbon monoxide also plays a role in the extraction of iron in the blast furnace.
Explain the role played by carbon monoxide in this extraction.

...........................................................................................

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

[Turn over

6  A student investigated the reaction between zinc and hydrochloric acid using the apparatus shown below. The zinc was in excess.

zinc + hydrochloric acid → zinc chloride + hydrogen
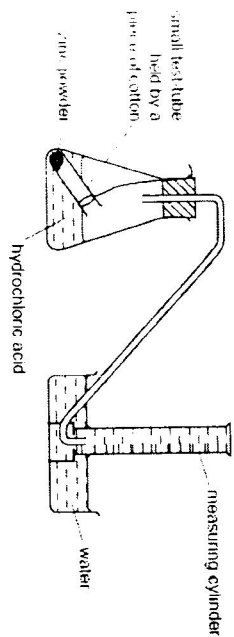


The student measured the volume of gas in the measuring cylinder at minute intervals.
The results are shown in the table.

| time / minutes | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| volume of gas / cm³ | 0 | 15 | 23 | 30 | 33 | 35 | 35 | 35 |

(a)  Plot the results on the grid below and draw the best curve through the points.



[2]
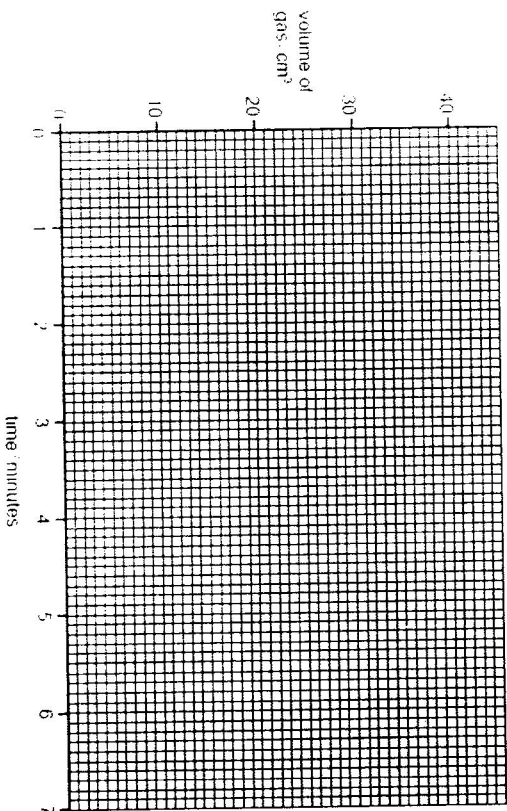
(b)  Explain why the volume of gas stays the same after 5 minutes.

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

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17

(c) Indicate on your graph how to estimate the volume of gas evolved after 2.5 minutes. Record your result below.

volume of gas evolved = .................... cm³ [1]

(d) Calculate the average speed of reaction over the first 4 minutes in cm³ per minute.

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

7 Urea, (NH₂)₂CO is formed by reacting together ammonia NH₃ and carbon dioxide CO₂.

$2NH_3 (g) + CO_2 (g) \rightarrow (NH_2)_2CO (s) + H_2O (l)$

(a) What mass of urea can be formed from 68g of ammonia?

Mass of urea = .................... [3]

(b) Use your knowledge of particles of gases to explain why an increase in temperature will increase the rate at which these two gases, ammonia and carbon dioxide, will react.

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

[Turn over

8 Petroleum is separated into fractions by fractional distillation.

(a) Explain how fractional distillation separates petroleum into different fractions.

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

(b) When long-chained alkanes are cracked in an oil refinery, shorter-chained alkanes and alkenes are formed.

(i) Give a reason why the process of cracking is carried out.

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

(ii) Tetradecane, C₁₄H₃₀ can be cracked to form an alkene containing eight carbon atoms and an alkane.

Construct an equation for this reaction.

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

**9 (a)** A plant contains the coloured compounds chlorophyll and carotene.
Chlorophyll and carotene can be made in the laboratory from isoprene.

$$CH_2 = C - CH = CH_2$$
$$\quad\quad | $$
$$\quad\quad CH_3$$
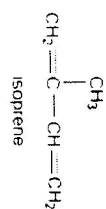
isoprene

Isoprene is an unsaturated compound

What do you understand by the term *unsaturated*?

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

**(b)** The diagram shows the repeat unit of poly(propene).

$$\left[ \begin{array}{cc} CH_3 & H \\ | & | \\ C - C \\ | & | \\ H & H \end{array} \right]_n$$
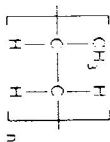
Draw the structure of the monomer used to make poly(propene).

[1]

[Turn over

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**Section B**

Answer any **two** questions in this section

Write your answers in the spaces provided

**10** A metallic element **M** has the following properties

- less dense than water
- soft
- melts below 100°C
- occurs naturally as its chloride, formula MCl

**(a)** Suggest to which Group of the Periodic Table metal **M** belongs

Suggest how metal **M** can be extracted from its compounds. Explain your reasoning.

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

**(b) (i)** Describe an experiment to prepare crystals of MCl, starting with the carbonate, M$_2$CO$_3$.

...................................................................................................................... [4]

**(ii)** Describe one chemical test to distinguish between ammonium chloride, NH$_4$Cl and MgCl$_2$.

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

11  Propane is an alkane and propene is an alkene.

(a)  Draw the structural formulae of propane and propene. Label your diagrams.

.................................................................................................................................

.................................................................................................................................

.................................................................................................................................

.................................................................................................................................

[2]

(b)  Compare the chemical properties of propane and propene.

Your answer should include the **similarities** and **differences** in their

•   combustion reactions,
•   reaction with aqueous bromine.

Give an equation for any of the reactions you discuss.

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.................................................................................................................................

[5]

(c)  Propane undergoes a photochemical substitution reaction with chlorine gas.

Explain, with the help of an equation, why this reaction is a *substitution* reaction and suggest why it is described as *photochemical*.

.................................................................................................................................

.................................................................................................................................

[3]

**[Turn over**

12  A student is asked to find an order of reactivity for the three elements: calcium, copper and sodium.

(a)  Describe how the reactions of the three elements with water could be used to find this order.

Write the chemical equation for any one of these reactions you describe.

State symbols **are not** required.

.................................................................................................................................

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.................................................................................................................................

[6]

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12 (b) Calcium reacts with dilute hydrochloric acid to form calcium chloride.

$$Ca(s) + 2HCl(aq) \longrightarrow CaCl_2(aq) + H_2(g)$$

A student added 1.5g of calcium to 50 cm³ of 0.10 mol / dm³ hydrochloric acid.

(i) Calculate the number of moles of calcium present.

(ii) Calculate the number of moles of hydrochloric acid present.

(iii) The calcium used is in excess. Calculate the volume of hydrogen formed in this reaction, measured at room temperature and pressure.

.....................................................................................................................................

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.....................................................................................................................................

.............................................. [4]

END OF PAPER

[Turn over

**Data Sheet**
**Colour of Some Common Metal Hydroxides**

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

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

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

[Turn over

15

22

**2016 4E5N Prelim 2 Sc Chem Paper 3**
**Marking Scheme**

| Qn | Answers | Mark |
|---|---|---|
| 1a | A, D, E [1] <br> They have the same number of protons and electrons. [1] | 2 |
| 1b | C [1] <br> It has more electrons than protons. [1] | 2 |
| 1c | B and F | 1 |
| 1d | They have the same number of protons but different number of neutrons | 1 |
| 2ai | $Cl_2 + 2KBr \longrightarrow 2KCl + Br_2$ | 1 |
| ii | A brown/ orange/ red-brown solution is formed | 1 |
| iii | Iodine is less reactive than chlorine / iodine is a less good oxidising agent <br> ALLOW bond between potassium and chlorine / iodine is too strong for iodine to react | 1 |

| halogen | state at room temperature | colour | boiling point/ °C | [6] |
|---|---|---|---|---|
| fluorine | gas | yellow | -188 | |
| chlorine | gas | green | -35 | |
| bromine | *liquid* | *red/ brown* | **59** <br> ALLOW range of 26 - 183 | |
| iodine | solid | *black* <br> NOT – brown/ brown-black/ purple | 184 | |

5 correct – 3m
3-4 correct – 2m
1-2 correct – 1m

---

| Qn | Answers | Mark | Examiner's Report |
|---|---|---|---|
| 3a | *substance oxidised* phosphorus / P [1] <br> *explanation* Phosphorus gains oxygen [1] <br> *substance reduced* potassium chlorate / KClO₃ [1] <br> *explanation* Potassium chlorate loses oxygen [1] | 2 | |
| 3bi | $P_2O_5 + H_2O \rightarrow 2HPO_3$ <br> ALLOW multiples <br> IGNORE state symbols | 1 | |
| 3bii | *aqueous sodium carbonate* effervescence / bubbling [1] <br> NOT carbon dioxide given off | 2 | |
| | *blue litmus paper* turns red [1] | 1 | |
| 4a | P calcium hydroxide / Ca(OH)₂ <br> Q calcium carbonate / CaCO₃ <br> R calcium chloride CaCl₂ <br> S silver chloride / AgCl <br> T hydrochloric acid / HCl | 5 | |
| 4b | any one equation below [1m] <br> CaO + 2HCl → CaCl₂ + H₂O <br> Ca(OH)₂ + 2HCl → CaCl₂ + 2H₂O <br> CaCl₂ + 2AgNO₃ → Ca(NO₃)₂ + 2AgCl <br> Ca(OH)₂ + CO₂ → CaCO₃ + H₂O <br> CaO + H₂O → Ca(OH)₂ | [6] | |
| 5a |  <br> - 8 shared electrons [1] <br> - 2 lone pairs per oxygen atom [1] <br> **Deduct 1m** if atoms are not labelled as C and O atoms | 2 | |
| 5bi | source is <u>incomplete combustion of carbon-containing substances</u> [1] <br> Harmful effect is <u>carbon monoxide is toxic and causes death/ it is poisonous and causes death/ prevents blood from absorbing oxygen and causes death.</u> [1] | 2 | |
| 5bii | Carbon monoxide reduces iron(III) oxide to iron | 1 | |

| Qn | Answers | Mark | Examiners Report |
|---|---|---|---|
| 6ai |  correct plotted points – 1m <br> smooth curve – 1m | 2 | |
| aii | All the hydrochloric acid is used up | 1 | |
| aiii | volume of gas evolved = 26.5 cm³ <br> ALLOW range of 26 – 27 cm³ AND indicate on graph | 1 | |
| aiv | 33 cm³ / 4 min = 8.25 cm³ per min [1] | 1 | |
| 7a | mol of NH₃ = 68 / 17 = 4 mol [1] <br> ratio of mol = 2 NH₃ : (NH₂)₂CO <br> 4 mol : 2 mol <br> mol of urea = 2 mol [1] <br> mass of urea = mol x Mᵣ <br> = 2 x 60 <br> = 120g [1] <br> ALLOW ecf | [5] <br> 3 | |
| 7b | - The particles of gas will gain more kinetic energy / move at a higher speed / more particles having the activation energy [1] <br> - resulting in increase in frequency of effective collisions [1] | 2 | |

| Qn | Answers | Mark | Examiners Report |
|---|---|---|---|
| 8a | any three from <br> - idea that fractions separate because they have different boiling points [1] <br> - temperature higher at bottom of column than at top [1] <br> - molecules move up column so heavier ones at the bottom/ lighter ones at top (larger ones at bottom/ smaller ones at top) [1] <br> - larger molecules have higher boiling points / smaller molecules have lower boiling points [1] <br> - molecules condense when temperature in column falls below boiling point [1] | 3 | |
| 8bi | to produce more petrol/ because the demand for petrol is greater than the supply <br> ALLOW short chained alkanes are in higher demand as fuels <br> ALLOW alkenes can be used to make polymers/ plastics | 1 <br> 1 | |
| 9a | contains carbon carbon double bond / C = C bond | 1 | |
| c | $C_{10}H_{20} \longrightarrow C_8H_{16} + C_2H_4$ | 1 <br> [5] <br> [2] | |
| | CH₃ H <br> \| \| <br> C = C <br> \| \| <br> H H | | |
| 10 a | Group I [1] <br> Metal M can be extracted by electrolysis [1] <br> This is because in the compound of M, the bonds are very strong and a lot of energy is needed to break the bonds. [1] | 3 | |
| b | acid used is hydrochloric acid [1] | 4 | |
| | any three from <br> • Pipette 25.0 cm³ of M₂CO₃ into a conical flask. <br> • Add 3-5 drops of screened methyl orange. The screened methyl orange turns green. <br> NOT Universal Indicator <br> ALLOW methyl orange / phenolphthalein <br> methyl orange turns yellow, phenolphthalein turns pink <br> • Add hydrochloric acid from a burette into the conical flask until the screened methyl orange turns red (methyl orange turns red, phenolphthalein turns colourless) <br> • Record the volume of M₂CO₃ used. Repeat the experiment <br> • The resulting solution is MCl. Evaporate the solution to the point of saturation. <br> • Wash the crystals with distilled water. / Dry the crystals with filter paper. <br> but without the indicator <br> [3] | | |

| Qn | Answers | Mark | Examiners Report |
|---|---|---|---|
| 10 bii | Add aqueous sodium hydroxide to both solutions [1]<br>Either<br>Ammonium chloride will produce ammonia gas on heating [1]<br>OR<br>Calcium chloride will not produce any gas on heating [1]<br>OR<br>Calcium chloride will form white ppt [1]<br>ammonium chloride will not form any ppt [1] | 3 | |
| 11 a | propene [1]<br><br>H H H<br>H – C – C – C – H<br>H H H<br>propene<br><br>H H H<br>H – C – C – C – H<br>H H H<br>propane [1] | 2 | |
| 11 b | • Both propane and propene undergo combustion to produce carbon dioxide and water<br>• But propene produces more soot than propane [1]<br>• Propene decolourises aqueous bromine (to form 1, 2 – dibromopropane) [1]<br>• Propane does not react with bromine [1]<br>any one of the following | 5 | |
| 11 c | An atom of hydrogen has been substituted with an atom of chlorine [1]<br>Photochemical means light is needed for the reaction to occur/ to catalyse the reaction [1]<br><br>$C_3H_8 + Cl_2 \rightarrow C_3H_7Cl + HCl$ [1]<br>$2C_3H_8 + 9O_2 \rightarrow 6CO_2 + 6H_2O$ OR<br>$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$ [1]<br>$C_3H_6 + Br_2 \rightarrow C_3H_6Br_2$ [1] | 3 | |
| 12 a | • Calcium reacts readily/ fast with cold water/ producing a lot of effervescence [1]<br>• Copper does not react with water or steam [1]<br>• Sodium reacts violently with cold water/ reacts faster with cold water than calcium/ producing a lot of effervescence, more than calcium [description must be more reactive than calcium] [1]<br>• The hydrogen may catch fire producing a yellow flame [1]<br>• Order of reactivity. Sodium is the most reactive followed by calcium and then copper [1]<br>• $Ca + 2H_2O \longrightarrow Ca(OH)_2 + H_2$ OR<br>$2Na + 2H_2O \longrightarrow 2NaOH + H_2$ [1] | 6 | |

| 12 b | mol of Ca = 1.5 ÷ 40<br>= 0.0375 mol [1]<br><br>mol of HCl = 2HCl<br>= vol of solution x conc<br>= 0.05 x 0.10 [1]<br>= 0.005 mol<br><br>ratio of mol = 2HCl : $H_2$<br>= 0.005 : 0.0025 mol [1]<br><br>vol of $H_2$ = mol x 24 dm³<br>= 0.0025 x 24 [1]<br>= 0.06 dm³<br><br>ALLOW ecf | 4 | |

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**SCIENCE(CHEMISTRY) Paper 1**
**SECONDARY 4E5N**

**MULTIPLE-CHOICE ANSWER TABLE**

**SCIENCE (CHEMISTRY)**

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

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26

## The Periodic Table of the Elements

Group

| I | II | | | | | | | | | | | III | IV | V | VI | VII | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 1 H hydrogen 1 | | | | | | | | | | | He |
| 7 Li lithium 3 | 9 Be beryllium 4 | | | | | | | | | | | B 5 | C 6 | N 7 | O 8 | F 9 | Ne |
| 23 Na sodium 11 | 24 Mg magnesium 12 | | | | | | | | | | | Al 13 | Si 14 | P 15 | S 16 | Cl 17 | Ar |
| 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 | Ge germanium 32 | As arsenic 33 | Se selenium 34 | Br bromine 35 | Kr |
| 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 | Te tellurium 52 | I iodine 53 | Xe xenon |
| 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 | At | Rn |
| — 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 | Tm thulium 69 | Yb ytterbium | Lu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 = relative atomic mass
X = atomic symbol
b = proton (atomic) number

$\begin{array}{c} a \\ X \\ b \end{array}$

The volume of one mole of any gas is 24 dm³ at room temperature and

## Section A: 45 m

1. Select from the following list and write the method used for separating the following mixtures. The list can be used once, more than once or not at all.

chromatography, crystallization, electrolysis, filtration, distillation, fractional distillation, precipitation, sublimation

To separate:

a) water from a mixture of green and blue dyes in solution. [1]

b) iodine from a mixture of potassium chloride and iodine. [1]

c) zinc nitrate from a mixture of zinc nitrate and water. [1]

d) petrol from crude oil. [1]

2. Study the reaction scheme below and answer the questions that follow.

```
                    ┌─────────────────┐
                    │        A        │
                    │ blue salt solution │
                    └─────────────────┘
         aqueous      │    zinc    │    aqueous sodium
         ammonia      │   powder   │    hydroxide,
            │         │            │    aluminium foil,
            ▼         ▼            │    warm.
                                   ▼
    ┌──────────────┐  ┌──────────────────┐  ┌──────────────────┐
    │      B       │  │        C         │  │      Gas D       │
    │ blue precipitate │  │ red brown solid in │  │ turns damp red litmus │
    └──────────────┘  │ colourless solution │  │   paper blue     │
            │         └──────────────────┘  └──────────────────┘
    excess aqueous
       ammonia
            │
            ▼
    ┌──────────────┐
    │  substance E │
    └──────────────┘
```

a) Identify the unknowns **A**, **B**, **C** and **D**.

   A: ....................................................................

   B: ....................................................................

   C: ....................................................................

   D: ....................................................................
   
   [4]

b) Describe the appearance of substance **E**.

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

3. A conical flask containing marble chips (mainly calcium carbonate) and excess dilute nitric acid is placed on an electronic balance. The mass of the conical flask and its contents is recorded at regular time intervals. The graph below shows the change in mass of the flask and its contents over time.
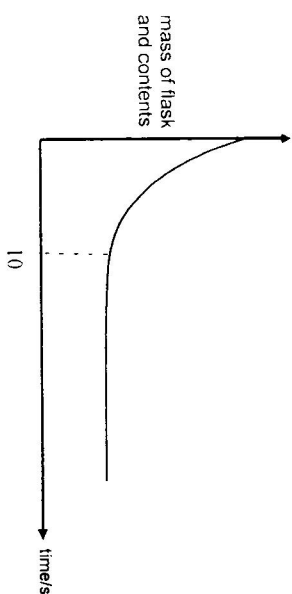
a) Write the balanced chemical equation between marble chips and nitric acid.

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

b) What causes the mass of the flask and its contents to decrease?

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

c) How can you tell from the graph that the rate of reaction is equal to zero, after 10 seconds?

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

d) The experiment is repeated under another set of conditions. The result is represented by curve **X**.

**4. a)** Magnesium chloride has a solubility of 55.8 g per 100 cm³ of water at 30 °C.

(i) Calculate the relative formula mass of magnesium chloride.

relative formula mass= ................... [1]

(ii) Calculate the number of moles of magnesium chloride that can be dissolved in 100 cm³ of water at 30 °C.

number of moles of magnesium chloride = ................... [1]

(iii) Use your answer in **(a)(ii)** to calculate the concentration of the magnesium chloride solution in mol/dm³.

concentration = ................... [1]

Suggest two changes that are made to the reaction mixture to obtain the results shown by curve **X**.

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

**b)** Magnesium chloride can be prepared by the reaction below.

$$MgCO_3 \, (s) + 2HCl \, (aq) \rightarrow MgCl_2 \, (aq) + CO_2 \, (g) + H_2O \, (l)$$

Calculate the mass of magnesium carbonate needed to produce 0.500 mol of magnesium chloride.

mass of magnesium carbonate = ................... [2]

**5.** Nitrogen oxide (NO), carbon monoxide and unburned hydrocarbons are some common pollutants that can be found in exhaust fumes.

A common way of cutting down the release of these pollutants is to pass the exhaust fumes through a catalytic converter.

A three-way catalytic converter converts these harmful gases into harmless gases through the process of reduction and oxidation as shown in equations **1** to **3**.

Equation **1**:   $2NO \, (g) \rightarrow N_2 \, (g) + O_2 \, (g)$

Equation **2**:   $2CO \, (g) + O_2 \, (g) \rightarrow 2CO_2 \, (g)$

Equation **3**:   unburned hydrocarbons + oxygen → carbon dioxide + water
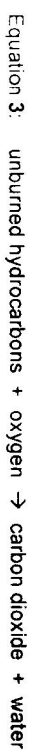
**a)** Classify equations **1** to **3** in the table below as shown in the headings below.

| *Reduction of pollutant has taken place* | *Oxidation of pollutant has taken place* |
| --- | --- |
| | |

[3]

b) The volume of nitrogen oxide (NO) remaining in the exhaust fumes after passing through catalytic converter is measured against temperature of the catalytic converter, and plotted as shown in the graph below.
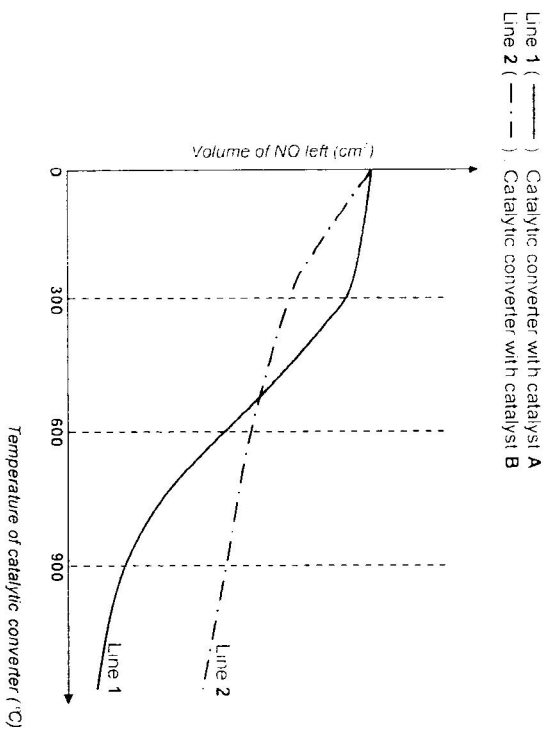


Line 1 ( ——— ) Catalytic converter with catalyst **A**
Line 2 ( — · — ) Catalytic converter with catalyst **B**

Optimal temperature of the catalytic converter is reached when there is a significant increase in the amount of nitrogen oxide removed from the exhaust fumes.

What is the optimal temperature that the catalytic converter with catalyst **A** (Line 1) must reach for catalyst **A** to be effective in removing nitrogen oxide from the exhaust fumes?

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

c) In your opinion, which is the better catalyst for use in a catalytic converter, catalyst **A** or **B**, for long journeys?

Briefly explain your choice, using information from the graph above.

.....................................................................................................

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

6. The diagram below illustrates the reaction that takes place when a small piece of potassium is dropped onto cold water mixed with a little Universal Indicator.
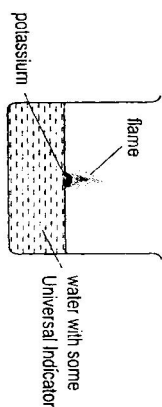


The potassium metal dissolves rapidly in the water, producing a large amount of heat and a gaseous product.

a) What is the name given to a reaction which produces heat energy?

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

b) Name the products formed when potassium reacts with cold water.

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

c) Predict how the observation would differ when a piece of caesium is used instead of potassium metal.

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

d) Write a balanced chemical equation for the reaction between caesium and water

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

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30

7. Hydrogen(H), Deuterium (D) and Tritium (T) are isotopes of one another. Their atomic structures are shown below.

Hydrogen      Deuterium      Tritium

| Neutron: ● |
| Proton: ○ |
| Electron: x |
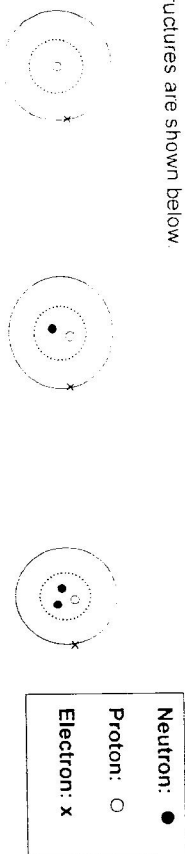
a)   Use the information above to complete the following table.

| Name | Nucleon Number | Number of Protons | Number of Neutrons |
|---|---|---|---|
| Hydrogen | | | |
| Deuterium | | | |
| Tritium | | | |

b)   Explain why the three atoms are described as isotopes.

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

8. a)   The table below shows information about solutions of an acid and an alkali. Complete the table by filling in the empty boxes.

| Solution | colour change when mixed with Universal Indicator solution | formula of ion that causes this colour change |
|---|---|---|
| dilute sulfuric acid | from green to red | |
| dilute sodium hydroxide | | |

[3]

b)   Potassium nitrate is a salt which can be prepared by reacting an acid with an alkali, using the titration method.

(i)   Name an acid and an alkali which react together to make potassium nitrate.

Acid: ....................................................................

Alkali: ................................................................... [2]

(ii)   Explain why the titration method is suitable for the preparation of potassium nitrate.

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

9. Chlorine, bromine and iodine are elements from Group VII of the Periodic Table. When chlorine gas is passed through a colourless solution of aqueous iron(II) bromide, the colour of the solution changes.

a)   State the colour change in the reaction above.

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

b)   Write the ionic equation, with state symbols, of the reaction above.

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

c)   Explain, with reason, the colour change if aqueous iodine is passed through a solution of aqueous iron(II) bromide.

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

## Section B: 20 m

**Answer any TWO questions in this section in the spaces provided.**

1. a) Oxygen can form ionic and covalent bonds with other elements.

   (i) Give an example of an ionic compound formed by oxygen

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

   (ii) Give an example of a covalent compound formed by oxygen.

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

   (iii) Draw a 'dot-and-cross' diagram to show the bonds between atoms in the compound you have named in (a)(i). Show only the valence electrons.

   [2]

   b) 'Tin cans' are often used as containers for food. In fact 'tin can' is made from a steel alloy with a thin coating of tin on it. To recover the tin from used cans, they are crushed and then warmed with chlorine. The tin forms tin(IV) chloride, boiling point 114°C, which distils from the mixture. On stronger heating, the tin(IV) chloride decomposes into molten tin and chlorine, which is reused.

   (i) Suggest why the steel alloy is coated with tin for use in food containers.

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

   (ii) Based on the information provided, what type of bonding is found in tin(IV) chloride? Explain your answer.

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

   (iii) Construct a balanced equation for the decomposition of tin(IV) chloride into molten tin and chlorine, with state symbol.

   Explain why this decomposition is an example of a redox reaction in terms of oxidation state.

   ..............................................................................................

   ..............................................................................................

   .............................................................................................. [4]

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32

2. a) Briefly describe three chemical properties of ethanoic acid ($CH_3COOH$).

...........................................................................................................................................

...........................................................................................................................................

[3]

b) Salts obtained from ethanoic acid are called ethanoates.
All ethanoates are soluble in water, except for silver ethanoate.

(i) Suggest a suitable reactant that can be used with ethanoic acid to produce the insoluble salt, silver ethanoate.

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

(ii) Using the reactant named in (b)(i) and ethanoic acid, briefly describe how you can obtain a dry sample of silver ethanoate.

...........................................................................................................................................

...........................................................................................................................................

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

c) Write the balanced chemical equation, with state symbols, for the reaction between zinc and sulfuric acid.
Describe the chemical test for the gas produced.

...........................................................................................................................................

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

3a) Organic compounds form homologous series. Give three general characteristics of members of homologous series.

...........................................................................................................................................

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

b) Ethene is an alkene. It reacts with hydrogen to form ethane.

$$C_2H_4 \text{ (g)} + H_2 \text{ (g)} \rightarrow C_2H_6 \text{ (g)}$$
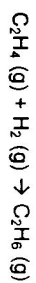
(i) Name the type of reaction and state the conditions for the reaction.

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

(ii) Both ethene and ethane are hydrocarbons. Define hydrocarbons.

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

(iii) Describe a test, including the observations, you will use to differentiate between ethene and ethane.

...........................................................................................................................................

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

(iv) Using ethene as a monomer, draw part of the structure of the polymer showing 6 carbon atoms.

[2]

# DATA SHEET

## 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 |

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34

## Marking Scheme

0Prelim Examination 2016
Secondary 4Exp/ 5NA
Science Chemistry

### Paper 1 [20m]:

| 1. B | 2. B | 3. C | 4. A | 5. D |
|------|------|------|------|------|
| 6. D | 7. D | 8. B | 9. A | 10. B |
| 11. B | 12. D | 13. C | 14. B | 15. C |
| 16. B | 17. A | 18. D | 19. B | 20. C |

### Paper 3: Section A [45m]:

1a) distillation;
b) sublimation;
c) crystallisation;
d) fractional distillation;

2a) A: copper(II) nitrate, CU(NO$_3$)$_2$ ;
B: copper(II) hydroxide, Cu(OH)$_2$;
C: copper, Cu
D: ammonia, NH$_3$;
b) dark blue solution;

3a) CaCO$_3$ + 2HNO$_3$ → Ca(NO$_3$)$_2$ + CO$_2$ + H$_2$O
[correct formula and balancing;]
b) CO$_2$ gas escapes from the flask;
c) the gradient of the graph is horizontal;
d) increase concentration of nitric acid;
crush up the marble chips;
increase temperature of acid;

4a)(i) Mr of MgCl$_2$ = 24 + 2(35.5) = 95;
(ii) no of moles = 55.8/ 95 = 0.587 mol;
(iii) concentration = 0.587/ (100/1000) = 5.87 mol/dm$^3$ ;
b) no of moles of MgCO$_3$ = 0.500 mol;
mass = 0.5 × [24 + 12 + 3(16)] = 42g ;

5a)

| Reduction of pollutant has taken place | Oxidation of pollutant has taken place |
|---|---|
| 1 | 2,3 |

1m each

b) 300 °C;
c) catalyst A.
at higher temperature, less nitrogen oxide is detected in the fumes [at 900 °C, Line 1 is lower than Line 2];

6a) exothermic;
b) potassium hydroxide; and hydrogen gas;
c) flame will be bigger, caesium metal dissolves/ disappears faster;
d) 2Cs + 2H$_2$O → 2CsOH + H$_2$
[correct formula and balancing- 1m]

**7a)**

| Name | Nucleon Number | Number of Protons | Number of Neutrons |
|---|---|---|---|
| Hydrogen | 1 | 1 | 0 |
| Deuterium | 2 | 1 | 1 |
| Tritium | 3 | 1 | 2 |

Correct column- 1m

**b)** they are atoms of the same element / same number of protons but different number of neutrons ;

**8a)**

| Solution | colour change when mixed with Universal Indicator solution | formula of ion that causes this colour change |
|---|---|---|
| dilute sulfuric acid | from green to red | $H^+$ |
| dilute sodium hydroxide | From green to purple | $OH^-$ |

Each – 1m

**b)(i)** Acid: nitric acid;
Alkali: potassium hydroxide;

**(ii)** both the reagents are soluble in water;

**9a)** colourless to brown

**b)** $Cl_2 (g) + 2Br^- (aq) \rightarrow Br_2 (l) + 2Cl^- (aq)$

---

correct formula and balancing – 1m

correct state symbols– 1m

**c)** there will be no reaction as iodine is less reactive than bromine thus no displacement reaction will take place;

**Paper 3:Section B [20m]:**

**1a)(i)** magnesium oxide, MgO [or any other relevant answers];

**(ii)** carbon dioxide, $CO_2$ [or any other relevant answers, oxygen, $O_2$ is rejected];

**(iii)**
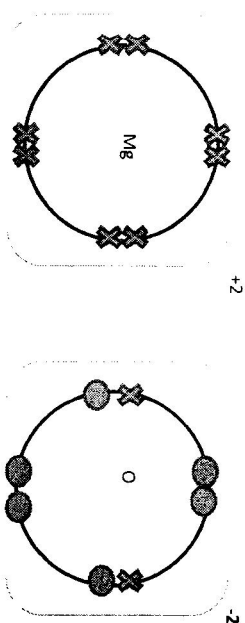


Key:  ✗✗ electrons of Mg
🔵 electrons of O

Correct drawing of electrons: 1m
Correct sharing of electrons: 1m
No key: minus 1m

**b)(i)** to prevent rusting of iron;

**(ii)** $SnCl_4$;

**(iii)** covalent bonding as its boiling point is low;

**(iv)** $SnCl_4 \rightarrow Sn + 2Cl_2$
Correct formula and balancing – 1m

Tin is reduced as its oxidation state decreases from +4 to 0;

Chlorine is oxidised as its oxidation state increases from -1 to 0 ;

2a)
1.    Ethanoic acid reacts with <u>reactive metals</u> to give <u>salt and hydrogen gas</u>;

2.    ethanoic acid reacts with a <u>base/ alkali</u> to give <u>salt and water</u>;

3.    ethanoic acid reacts with a <u>metal carbonate</u> to give <u>salt, water and carbon dioxide gas</u>;

(iii)   Test: using <u>aqueous bromine</u>;

Observation: for ethene, aqueous bromine will turn from <u>brown to colourless</u>, for ethane, it will <u>remain brown</u>;

(v)



b)(i)   <u>silver nitrate</u> [or other soluble silver salts];

(ii)   1. Measure 10cm³ of silver nitrate solution and ethanoic acid and pour into a small beaker.

2. Filter through a filter funnel.

3. Wash the precipitate obtained [residue] with distilled water and dry it between filter paper. Collect the salt.

1m each

c)   $Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$
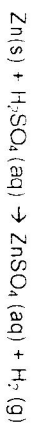
correct formula and balancing – 1m

correct state symbol- 1m

using a <u>lighted wooden splint</u>, it will <u>extinguish with a 'pop' sound</u>,

3a)
1. They have same functional group.
2. They have similar chemical properties.
3. They show a gradual change in their physical properties.
4. Each member differs by a –CH₂- group.

[any 3 points- 1m each]

b)(i)   <u>addition of hydrogen/ hydrogenation</u>; nickel catalyst, 200°C;

(ii)   compounds that contains <u>only hydrogen and carbon</u>;

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37

Name: _____ ( )

Class: _____

# CHIJ KATONG CONVENT
# PRELIMINARY EXAMINATIONS 2016
## Secondary Four Express and
## Secondary Five Normal (Academic)

## SCIENCE (CHEMISTRY)

5076/03
5078/03

Duration: 1 hour 15 minutes

Classes: 403, 404, 405, 406 and 500

Candidates answer on the Question Paper.

**READ THESE INSTRUCTIONS FIRST**

Write your name, class and registration number 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 or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid/ tape.

**Section A**
Answer **all** questions
Write your answers in the spaces provided on the Question Paper.

**Section B**
Answer **any two** questions
Write your answers in the spaces provided on the Question Paper.

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 14.
A copy of the Periodic Table is printed on page 15

| FOR EXAMINER'S USE | |
|---|---|
| Paper 1 | / 20 |
| Paper 3 | |
| Section A | / 45 |
| Section B | / 20 |
| TOTAL | / 85 |

This question paper consists of 15 printed pages

[Turn over

---

**Section A [45 marks]**
Answer **all** the questions in the spaces provided

1   Fig. 1.1 shows the chromatogram of dyes F, G, H, I, J and K
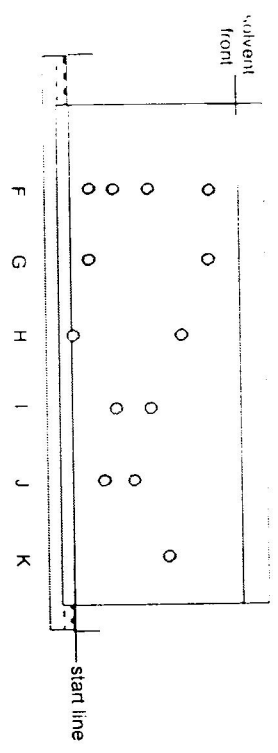


Fig. 1.1

(a)   State and explain which of the dye(s) is/are pure

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

(b)   State the dye which **is** a mixture of dyes G and I.

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

[Total: ]

2   An early version of the Periodic Table has several missing elements which had not yet been discovered. One of the elements is the transition element, talendium, Ta.

One isotope of talendium has the symbol $^{98}_{43}Ta$.

(a)   Complete the table to show the number of sub-atomic particles in one atom of this isotope.

| number of protons | |
|---|---|
| number of electrons | |
| number of neutrons | |

[1]

(b)   Define the term *isotopes*

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

2

[Turn over

2 (c) Explain, in terms of sub-atomic particles and their charge, why an atom of $^{98}_{43}Ta$ is electrically neutral.

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

3   In each of the following, <u>underline</u> the formula of substance that is being reduced.

Give a reason in each case.

(a)   $CO_2 + H_2 \rightarrow H_2O + CO$

reason .................................................................

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

(b)   $2Fe^{3+} + Sn^{2+} \rightarrow 2Fe^{2+} + Sn^{4+}$
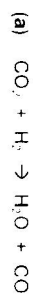
reason .................................................................

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

[Total: 4]

4   A student has mixed up two beakers of colourless aqueous solutions, one containing sodium chloride and the other containing calcium chloride.

Describe one test the student can perform to differentiate the two solutions and state the outcome of the test for each solution

test .................................................................[1]

outcome with sodium chloride .................................................................[1]

outcome with calcium chloride .................................................................[1]

[Total: 3]

3

---

5   The equation for the reaction of sodium oxide with water is shown.

$$Na_2O + H_2O \rightarrow 2NaOH$$
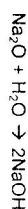
(a)   The sodium hydroxide solution is made by dissolving 1.24 g of sodium oxide in water and making the volume up to 500 cm³.

(i)   Calculate the concentration of the sodium hydroxide solution in mol/dm³.

concentration = ....................... mol/dm³ [2]

(ii)   Hence or otherwise, calculate the concentration of sodium hydroxide solution in g/dm³.

concentration = ....................... g/dm³ [1]

(b)   If 1.24 g of sodium oxide is reacted with 1.80 g of water, calculate the mass of sodium hydroxide formed and the mass of water which remains unreacted.

mass of sodium hydroxide formed ...........g [2]

mass of unreacted water ..........g [2]

[Total: 7]

4

[Turn over]

**6** Table 6.1 shows the average percentage composition of air in Singapore in January 2015 measured over two time intervals.

Table 6.1

| gas | % composition of air 9 am - 3 pm | % composition of air 9 pm - 3 am |
|---|---|---|
| $CO_2$ | 0.03 | 0.03 |
| CO | 0.3 | 0 |
| $N_2$ | 78 | 78 |
| $SO_2$ | 0.9 | 0.1 |
| R | 20 | 20 |

**(a)** Suggest the name of gas R and describe a test to confirm the identity of the gas.

.............................................................................................................

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

**(b)** With reference to Table 6.1, explain why the percentage composition of air is different between 9 am - 3 pm and 9 pm - 3 am.

.............................................................................................................

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

**(c)** Name the pollutants shown in the table and state their harmful effects.

.............................................................................................................

.............................................................................................................

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

**(d)** Name one other air pollutant not shown in the table and state the source of this pollutant.

.............................................................................................................

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

[Total: 8]

---

**7** Three solid samples are placed in beakers L, M and N for investigation.

The contents of the beakers are as follows.
Beaker L - 1 g of copper(II) carbonate powder
Beaker M - 1 g of copper(II) carbonate lumps
Beaker N - 1 g of copper powder

The beakers L, M and N containing the solid samples are placed on three electronic balances and 50 cm³ of dilute sulfuric acid is added to each beaker. A data logger is used to plot the mass of the contents in each beaker against time. The results for beakers M and N are shown in Fig. 7.1.



Fig. 7.1
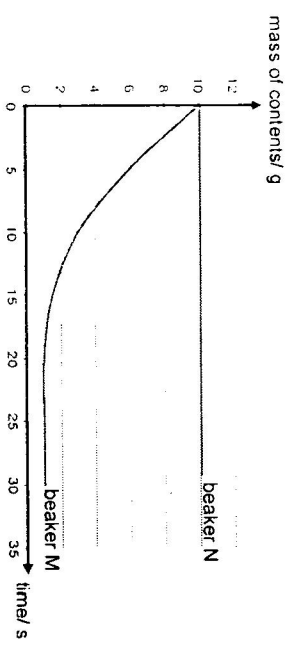
**(a)** Explain the loss in mass for beaker M.

.............................................................................................................

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

**(b)** State and explain the shape of the graph for beaker N.

.............................................................................................................

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

**(c) (i)** On Fig. 7.1, sketch and label the graph for beaker L.

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

**(ii)** Explain how the particle size of copper(II) carbonate affects the rate of reaction as shown in (c)(i).

.............................................................................................................

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

[Total: 6]

41

8   Fig. 8.1 gives the properties and reactions of substances **A** to **E**.
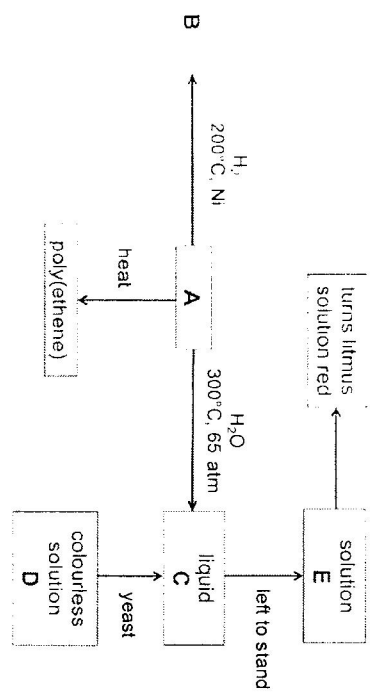


**Fig. 8.1**

(a)   Name solution **D**

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

(b)   Draw the full structural formula of compound **C**.

[1]

(c)   Describe a test to distinguish compounds **A** and **B**.

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

(d)   Compound **A** can be converted into poly(ethene) under high temperature and pressure.

Write an equation for this conversion, using the structural formulae of **A** and poly(ethene).

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

8   (e)   Solution **E** turns litmus solution red.

Draw the functional group responsible for this change.

[1]

[Total: 6]

9   Table 9.1 shows the melting and boiling points of some substances

**Table 9.1**

| substance | melting point/°C | boiling point/°C |
|---|---|---|
| sodium | | 182 |
| methane | 114 | 182 |
| | -370 | 914 |
| methane | 182 | 161 |
| bromine | -7 | 59 |
| silicon dioxide | 1610 | 2230 |
| lithium | 180 | 1360 |

Use the substances in Table 9.1 to answer the following questions. You may use each substance once, more than once, or not at all.

(a)   Which substance(s) is/are not solid(s) at room temperature and pressure?

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

(b)   Which substance is a liquid over the largest temperature range?

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

(c)   (i)   Which substance(s) conduct(s) electricity when molten?

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

    (ii)   For the substance(s) mentioned in (c)(i), explain why it conducts electricity when molten.

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

**9** (d) Methane and lead(II) bromide have very different melting points.

Explain in terms of bonding why this is so.

..............................................................................................................................................

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

[Total: 6]

---

Name ............................ (   )     Class _____

**Section B [20 marks]**

Answer any **two** questions in this section

Write your answers in the spaces provided

**10** A student wanted to prepare a sample of hydrated iron(II) sulfate crystals and recorded her procedure in her journal.

"I added granules of iron(II) carbonate to 100 $cm^3$ of 1.0 mol/dm³ of sulfuric acid at room temperature. Bubbles were observed and I kept on adding iron(II) carbonate until the bubbling stopped. There were some iron(II) carbonate that were left behind, which I removed. With the filtrate, I heated it until all the solvent was completely evaporated and a white solid was left behind."

(a) Write a balanced chemical equation, with state symbols, for the reaction between iron(II) carbonate and sulfuric acid.

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

(b) Draw a labelled diagram to show how she could have removed the iron(II) carbonate that was left behind

[2]

(c) State one error that he made in her preparation and describe what should have done instead.

..............................................................................................................................................

..............................................................................................................................................

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

**(d)** Calculate the volume of gas collected at r.t.p. from this reaction.

volume of gas = ..................................... $cm^3$ [3]

[Total: 10]

11 Iron is extracted by reducing iron ore in a blast furnace. Blasts of hot air are blown into the furnace from the bottom and waste gases which consist of carbon monoxide, carbon dioxide and nitrogen are released from the top.

**(a) (i)** Explain how carbon dioxide is produced in the blast furnace.

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

**(ii)** Draw a 'dot and cross' diagram showing the electronic structure of nitrogen gas. Show only the valence electrons.

**(iii)** Nitrogen gas does not take part in any reaction in the blast furnace as it is an inert gas. With reference to the diagram in **(a)(ii)**, give a reason for its inertness.

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

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

11 **(b)** In the centre of the blast furnace, iron(III) oxide is reduced by carbon monoxide to form iron and carbon dioxide. Near the bottom of the blast furnace, the remaining iron(III) oxide is reduced by carbon to from iron and carbon monoxide.

Write balanced chemical equations for both of these reactions.

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

**(c) (i)** The iron obtained from the blast furnace has high carbon content.

Draw a labelled diagram to show the arrangement of the atoms in this alloy.

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

**(ii)** With reference to the arrangement of the atoms in **(c)(i)**, explain why the alloy is stronger than pure iron.

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

[Total: 10]

**[Turn over**

12 The Periodic Table lists the elements in order of atomic number. With reference to the Periodic Table, answer the following questions.

(a) (i) Magnesium is an element in Period 3.

Explain how the electronic structure of this element can be used to determine which group the element is in.

.........................................................................................................................

.........................................................................................................................

.........................................................................................................................

[3]

(ii) On moving across Period 3 from Group I to Group VII the character of the elements changes.

Describe and explain the change.

.........................................................................................................................

.........................................................................................................................

.........................................................................................................................

[3]

(b) Francium is the heaviest of the known alkali metals and one of the most unstable elements in the Periodic Table.

By considering the properties of other elements in the same group as Francium, predict one physical property and one chemical property of this element.

Write a balanced chemical equation and one observation for the chemical property that you have described.

.........................................................................................................................

.........................................................................................................................

.........................................................................................................................

.........................................................................................................................

[4]

[Total: 10]

**Data Sheet**

**Colours of Some Common Metal Hydroxides**

| | |
|---|---|
| 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 |

| | | | | | | | | | | | | | | | | | | 4<br>He<br>Helium<br>2 |

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

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

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

Key: 
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.).

15

[Turn over

CHIJ Katong Convent Secondary
4E/5N Science Chemistry Prelim Exam 2016
Answer scheme

## Paper 1

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|----|
| C | B | A | C | A | B | C | D | D | D |

| 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|----|----|----|----|----|----|----|----|----|----|
| C | C | A | A | C | B | B | C | D | D |
| C | C | D | D | B | A | D | C | B | B |

### Section A

| Q. No. | Answers | Marks/ Remarks |
|---|---|---|
| 1(a) | Dye K shown in the chromatogram is pure as it has only one component/ spot. | [1] |
| 1(b) | Dye F.<br>R: one chromatogram/ one dye/ one susbtance | [1] |
| 2(a) | <table><tr><td>number of protons</td><td>43</td></tr><tr><td>number of electrons</td><td>43</td></tr><tr><td>number of neutrons</td><td>55</td></tr></table> | [1] |
| 2(b) | Isotopes are atoms of the same element having the same number protons but different number of neutrons | [1] |
| 2(c) | The atom is electrically neutral as it has 43 positively charged protons and 43 negatively charged electrons. | [1] |
| 3(a) | $CO_2 + H_2 \rightarrow H_2O + CO$ | [1] |
| | Carbon dioxide lose an oxygen atom to form carbon monoxide /<br>Oxidation number of carbon decreased from +4 in carbon dioxide to +2 in carbon monoxide. | [1] |
| 3 (b) | $2Fe^{3+} + Sn^{2+} \rightarrow 2Fe^{2+} + Sn^{4+}$ | [1] |
| | Iron(III) ion gain an electron to form iron(II) iron /<br>Oxidation number of iron decreased from +3 in iron(III) ion to +2 in iron(II) ion | [1] |
| 4 | test: Add aqueous sodium hydroxide/ sulfuric acid (separately to each solution | [1] |
| | outcome with sodium chloride:<br>No visible change/reaction when sodium hydroxide / visible change/reaction when sulfuric acid is added/solution remains colourless | [1] |
| | outcome with calcium chloride: | [1] |

5(a)(i) White precipitate (calcium hydroxide) forms, it is insoluble in excess sodium hydroxide/

**When sodium oxide reacts with HCl/ forms when sulfuric acid is added.**

Number of mole of $Na_2O = 1.24 \div 62 = 0.02$ mol
Number of mole $NaOH = 0.02 \times 2 = 0.04$ mol  [1]

5(a)(ii) Number of mole of $Na_2O = 1.24 \div 62 = 0.02$ mol
Number of mole $NaOH = 0.02 \times 2 = 0.04$ mol  [1]

Concentration of NaOH
= 0.04 / (500÷ 1000)
= 0.0800 mol/dm³  [1]

**Concentration of NaOH**
= 0.0800 × (23+16+1)
= 3.2 g/dm³

Or:
Mass of NaOH
= 0.04 x (23 + 16 +1)
= 1.6 g
Concentration of NaOH
= 1.6 / (500 ÷ 1000)
= 3.2 g/dm³  [1]

5(b) No. of moles of water = 1.8 ÷ 18 = 0.1 mol
No. of moles of sodium oxide = 0.02 mol  [1]

Sodium oxide is limiting reactant. (clue given in question)  [1]

Mass of water reacted
= 0.02 x 18
= 0.36 g  [1]

Mass of water remained
= 1.8 – 0.36
= 1.44 g  [1]

Mass of NaOH formed
= 0.04 x (23 + 16 + 1)
= 1.60 g  [1]

Allow ECF for mass obtained if number of moles is calculated correctly.  [1]

6 (a) Oxygen  [1]

Use a glowing splint. If it rekindles, the gas is oxygen.  [1]

6 (b) The percentage of CO and $SO_2$ are higher between 9 am – 3 pm ;  [1]

This is due to factories burning fossil fuel which give out $SO_2$ and more vehicles on the road which give out CO from incomplete combustion of fuel.  [1]

6 (c) Sulfur dioxide: respiratory problems / eyes irritation / acid rain which destroys building  [1]

Carbon monoxide: headaches / breathing difficulties / loss of consciousness which lead to eventual death as the gas prevents the blood from carrying oxygen to the parts of the body.  [1]
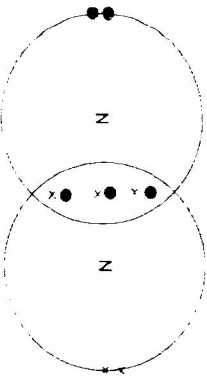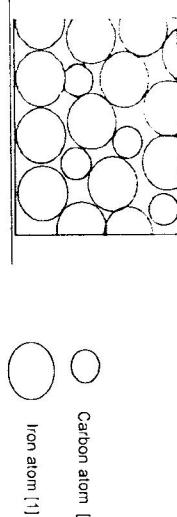
6 (d) Oxides of nitrogen: Lightning activity / internal combustion engines at high temperature  [1]

| Q. No. | Answers | Marks/Remarks |
|---|---|---|
| 7(a) | Methane: decay of plant or animal matter | |
| 7(a) | Carbon dioxide produced from the reaction of copper(II) carbonate and dilute sulfuric acid escapes to the surroundings – hence loss in mass | [1] |
| 7(b) | Graph is horizontal, gradient is zero – there is no reaction in beaker **N**. | [1] |
| | Copper is below hydrogen in the reactivity series, hence it has no reaction with dilute sulfuric acid / Copper is an unreactive metal. | [1] |
| | R graph remains constant, graph is a straight line, constant gradient | [1] |
| | R copper does not react, copper is not very reactive | |
| 7(c)(i) | Sleeper than graph for beaker M and ends in the same place. | [1] [1] |
| | beaker N | |
| | beaker L          beaker M | |
| 7(c)(ii) | The smaller the particle size of copper(II) carbonate (larger exposed surface area), the greater the total surface area in contact with the acid → greater the number of collisions→greater the number of effective collisions→ faster the rate of reaction. | [1] [1] |
| 8(a) | Glucose / sugar solution | [1] |
| 8(b) | Structure of ethanol | [1] |
| 8(c) | Bubble A and B into separate solutions of aqueous bromine | [1] |
| | A will decolourise reddish- brown aqueous bromine rapidly, while B will have no effect on aqueous bromine | [1] |
| | Note: A and B reacts, bromine cannot add bromine to A and B instead bubble A and B into bromine solution | |
| 8(d) | | [1] |
| 8(e) | high temperature and pressure / catalyst | [1] |
| 9(a) | Methane and bromine | [1] |
| 9(b) | Lithium | [1] |

3

| Q. No. | Answers | Marks/Remarks |
|---|---|---|
| 9(c)(i) | Lead(II) bromide and lithium | [1] |
| 9(c)(ii) | Lead bromide: it has mobile ions which can conduct electric current. / Lithium: it has mobile electrons which can conduct electric current | [1] |
| 9(d) | Methane exists as molecules, thus requires little heat energy to overcome its weak intermolecular forces of attraction during melting. | [1] |
| | Lead bromide exists as an ionic compound with strong electrostatic forces of attraction between the ions that require a large amount of heat energy to overcome during melting. | [1] |
| | Hence, methane and lead bromide have very different melting points. | |

**Section B**

| Q. No. | Answers | Marks/Remarks |
|---|---|---|
| 10(a) | $FeCO_3 (s) + H_2SO_4 (aq) \rightarrow FeSO_4 (aq) + H_2O (l) + CO_2 (g)$ | |
| | [1m - formula and state symbols, 1m – balanced equation] | |
| 10(b) | | |
| 10(c) | She should not evaporate the filtrate to dryness | |
| | Heat up the filtrate until saturated and allow it to cool and crystallise. | |
| | Filter, wash crystals with distilled water and press dry with filter paper | |
| | [1m – correct diagram, collection vessel can be test tube, beaker] | [1] |
| | [1m –label filter funnel, filter paper and iron(II) carbonate] | [1] [1] |
| 10(d) | Number of moles of sulfuric acid = 1 ×0.1 = 0.1 mol | [1] |
| | Mole ratio $H_2SO_4$ : $CO_2$ = 1 : 1 | |
| | Number of moles of $CO_2$ = 0.1 mol | |
| | Mass of iron = 24 × 0.1 = 2.4 dm³ | [1] |
| | Number of moles of $CO_2$ | |
| | Allow ecf from (a) | |

4

**11(a)(i)** Coke/ carbon reacts with oxygen to form carbon dioxide [1]

**11(a)(ii)**



legend
● electrons of nitrogen

**11(a)(iii)** correct no. of electrons shared [1]
correct key [1]

**11(c)(i)**

Note: carbon atoms should not exceed iron atoms



Carbon atom [1]

Iron atom [1]

**11(c)(ii)** With the presence of the carbon atoms, it disrupts the regular arrangement [1] of iron atoms and thus the layers of atoms cannot slide over easily [1] when force is applied. [2]

**12(a)(i)** Magnesium has an electronic structure of 2.8.2. [1]

There are 2 electrons in the outermost shell. [1]

Since magnesium has 2 valence electrons, it belongs to Group II. [1]

**12(a)(ii)** Across the period, the characters of the elements change from metallic to non-metallic. [1]

As the number of valence electrons increases, the elements have a lower tendency to lose their electrons and a higher tendency to gain or share electrons in order to achieve the noble gas configuration. [1]

---

**11(b)** A large amount of energy is needed to break the triple covalent bonds before it can react [1]

**11(c)(i)**
$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ [1]

$Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$ [1]

[2]

---

**12(b)(i)** Physical property (unique to Group I)
· soft metal that can be cut with a knife / · low melting and boiling point / · low density [1]

Chemical property
· reacts with water to form alkali and hydrogen
· $2Fr + 2H_2O \rightarrow 2FrOH + H_2$
· Francium reacts explosively. [1]

OR

· powerful reducing agent [1]
· $2Fr + Cl_2 \rightarrow 2FrCl$ [1]
· A white residue is formed after the reaction. [1]

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50

Name: ............................................ ( ) Class: Sec ...............

# St. Gabriel's Secondary School
## 2016 'O' Preliminary Examination
### Science (Physics, Chemistry) / Science (Chemistry, Biology)

| | | |
|---|---|---|
| Subject | : | Science (Physics, Chemistry) / Science (Chemistry, Biology) |
| Paper | : | 5076/03 or 5078/03 |
| Level/Stream | : | 4 Express / 5 Normal |
| Duration | : | 1 h 15 minutes |
| Date | : | 29 August 2016 |
| Setter(s) | : | Mrs Chang CN |

*Additional materials:*
*Writing paper*
*String*

## READ THESE INSTRUCTIONS FIRST

Write your name, register number and class clearly in the spaces provided above and on all the work you hand in.

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 on the question paper.

**Sections B**

Answer any **two** questions.

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 13.

| For Examiner's Use | |
|---|---|
| Section A [45m] | |
| Section B [20m] | |
| TOTAL [65m] | |

This question paper consists of **13** printed pages including this cover page.

[Turn Over

---

2

## Section A [45m]
Answer all questions.

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

**Table 1.1**

| Sulfur dioxide | Ammonium chloride | Silver chloride |
|---|---|---|
| Calcium hydroxide | Carbon monoxide | Copper(II) sulfate |

From **Table 1.1**, identify

(a) a base.

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

(b) a neutral oxide.

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

(c) an insoluble salt.

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

(d) a salt which can be prepared by adding an acid to an insoluble carbonate.

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

(e) a compound that produces a gas when warmed with sodium hydroxide.

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

**2** The table below shows the properties of some elements in Group VII of the Periodic Table.

| Element | Melting point/°C | Boiling point/°C | Electronic configuration |
|---|---|---|---|
| Fluorine | -220 | -188 | 2.7 |
| Chlorine | -102 | -34 | 2.8.7 |
| Bromine | -7 | 59 | 2.8.18.7 |
| Iodine | 114 | 184 | 2.8.18.18.7 |

(a) Which halogen exists as a liquid at 55°C?

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

(b) Draw a 'dot and cross' diagram of one molecule of Iodine. Show the valence electrons only.

[1]

**(c) (i)** State and explain an observation when chlorine gas is bubbled into potassium iodide solution.

[2]

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

[1]

**3** The diagram below shows an experiment to investigate the reaction of steam and magnesium powder.
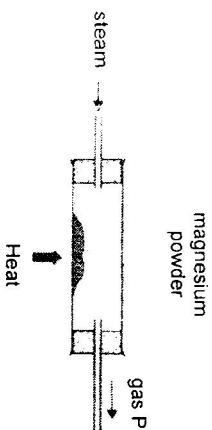


**(a)** Suggest the identity of gas P.

[1]

**(b)** Explain, in terms of collisions between reacting particles, what would happen when granulated magnesium were used instead of magnesium powder.

[3]

**(c)** Write a balanced chemical equation, with state symbols, for the reaction.

[1]

[Turn Over]

**(d)** 0.18g of steam reacts completely with magnesium powder. Calculate the **mass of solid** formed. **Show your working clearly.**

Mass of solid formed = _____ g

[2]

**4** Gold and iron are classified as metals
**(a)** Give **two** physical properties shown by both metals.

Property 1 _____

Property 2 _____

[2]

**(b)** What is **meant by** *recycling* ? Give **two** reasons why iron is recycled.

Recycling is _____

[1]

**Two** reasons for recycling iron:

[2]

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52

5  Nitrogen oxide (NO), carbon monoxide and unburned hydrocarbons are some of the common pollutants that can be found in exhaust fumes.

A common way of cutting down the release of these pollutants is to pass the exhaust fumes through a catalytic converter.

A three-way catalytic converter converts these harmful gases into harmless gases through the processes of reduction and oxidation as shown in equations 1 to 3.

Equation 1    $2NO(g) \rightarrow N_2(g) + O_2(g)$
Equation 2    $2CO(g) + O_2(g) \rightarrow 2CO_2(g)$
Equation 3    unburned hydrocarbons + oxygen $\rightarrow$ carbon dioxide + water
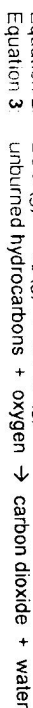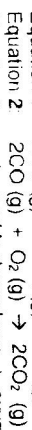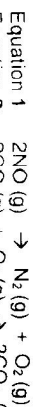
(a)  Classify equations 1 to 3 in **Table 5.1** as shown in the headings below.

| Reduction of pollutant has taken place | Oxidation of pollutant has taken place |
|---|---|
|  |  |

Table 5.1

[3]

(b)  The volume of nitrogen oxide (NO) remaining in the exhaust fumes after passing through a catalytic converter is measured against temperature of the catalytic converter, and plotted as shown in **Graph 5.2** below.

Line 1 ( ——— ) : Catalytic converter with catalyst **A**
Line 2 ( — · — ) : Catalytic converter with catalyst **B**
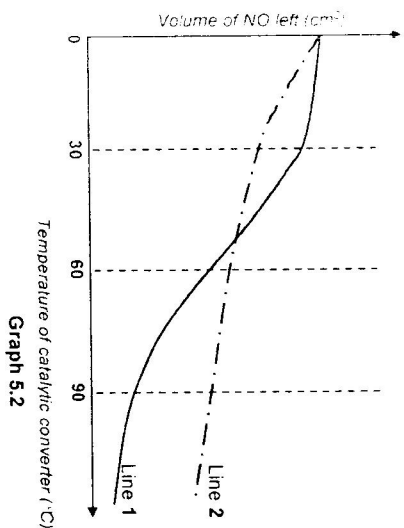


Graph 5.2

Optimal temperature of the catalytic converter is reached when there is a significant increase in the amount of nitrogen oxide removed from the exhaust fume such that there is a sharp decrease in the volume of nitrogen oxide left in the exhaust fumes.

What is the optimal temperature that the **catalytic converter with catalyst A (Line 1)** must reach for catalyst **A** to be effective in removing nitrogen oxide from the exhaust fumes?

Optimal temperature for catalyst **A** = _____ °C    [1]

[Turn Over

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(c)  In your opinion, which is the better catalyst for use in a catalytic converter, catalyst **A** or **B**, for long journeys?
Briefly explain your choice, using information you can deduce from **Graph 5.2**.

_____

_____

_____

[2]

6  When an electric current is passed through aqueous calcium chloride, chlorine gas is released. The **overall equation** for the reaction taking place is shown below:

$$CaCl_2(aq) + 2H_2O(l) \rightarrow Ca(OH)_2(aq) + H_2(g) + Cl_2(g)$$

(a)  The table below describes some laboratory tests carried out for the products formed from this reaction. Fill in the blank boxes to complete the table.

| Products | Laboratory test | Result of test |
|---|---|---|
| Calcium hydroxide | universal indicator |  |
| Hydrogen gas |  | extinguished with a 'pop' sound |
| Chlorine gas | Insert damp litmus paper |  |

[3]

(b)  Explain why an aqueous solution of calcium chloride conducts electricity whereas solid calcium chloride does not.

_____

_____

_____

[2]

**(c)** Name a substance that be added to dilute hydrochloric acid to produce calcium chloride in the laboratory.

_____ [1]

**7 (a)** 55.8g of Magnesium chloride, $MgCl_2$, is dissolved in 100 cm³ of water.

(i) Calculate the relative molecular mass, $M_r$, of magnesium chloride.

relative molecular mass = _____ [1]

(ii) Calculate the number of moles of magnesium chloride in the solution formed.

number of moles of magnesium chloride = _____ [2]

(iii) Use your answer in **(a)(ii)** to calculate the concentration of the magnesium chloride solution in **mol / dm³**.

concentration = _____ **mol / dm³** [2]

**(b)** Magnesium chloride can be prepared by the reaction below:

$$MgCO_3 (s) + 2HCl (aq) \rightarrow MgCl_2 (aq) + CO_2 (g) + H_2O (l)$$

What is the mass of magnesium carbonate needed to produce 0.5 mol of magnesium chloride?

mass of magnesium carbonate = _____ [3]

[Turn Over

**8** An alkene in the liquid state reacts with bromine solution to form a compound called dibromopentane with the structural formula shown below.
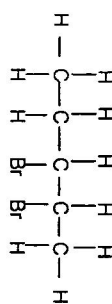


**(a)** Draw the alkene, which reacts with bromine solution to form the compound, dibromopentane.

**(b)** Write the chemical equation for the reaction between bromine and the alkene drawn in **(a)**. [1]

**(c)** What is the colour change observed in the reaction between bromine solution and the alkene drawn in **(a)** [1]

_____

*********** *END OF SECTION A* ***********

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54

## Section B [20m]

Answer any **two** questions

Write your answers on the spaces provided.

9 (a) Petrol, diesel oil and lubricating oil are fractions obtained from the fractional distillation of petroleum. Each fraction is a mixture of alkanes. The table below shows the number of carbon atoms present in a molecule of each fraction.

| Fraction | Number of carbon atoms per molecule |
|---|---|
| Petrol | 5 to 10 |
| Diesel oil | 15 to 25 |
| Lubricating oil | 19 to 35 |

(i) Using the data given in the table above, state the fraction that will burn most easily. Give a reason for your answer.

In combustion, the fuel vapourises before it catches fire. Hence in burning a solid or liquid alkane, the outer layer of the alkane changes into a vapour before it burns.

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[2]

(ii) Describe the separation process (fractional distillation) of petroleum into its fractions.

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[4]

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(b) Octane, $C_8H_{18}$, is a hydrocarbon in petrol. Hexadecane, $C_{16}H_{34}$, is one of the hydrocarbons in ship fuel.

(i) Show by calculation that hexadecane contains a higher percentage of carbon by mass than octane.

[2]

The following equations show the complete combustion of octane and hexadecane.

$$2C_8H_{18} (l) + 25 O_2 (g) \longrightarrow 16 CO_2 (g) + 18 H_2O (g)$$

$$2C_{16}H_{34} (l) + 49 O_2 (g) \longrightarrow 32 CO_2 (g) + 34 H_2O (g)$$
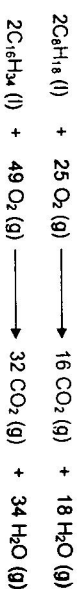
(ii) Use the equations to explain why hexadecane burns with a smokier flame than octane.

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[2]

10 The following table gives some information about the chloride of elements in Period 3.

| Name | Formula | Melting point/°C | Boiling point/°C | Behaviour with water |
|---|---|---|---|---|
| Sodium chloride | NaCl | 801 | 1465 | Dissolves in water |
| Magnesium chloride | MgCl₂ | 714 | 1418 | Dissolves in water |
| Silicon tetrachloride | SiCl₄ | -70 | 58 | Reacts with water to produce an acidic solution |
| Phosphorus trichloride | PCl₃ | -92 | 76 | Reacts with water to produce an acidic solution |
| Disulfur dichloride | S₂Cl₂ | -80 | 138 | Reacts with water to produce an acidic solution and a yellow precipitate |

[2]

**(a) (i)** Deduce one physical difference between the metallic chlorides and non-metallic chlorides.

_____

_____ [1]

**(ii)** Explain, in terms of bonding, for your answer in **(a)(i)**

_____

_____

_____

_____ [2]

**(b)** When disulfur dichloride dissolves in water, a yellow precipitate (sulfur) and an acidic solution are formed. The acidic solution contains sulfurous acid and hydrochloric acid. Describe a simple test to confirm the presence of chloride ions in the solution.

_____

_____ [2]

**(c)** Briefly describe how a **dry** sample of magnesium chloride crystals can be prepared from a reaction between magnesium and dilute hydrochloric acid.

_____

_____

_____

_____

_____

_____ [5]

[Turn Over

**11** Sugar can be converted to ethanol.

**(a)** Give the name of the conversion process and describe how this process is completed in the laboratory to obtain pure ethanol.

_____

_____

_____

_____

_____

_____ [5]

**(b)** Write a balanced chemical equation for this process. Include state symbols.

_____

_____ [2]

**(c)** Calculate the relative molecular mass of ethanol, $C_2H_5OH$, and the percentage by mass of carbon in **each** molecule of ethanol.

_____

_____ [3]

********** *END OF PAPER* **********

**21** Substance **E** has a melting point of −7.2 °C and a boiling point of 58.8 °C.

What can you conclude about the arrangement and distance between the particles of substance **E**, at 0 °C?

| | Arrangement of particles | Distance between particles |
|---|---|---|
| A | Orderly | Close |
| B | Orderly | Far apart |
| C | Disorderly | Close |
| D | Disorderly | Far apart |

**22** Which of the following substances would **not** melt at a fixed temperature?

A Copper metal

B Copper(II) sulfate crystals

C Steel

D Sugar

**23** Two methods of collecting a gas **G** are shown.
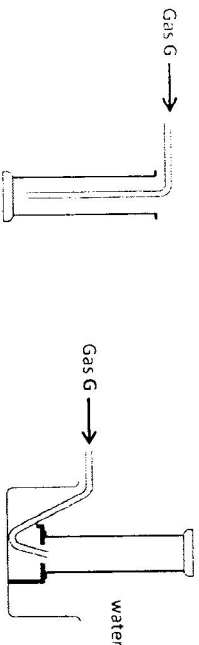


Which properties of gas **G** are shown by these collection methods?

| | Density of gas G | Solubility of gas G in water |
|---|---|---|
| A | less dense than air | soluble |
| B | less dense than air | not soluble |
| C | denser than air | soluble |
| D | denser than air | not soluble |

8

**24** The table below shows the information of three different substances.

| Substance | Heat-stable | Solubility in water | Solubility in alcohol |
|---|---|---|---|
| X | Yes | No | No |
| Y | Yes | Yes | No |
| Z | No | Yes | No |

The following operations could be carried out to separate substance **Z** from a mixture of these three substances.

1. Filtration
2. Dissolving in water
3. Dissolving in alcohol
4. Evaporation to dryness
5. Crystallisation

What would be the correct order to obtain substance **Z** from the mixture

A 2, 1, 5

B 3, 1, 2, 4

C 3, 1, 4

D 2, 3, 1, 5

**25** The symbol of element **L** is given as $^m_n L$. Which of the following statements is correct about element **L**?

A An atom of **L** has $m$ neutrons and $n$ electrons.

B An atom of **L** has $n$ protons and $n$ electrons.

C The charge of the ion formed by element **L** is $\frac{1}{4}(m - n)$.

D The nucleus of an atom of **L** is made up of $n$ protons and $(n - m)$ neutrons.

**26** The table below shows the melting and boiling points of four pure substances.

Which substance is a liquid at room temperature and would rapidly evaporate if left exposed to the air?

| Substance | Melting Point (°C) | Boiling Point (°C) |
|---|---|---|
| A | −26 | 220 |
| B | −9 | 52 |
| C | −143 | −10 |
| D | 8 | 97 |

9

57

**27** Which diagram represents a mixture of diatomic elements?
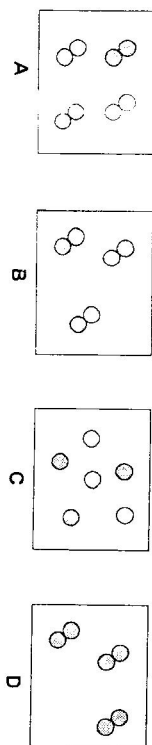


**28** Two elements, P and Q, with proton number 11 and 16 respectively, combine to form a compound. Which one shows the correct chemical formula and bonding in the compound?

| | Chemical formula | Type of bonding |
|---|---|---|
| A | PQ | Covalent |
| B | PQ | Ionic |
| C | P$_2$Q | Ionic |
| D | PQ$_2$ | Ionic |

**29** Hydrogen peroxide decomposes according to the equation.

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

The volume of oxygen, measured at room temperature and pressure, produced from the decomposition of 17g of hydrogen peroxide is

A 3.0 dm³

B 6.0 dm³

C 8.5 dm³

D 12.0 dm³

**30** Magnesium reacts with hydrochloric acid.
Which solution of hydrochloric acid would give the fastest initial rate of reaction?

A 40 g of HCl in 1000 cm³ of water

B 20 g of HCl in 1000 cm³ of water

C 10 g of HCl in 100 cm³ of water

D 4 g of HCl in 50 cm³ of water

**31** Solution **P** is 0.100 mol/dm³ sulfuric acid. Solution **Q** is 0.200 mol/dm³ potassium hydroxide. What is the volume of solution P required to completely neutralise 20.0 cm³ of **Q**?

A 20.0 cm³

B 30.0 cm³

C 40.0 cm³

D 50.0 cm³

**32** The diagram shows the steps of preparing a salt.
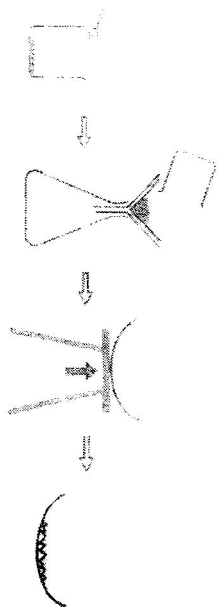


Which of the following salts is most suitable to be prepared by this technique shown above?

A Ammonium sulfate

B Calcium chloride

C Sodium nitrate

D Silver chloride

**33** When a piece of magnesium reacts with dilute hydrochloric acid, heat is given out. Which of the following graphs shows how the temperature of the mixture changes as the reaction progresses and the remaining mixture is left to stand for some time?
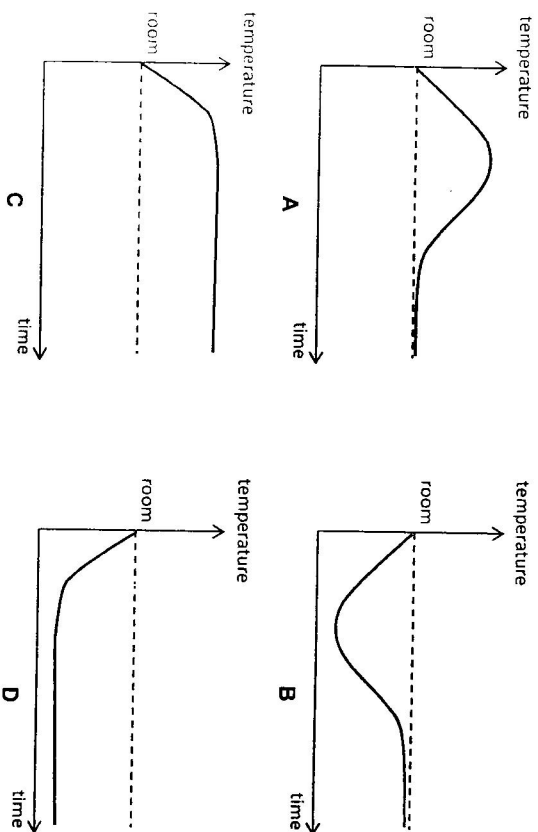
**34** Consider the following reaction:

$$2I^-(aq) + 2Fe^{3+}(aq) \longrightarrow 2Fe^{2+}(aq) + I_2(aq)$$

Which of the following is **true** of the ionic equation?

A Fe³⁺ is a reducing agent.
B Fe³⁺ is oxidized.
C I⁻ donates electrons to Fe³⁺.
D I⁻ is an oxidizing agent.

**35** The diagram below shows a reaction scheme involving solution **P**.

Solution **P** → Add HNO₃(aq) → Colourless solution (No effervescence)

Add a little NaOH(aq) → White precipitate
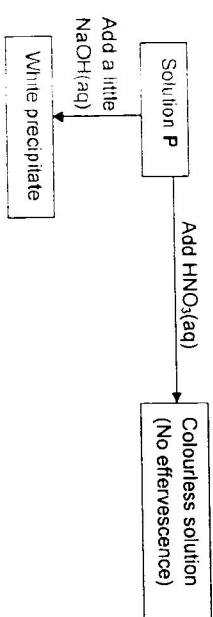
What is the identity of solution **P**?

A Copper(II) nitrate
B Sodium sulfate
C Zinc carbonate
D Zinc sulfate

**36** Rubidium, Rb, is an element in the same group of the Periodic Table as lithium, sodium and potassium.

Which statement/s about rubidium is/are likely to be **wrong**?

I   It reacts explosively with cold water.
II  It forms a soluble carbonate salt.
III It forms a carbonate with a formula of RbCO₃.
IV  It can be extracted via electrolysis of concentrated aqueous RbCl.

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

**37** The diagram below represents the process of fractional distillation of crude oil.
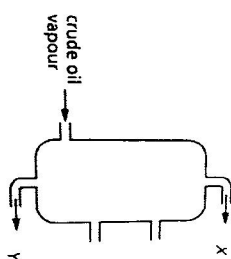


Which statement about fractions **X** and **Y** is correct?

A **X** burns less easily than **Y**.
B **X** has a lower boiling point than **Y**.
C **Y** is used as fuel for airplane
D **Y** is the lighter fraction compared to **X**.

**38** Poly(ethene) can be manufactured by the process below.

decane → cracking → ethene → polymerisation → poly(ethene)
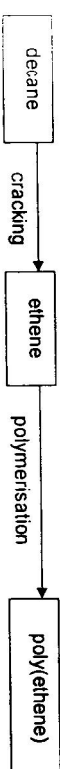
Which graph shows the change in molecular size during this process?
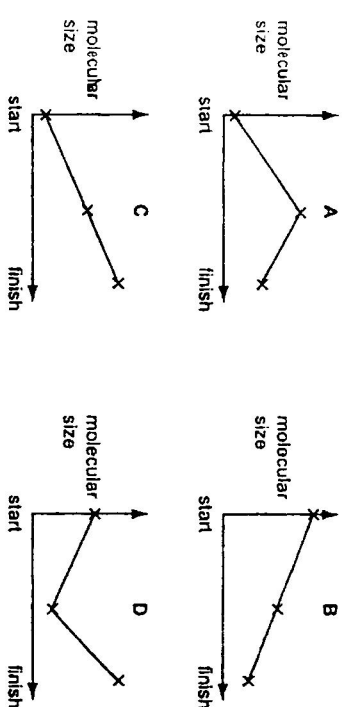
Which of the following pollutants from a car engine undergo(es) reaction(s) in the catalytic converter to produce less harmful products?

(i) Carbon monoxide

(ii) Hydrocarbons

(iii) Nitrogen dioxide

A (i) only

B (i), (ii) only

C (ii), (iii) only

D (i), (ii) and (iii)

40 The structural formula of a polymer is shown below.
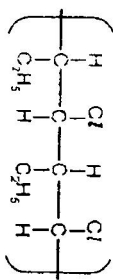


Which substance will form this polymer?

A



B



C



D



*************** END OF PAPER ***************
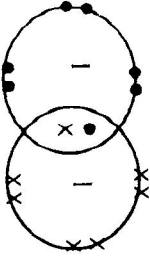
14

## DATA SHEET

### Colours of some Common Metal Hydroxides

| Calcium hydroxide | White |
| Copper(II)hydroxide | Light blue |
| Iron(II) hydroxide | Green |
| Iron (III) hydroxide | Red-brown |
| Lead (II) hydroxide | White |
| Zinc hydroxide | white |

15

St Gabriel's Secondary School
2016 Preliminary Examination
Sec 4E5N Science(Chemistry)
Marking Scheme

## Paper 1 (20m)

| 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| C | C | D | A | B | B | A | C | B | C | A | B | A | C | D | D | B | D | D | B |

## Section A (45m)

| Question | Answer | Mark |
|---|---|---|
| 1 (a) Calcium hydroxide | | 1 |
| (b) Carbon monoxide | | 1 |
| (c) Silver chloride | | 1 |
| (d) Copper(II) sulfate | | 1 |
| (e) Ammonium chloride | | 1 |
| 2 (a) Bromine | | 1 |
| (b) |  | 1 |

2 (c) (i) <u>Colourless</u> solution of potassium iodide <u>turns reddish brown</u>. Chlorine being more reactive than iodine, <u>displace</u> iodine out from potassium iodide solution to form potassium chloride and iodine. — 1, 1

(ii) $Cl_2\ (g)\ +\ 2I^-\ (aq) \longrightarrow 2Cl^-\ (aq)\ +\ I_2\ (aq)$ — 1

3 (a) Hydrogen — 1

(b) The reaction will be <u>slower.</u>
Larger particle size <u>decreases the surface area exposed</u> for collision to take place, <u>chances of effective collision decreases, collision frequency decreases</u> hence rate of reaction decreases. — 1, 1

(c) $Mg\ (s)\ +\ H_2O\ (g) \longrightarrow MgO\ (s)\ +\ H_2\ (g)$ — 1

(d) No of mols of steam $= \dfrac{0.18}{2(1)+16}\ =\ 0.01$ — 1

No of mols of MgO formed $= 0.01$

Mass of MgO formed $= (0.01) \times (24 + 16) = \underline{0.4g}$ — 1

4 (a) Any two of the following physical properties:
- High melting point and boiling point
- High density
- Malleable / Ductile
- Shiny / Sonorous
- Good electrical and heat conductor

*[Reject "hard"]* — 1

(b) Recycling is the process in which old, waste materials (scrap metals) are collected back and (melted) made into new materials (metals). — 1

Reason for recycling: (Choose any 2)
➤ To conserve limited natural resources like fossil fuel which was used to extract the metal
➤ Recycling does not produce as much waste as that may endanger human health, hence reduce environmental problem related to extracting metal from metal ores.
➤ To save money spent on creating landfill sites. There will be less need to dig for metal ores and the land will be free for other uses such as agriculture — 1, 1

5 (a) Reduction – Equation 1
Oxidation – Equation 2 and
Equation 3 — 1, 1

(b) 30 °C — 1

(c) Catalyst A
Car engine (and catalytic converter) heats up in long journeys, and catalyst A is <u>more effective in removing nitrogen oxide from the exhaust fumes at high temperatures, as shown in graph</u>, with less nitrogen oxide detected in the fumes as temperature of the catalytic converter increases. — 1, 1

6 (a)

| Products | Laboratory test | Result of test |
|---|---|---|
| Calcium hydroxide | universal indicator | colour changes to purple /Blue **[1]** |
| Hydrogen gas | Insert a lighted splint into the gas **[1]** | extinguished with a 'pop' sound |
| Chlorine gas | Insert damp litmus paper | litmus paper **bleaches [1]** |

(b) Aqueous calcium chloride contains <u>mobile ions which can carry electric charge and hence conducts electricity.</u>
In solid calcium chloride, <u>the ions are held in fixed position</u> (not mobile) and thus cannot carry electric charge to conduct electricity. — 1, 1

(c) Calcium metal /Calcium chloride / Calcium oxide / Calcium hydroxide / Calcium carbonate — 1

7 (a) (i) $M_r = 24 + 2(35.5) = \underline{95}$ — 1

| Question | Answer | Mark |
|---|---|---|

**(ii)** Number of moles = $\dfrac{55.8}{95}$

= **0.587** (to 3 s.f.) — 1

**(iii)** Concentration = $\dfrac{0.587}{0.1}$

= **5.87 mol/dm³** — 1

**(b)** Mole ratio of $MgCl_2$ : $MgCO_3$

Moles of $MgCO_3$ = 0.5

Moles of $MgCO_3$ = (0.5)(84)

Mass of $MgCO_3$

= **42 g** — 1

**8 (a)** — 1, 1, 1

**(b)** $C_5H_{10} + Br_2 \rightarrow C_5H_{10}Br_2$ — 1

**(c)** Reddish brown bromine turns colourless — 1

**Section B (20m)**

**9 (a)(i)** Petrol

It has the **lowest relative molecular mass** / **fewest number of carbon atoms** / smallest molecules / short-chain molecules, hence **less** / **weaker intermolecular forces of attraction**, result in **lower boiling point** and so easier to vapourise (burn easily) — 1, 1

**(ii)** In the furnace, petroleum is **heated and turned into vapour** (vapourised)

The **hot vapour rises up** the column, it begins to **cool**.

The fraction will **condense when its boiling point is equal to the temperature of the plates in the column**.

Lighter fractions have lower boiling points will be condensed and collected at the top of the fractionating column as gases.

Heavier fractions have higher boiling point will be condensed and collected at the lower sections of the column. — 1, 1, 1, 1

**(b)(i)** % of carbon in octane = $\dfrac{8(12)}{8(12)+18(1)} \times 100$

= **84.2%** — 1

% of carbon in hexadecane = $\dfrac{16(12)}{16(12)+34(1)} \times 100$

**10 (ii)** 2 moles of hexadecane require more moles of oxygen for complete combustion as compared to octane, hence hexadecane has a **higher tendency of undergoing incomplete combustion**, so it tends to produce more smoky flame.

= **85.0%** — 1, 1, 1

**(a)(i)** Metallic chlorides have **high melting points** while non-metallic chlorides have **low melting points**.

Or

Metallic chlorides are **solids at room temperature** while non-metallic chlorides are **liquids at room temperature**.

*[must show between the 2 chlorides, use info from table]* — 1

**(ii)** **Large amount of energy** is required to overcome strong electrostatic **forces** of attractions between the positive metallic ions and the negative chloride ions, hence high melting point.

**Very little energy** is required to **overcome weak intermolecular forces** between the molecules of non-metallic chlorides, hence low melting point — 1, 1

**(b)** To a portion of the solution, add **dilute nitric acid followed by aqueous silver nitrate**. OR **add acidified silver nitrate solution**

A **white precipitate** formed indicates the presence of chloride ions. — 1, 1

**(c)** An **excess of magnesium** is added to a sample of dilute hydrochloric acid, stir to dissolve magnesium.

**Filter** mixture to remove unreacted magnesium, collect filtrate

**Heat** the filtrate to evaporate some water / **till saturated**

Let the saturation solution **cools for crystallisation** to occur

Filter mixture to collect crystals as residue and press **dry between pieces of filter papers** — 1, 1, 1, 1

**11 (a)** Fermentation

**Add water to dissolve the cane sugar** then add **yeast**.

Keep the sugar solution at **37°C**.

**Keep the air out** and leave for a few days.

The product must be **fractionally distilled to get almost pure ethanol** — 1, 1, 1, 1

**(b)** $C_6H_{12}O_6(aq) \rightarrow 2C_2H_5OH(aq) + 2CO_2(g)$

*[ correct balance eqn — 1m, correct state symbol —1m]* — 1, 1

**(c)** Relative molecular mass of ethanol = 2(12) + 5(1) + 16 +1

= **46** — 1

% by mass of carbon in ethanol = $\dfrac{2(12)}{46} \times 100$

= **52.2%** — 1

# 4E/5N

HUA YI SECONDARY SCHOOL

Preliminary Examination 2016

# 4E/5N

## SCIENCE (CHEMISTRY/BIOLOGY)

Paper 1                                                              5078/1

15 September 2016

1 hour

Candidates answer on the Optical Answer Sheet (OTAS)
Additional Materials: OTAS

### READ THESE INSTRUCTIONS FIRST

Write your Name, Class and Index Number on all the work you have done.
Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.

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 Optical 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.

Setter: Mrs Celine Wong/ Ms Chiang WK

**[Turn Over**

---

1   Samples of tinned apricots, beans, corn and tomatoes were tested for additives using chromatography. The chromatograms were compared with those of **three** artificial additives, $P_1$, $P_2$ and $P_3$.
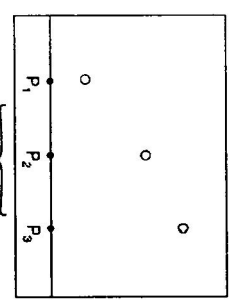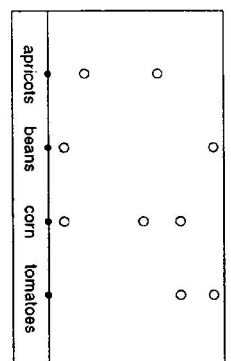


Which tinned food does **not** contain any artificial additives?

A   apricots

B   beans

C   corns

D   tomatoes

2   A gas, Y, is less dense than air and is very soluble in water. Which is the most suitable method to collect a sample of this gas?
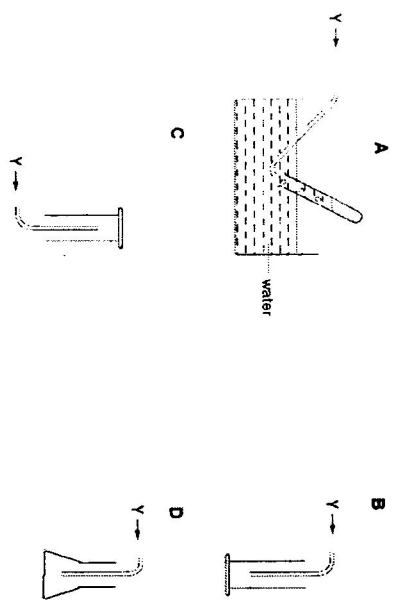
**3** Sulfur dioxide has a melting point of -70 °C and boiling point of -10°C. Which graph shows the change in temperature as it is warmed from solid to gas?



**4** Elements X and Y are found in Group VI and Group IV of the Periodic Table respectively. Which of the following shows the electron arrangement of the compound formed by elements X and Y?
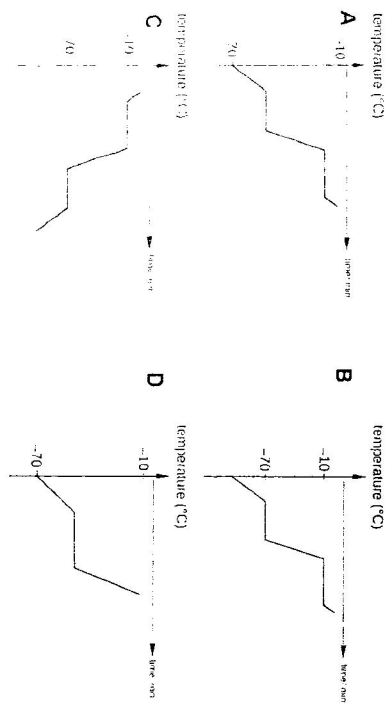
**5** The following describes the properties of substance X.

| | |
|---|---|
| state at room temperature | solid |
| malleability | malleable |
| conduction of electricity | good |

Which substance can X be?

A    chlorine, $Cl_2$

B    zinc chloride, $ZnCl_2$

C    carbon tetrachloride, $CCl_4$

D    zinc, Zn

**6** A thermometer is placed in water and the temperature is measured as shown.
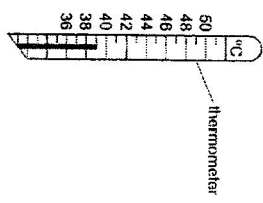


An exothermic change takes place as a solid is dissolved in the water. The temperature changes by 3.5°C. What is the initial temperature?

A    35.0°C

B    35.5°C

C    42.0°C

D    42.5°C

**7** A mixture of 4.0 g hydrogen with 4.0 g of oxygen is ignited. What is the mass of water formed?

A    4.5 g

B    9.0 g

C    18.0 g

D    36.0 g

8 Which of the following reactions is **not** a redox reaction?

A $CuO + 2HNO_3 \rightarrow Cu(NO_3)_2 + H_2O$

B $2FeCl_2 + Cl_2 \rightarrow 2FeCl_3$

C $CuO + H_2 \rightarrow Cu + H_2O$

D $Mg + 2HCl \rightarrow MgCl_2 + H_2$

9 Which of the following methods would **not** produce ammonia?

A heating ammonium sulfate with sodium hydroxide

B heating ammonium chloride with calcium oxide

C heating ammonium sulfate with dilute hydrochloric acid

D heating ammonium chloride with copper(II) oxide

10 P, Q and R are in the same period of the Periodic Table. Oxide of P is acidic, oxide of Q is basic and oxide of R is amphoteric.

What is the order of **P, Q** and **R** across the Periodic Table from left to right?

A P, R, Q

B Q, P, R

C Q, R, P

D R, P, Q

11 What does **not** increase across a period of the Periodic Table?

A the number of electron shells

B the number of outer shell electrons

C the number of protons

D the nucleon number

12 In experiment X, excess finely divided iron(II) carbonate powder is added to 50 cm³ of 1.0 mol/dm³ hydrochloric acid at room temperature. The total volume of carbon dioxide evolved is determined at intervals and plotted against time as shown in the graph below.
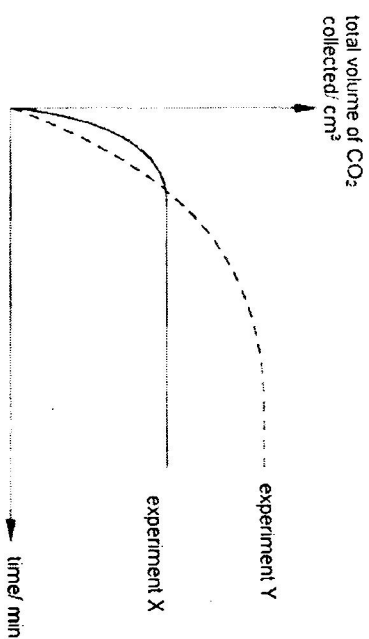


Which of the following conditions will produce the results of experiment Y?

A 100 cm³ of 0.5 mol/dm³ hydrochloric acid is used

B 50 cm³ of 2.0 mol/dm³ hydrochloric acid is used

C iron(II) carbonate lumps are used instead

D hot acid is used

13  Heated copper reacts with oxygen to produce copper(II) oxide.

The percentage of oxygen in air can be found by passing air over heated copper. In the apparatus shown, the plungers are alternately pushed so that air passes over the hot copper.

The original volume of air was 50.0 cm³.
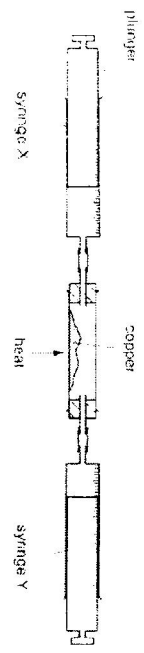


Which graph shows how the volume of air changes during the experiment?



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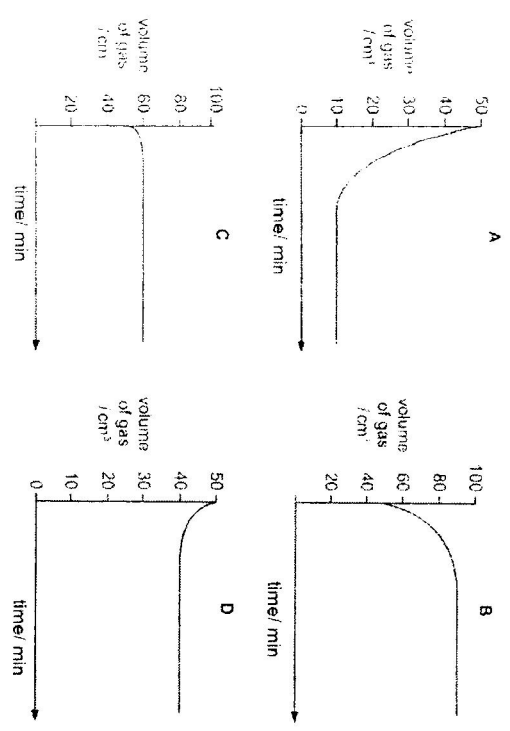
14  The table shows the results of halogen displacement experiments.

| halogen added | halide solution | | |
| --- | --- | --- | --- |
| | X⁻ | Y⁻ | Z⁻ |
| $X_2$ | - | $Y_2$ displaced | $Z_2$ displaced |
| $Y_2$ | no reaction | - | no reaction |
| $Z_2$ | no reaction | $Y_2$ displaced | - |

What are halogens X, Y and Z?

| | $X_2$ | $Y_2$ | $Z_2$ |
| --- | --- | --- | --- |
| A | bromine | chlorine | iodine |
| B | bromine | iodine | chlorine |
| C | chlorine | bromine | iodine |
| D | chlorine | iodine | bromine |

15  Which of the following does **not** match an atmospheric pollutant to its source?

| | pollutant | source |
| --- | --- | --- |
| A | nitrogen oxides | incomplete combustion of fuels in car exhaust |
| B | nitrogen oxides | lightning |
| C | sulfur dioxide | volcanoes |
| D | sulfur dioxide | combustion of fossil fuels |

16  What is the main constituent of natural gas?

A  ethane

B  hydrogen

C  nitrogen

D  methane

**17** The following shows a result of an experiment on rusting.
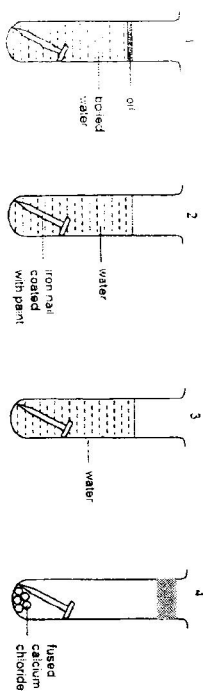


Which of the above test tubes will show rust on the iron nail?

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

**18** Which type of reaction is illustrated by the following equation?

$$C_{15}H_{32} \rightarrow C_{10}H_{22} + C_3H_6 + C_2H_4$$
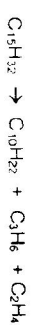
A  addition
B  cracking
C  polymerisation
D  substitution

**19** Oleic acid is found in olive oil. It has the following formula.
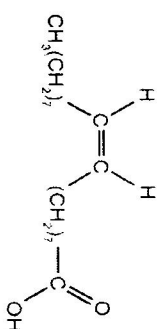


Which reagents will give a positive result with oleic acid?

1  aqueous bromine
2  aqueous sodium carbonate
3  silver

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

**20** A polymer has the following structure.
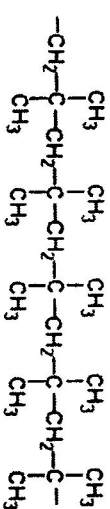


What is the possible monomer of this polymer?
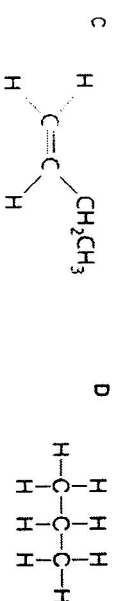
**21** The diagram shows four different types of cells, not drawn to scale.
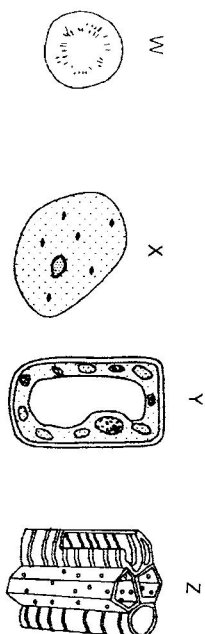


Which cells are adapted for transport?

A   W and Y
B   W and Z
C   X and Y
D   X and Z

**22** Four shoots from the same plant were prepared as follows:

| shoot | treatment |
|---|---|
| P | left untreated |
| Q | upper surfaces of leaves smeared with petroleum jelly |
| R | lower surfaces of leaves smeared with petroleum jelly |
| S | both surfaces of leaves smeared with petroleum jelly |

The shoots were then each placed in a potometer in daylight and the amount of water absorbed over time by each shoot was recorded and plotted on a graph.

Which of the following graphs represent the results for shoot R?
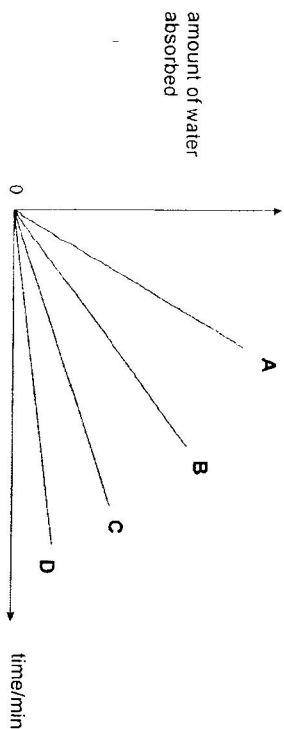
**23** The diagram shows an experiment set up to investigate osmosis.
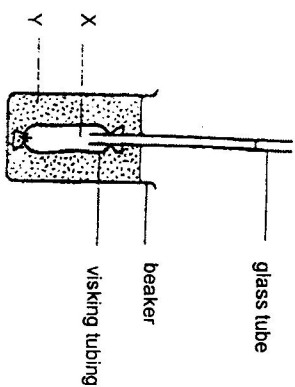


Identify liquid X and Y such that the level in glass tube will rise the highest level after three hours?

| | liquid X inside bag | liquid Y in beaker |
|---|---|---|
| A | 0.2 mol/dm³ sucrose solution | water |
| B | 0.4 mol/dm³ sucrose solution | water |
| C | water | 0.2 mol/dm³ sucrose solution |
| D | water | 0.4 mol/dm³ sucrose solution |

**24** A substance found in bananas causes them to turn brown when exposed to air. How would you determine that the substance is an enzyme?

A   Boil the banana and see if it turns brown in the air.
B   Cut the banana to small pieces and see if it turns brown.
C   Test whether the unpeel banana turns brown.
D   Test whether banana turns brown in an atmosphere of pure carbon dioxide.

**25** A sample of food mixed with water was tested to study its contents. The results are shown in the table.

| food test | result |
|---|---|
| iodine solution added | blue-black colour |
| Benedict's solution added and mixture heated | blue solution |
| Biuret's solution added | blue solution |
| shaken with ethanol | cloudy white emulsion |

Which nutrient(s) were present in the food?

A   fats only
B   proteins and fats
C   reducing sugar and fats
D   starch and fats

**26** Three test tubes were set up in the same conditions as shown below. Oil and red hydrogencarbonate solution were added to all set ups in equal amounts.
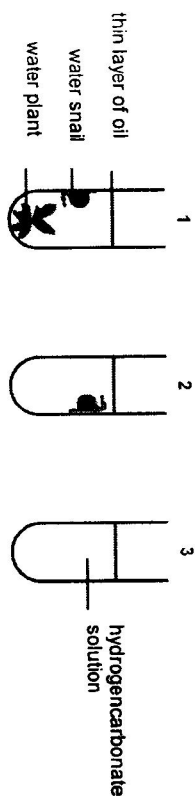


After three hours, the colour of the hydrogencarbonate solution in the three test tubes was recorded below.

| test tube | colour of hydrogencarbonate solution | pH |
|---|---|---|
| 1 | yellow | 5.8 |
| 2 | yellow | 6.5 |
| 3 | red | 7 |

What was the likely condition the three set ups were subjected to during the experiment?

| | light intensity/lx | temperature/°C |
|---|---|---|
| A | 0 | 60 |
| B | 5 | 30 |
| C | 20 | 20 |
| D | 40 | 20 |

**27** Only two of the following statements accurately describe what happens in the mouth.

1. Amylase breaks down large starch molecules into smaller maltose molecules.
2. Chewing increases the surface area of food for digestion.
3. Saliva emulsifies fats into smaller droplets.
4. Teeth break up large insoluble molecules into smaller soluble molecules.

Which statements are correct?

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

**28** Which blood vessels carry deoxygenated blood?
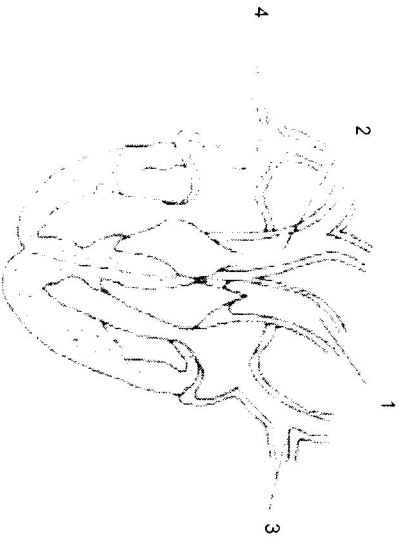


A. 1 and 2
B. 1 and 3
C. 2 and 3
D. 2 and 4

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**29** The photomicrograph shows a section of the root of a plant. Through which tissue are sugars and amino acids transported?
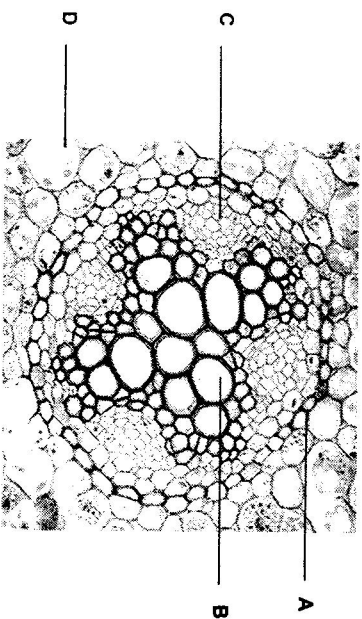


**30** The graph below shows the changes in pupil size when a light of varying intensity was shone into a person eye for 50 seconds.
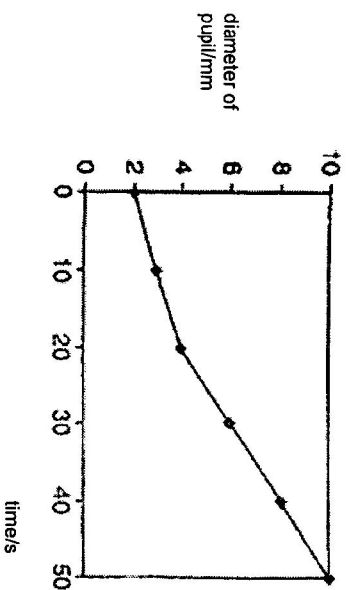


Which statement explains the change in pupil size correctly?

A. The light slowly became brighter.
B. The light slowly became dimmer.
C. The light suddenly became brighter.
D. The light suddenly became dimmer.

**31** The graph shows the volume of oxygen absorbed by the blood as a student plays a game of tennis.

At which period of time does the student respire both aerobically and anaerobically?
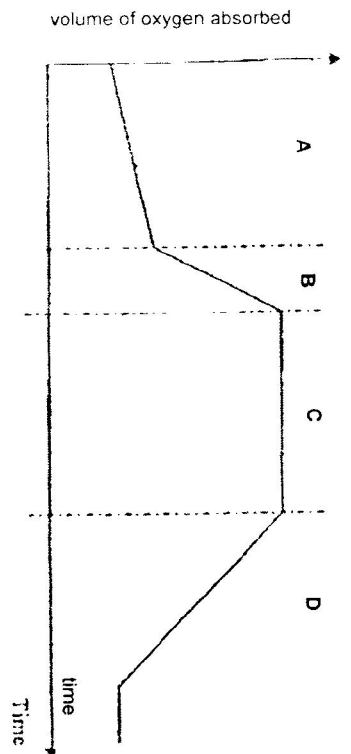


**32** In a nerve pathway, the following events take place.

1    activation of receptor
2    activation of muscle
3    passage of impulses along a motor neurone
4    passage of impulses along a sensory neurone

What is the correct order of these events?

first ------- > last

| | | | | |
|---|---|---|---|---|
| A | 1 | 2 | 3 | 4 |
| B | 1 | 4 | 3 | 2 |
| C | 4 | 1 | 2 | 3 |
| D | 4 | 3 | 1 | 2 |

Questions **33** and **34** refer to the diagram of the human reproductive system below.
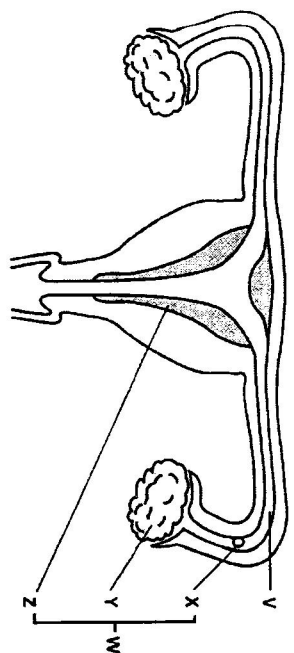


**33** Which of the following is correct?

| | cell | tissue | organ | system |
|---|---|---|---|---|
| A | W | Y | Z | Y |
| B | X | Z | Y | X |
| C | Y | X | W | Z |
| D | Z | W | X | Y |

**34** Where do fertilisation, implantation and ovulation occur?

| | fertilisation | implantation | ovulation |
|---|---|---|---|
| A | V | Y | X |
| B | V | Z | Y |
| C | Y | N | V |
| D | Z | V | Y |

**35** The graph shows changes in a person's blood glucose concentration over four hours.

What might cause the changes at X and Y?
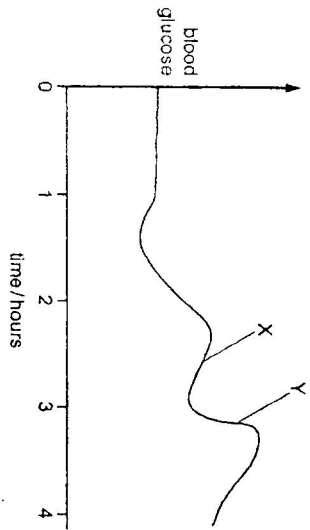


| | X | Y |
|---|---|---|
| A | decreased insulin | decreased adrenaline |
| B | decreased insulin | increased adrenaline |
| C | increased adrenaline | increased insulin |
| D | increased insulin | increased adrenaline |

**36** An experiment was set up using four groups of insect-pollinated flowers in a field. In each group, different parts of the flower were removed, as shown in the table below, and insects were allowed to visit all the flowers freely.

| group of flowers | stigma | anthers | petals |
|---|---|---|---|
| A | removed | removed | left |
| B | removed | left | removed |
| C | left | left | removed |
| D | left | removed | left |

Which group of flowers, **A, B, C** or **D**, would produce the most seeds?

**37** The following diagram showing the family tree of a family with phenylketonuria (PKU). PKU is a disease that is expressed in homozygous recessive individuals.

Key
- ○ normal female
- □ normal male'
- ● PKU female
- ▦ PKU male
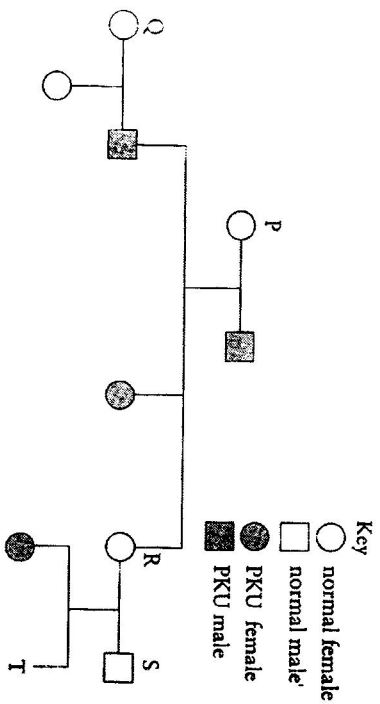


Which of the following correctly describes the genotype of individuals in the family tree?

A P and Q are heterozygous.
B P and R are homozygous dominant.
C R and S are heterozygous.
D R is homozygous dominant while S is heterozygous.

38 The diagram shows part of a DNA molecule.
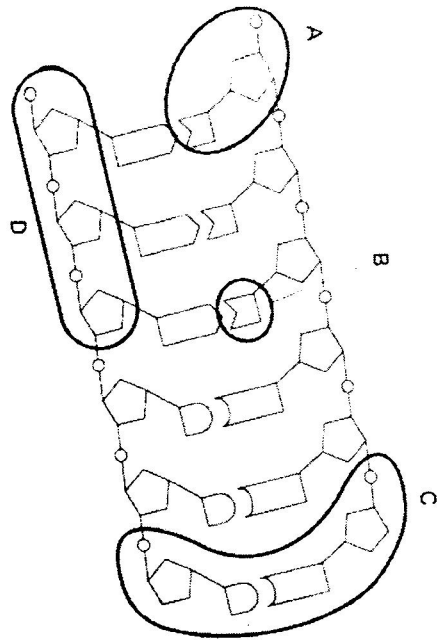


Which part of the DNA molecule shows a nucleotide?

39 The protozoan *Leptomonas* is a parasite of fleas. One flea may contain several thousand *Leptomonas*. A food chain containing *Leptomonas* is:

grass → herbivores → fleas → *Leptomonas*

Which diagram represents a pyramid of numbers for this food chain?
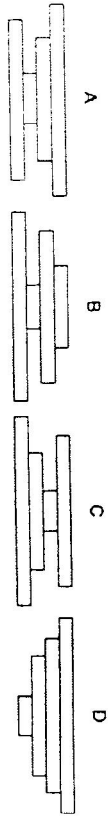


40 Which two traits show discontinuous variation?

A weight and eye colour
B gender and blood group
C skin colour and height
D intelligence and hair colour

**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 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 | 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.).

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74

## Section A (45 marks)

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

1. The properties of a substance make it suitable for particular tasks. Complete Table 1.1 by naming a suitable substance for each of the tasks shown.

Table. 1.1

| task | substance needed |
|---|---|
| catalyst to make margarine from unsaturated vegetable oils | |
| lowering acidity of soil | |
| removing of acidic impurities in extraction of iron | |

[Total: 3]

2. Zinc smelting is a process that converts zinc concentrates (ores that contain zinc) into pure zinc. One of the last stages involves purifying zinc by fractional distillation in a column made up of silicon carbide. The main impurities in zinc are shown in the table below. Pure zinc has a boiling point of 908 °C.

Table. 2.1

| impurities | boiling point /°C |
|---|---|
| cadmium | 765 |
| copper | 2582 |
| iron | 2887 |
| lead | 1751 |

(a) State why it is possible to purify zinc by fractional distillation.

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

(b) When fractional distillation is carried out, which metal will be distilled first?

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

(c) How would you test if the zinc purified from the fractional distillation is free from any impurities?

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

(d) State one other industrial application of fractional distillation.

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

[Total: 4]

3. Musical instruments are usually made of brass, which is an alloy. Brass is an alloy made by the addition of small amounts of copper to zinc. The resulting alloy is harder compared to either of its constituents, copper and zinc.

(a) In the space below, draw the arrangement of atoms in pure zinc and brass alloy.

| zinc metal | brass |
|---|---|
| | |

[2]

(b) With reference to your answer in (b), explain why brass is much harder as compared to pure zinc metal.

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

[Total: 4]

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75

4 (a) In order to make data entry more convenient, a code system is developed by using a certain number of an element rather than names or formulae of substances. Table 4.1 illustrates this code system.

| substance | formula | code |
|---|---|---|
| potassium chloride | KCl | 19, 17 |
| aluminium oxide | Al$_2$O$_3$ | 13(2), 8(3) |
| zinc bromide | | 30, 35(2) |

Table 4.1

(i) Complete the table above.

[1]

(ii) What is this system code number based on?

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

(b) A potassium ion can be represented as

$$^{40}_{19}K^+$$

Determine how many protons, neutrons and electrons are present in a single ion of potassium, K$^+$.

(i) number of protons: ...............

(ii) number of neutrons: ...............

(iii) number of electrons: ............... [3]

(c) Not all of the atoms of potassium are identical. They can have different masses.

(i) What is the name given to different atoms of the same element?

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

(ii) Explain why potassium atoms can have different masses.

......................................................................................................................

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

(iii) Draw a diagram to show the electronic structure of a potassium atom.

[1]

[Total: 8]

5 Study the reaction as shown in figure 5.1 below.
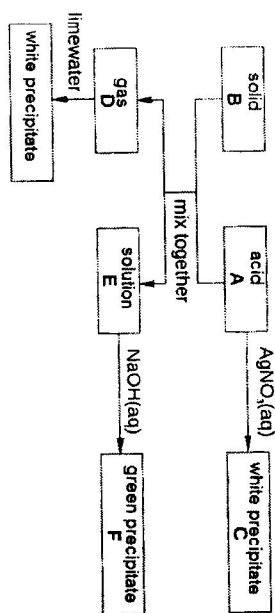


Figure 5.1

(a) Identify substances A to F.

A: ...........................................................

B: ...........................................................

C: ...........................................................

D: ...........................................................

E: ...........................................................

F: ........................................................... [6]

(b) Write a balanced chemical equation for any one of the reactions that are described within Figure 5.1.

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

[Total: 7]

6 Four unlabelled metals, **A**, **B**, **C** and **D** are tested in a laboratory. The following shows the results:

Metal **A** has to be hot before it will react with steam.
Metal **B** does not react with dilute hydrochloric acid.
Metal **C** is the only one to react with cold water. The reaction with water is steady but not violent.
Metal **D** has to be very hot before it will react with steam. It reacts slowly with dilute hydrochloric acid.

(a) Place the metals **A**, **B**, **C** and **D** in order of reactivity.

most reactive ...........

............

............

least reactive ...........

[2]

(b) Suggest a possible name for metals **B** and **C**.

Metal **B**: ...........

Metal **C**: ...........

[2]

(c) Write a chemical equation, including state symbols, to represent the reaction of metal **C** with cold water.

...........

[2]

[Total: 6]

7 Explain why

(a) some metals can occur in the ground as uncombined metal.

...........

[1]

(b) recycling is beneficial to the environment.

...........

[1]

(c) carelessly disposing plastics can result in long-term environmental problems.

...........

[1]

[Total: 3]

8 Magnesium metal reacts with hydrochloric acid as follows.

$$Mg + 2HCl \rightarrow MgCl_2 + H_2$$

(a) 50cm³ of 0.15 mol/dm³ of hydrochloric acid is used to react with excess magnesium.

(i) Calculate the number of moles of hydrochloric acid used.

[1]

(ii) Calculate the mass of magnesium chloride formed.

[2]

(b) The same experiment was conducted and the temperature was measured before and after the reaction.



hydrochloric acid

temperature 30°C

hydrochloric acid and magnesium powder

temperature 40°C
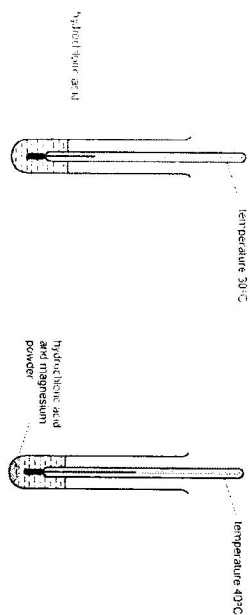
**Figure 8.1**

Is the reaction exothermic or endothermic? Explain your answer.

...........................................................................................................

...........................................................................................................

[1]

[Total: 4]

9 (a) Diagram 9.1 shows the apparatus used to form ethanol by yeast.



sugar and yeast in water

water containing Universal Indicator
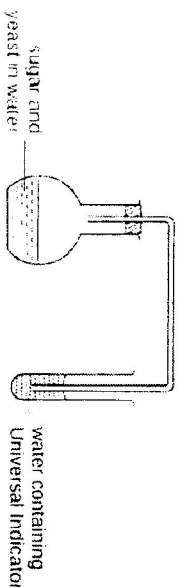
**Figure 9.1**

(i) Name the reaction investigated in this experiment.

...........................................................................................................

[1]

(ii) Explain why it is **not** advisable to use hot water to increase the rate of reaction.

...........................................................................................................

[1]

(b) After some time, the colour of the Universal indicator changes from pale green to orange.

(i) Explain why the Universal indicator changes colour.

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[2]

(ii) A compound will be formed if the ethanol in the resulting mixture is exposed to air. Draw the full structural formula of the compound formed.

[1]

(iii) State and explain one other function of the Universal indicator in the production of ethanol.

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[1]

[Total: 6]

**Section B (20 marks)**
Answer any **two** questions only.

**10** Zinc sulfate can be formed when acids reacts with insoluble metal carbonates.

(a) (i) State the acid and metal carbonate used to prepare zinc sulfate in a laboratory.

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(ii) Write a chemical equation to represent the reaction in **(a)(i)**.

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(iii) Describe the steps that are needed to prepare the above salt.

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[8]

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(b) State **two** other characteristic properties of acids.

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[2]

[Total:10]

**11** (a) Group VII elements such as chlorine have the ability to behave as an oxidising agent.

(i) Describe what can be observed when potassium iodide is added to chlorine.

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(ii) With a balanced chemical equation for the reaction in **(a)(i)**, explain in terms of electron transfer, how chlorine act as an oxidising agent.

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[3]

(b) A student reacted hydrochloric acid with calcium carbonate lumps to form calcium chloride.

(i) Draw a 'dot and cross' diagram to show the arrangement of electrons in the calcium chloride formed.

(ii) Explain why hydrogen chloride has a low melting point but calcium chloride has a high melting point.

(iii) State and explain, using your knowledge on reacting particles, why using powder calcium carbonate increases the speed of reaction in this reaction.

(iv) State another way to increase the rate of reaction.

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.......................................................... [7]

12 (a) Petroleum is separated into several useful substances in a fractionating tower.

(i) Describe the separation process.

(ii) State the change in viscosity of the fractions changes going down the fractionating tower.

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.......................................................... [5]

(b) Octane, $C_8H_{18}$, a major component in petrol, burns in a good supply of oxygen in a car engine to form carbon dioxide and water.

$$2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$$

(i) What volume of carbon dioxide, measured at room temperature and pressure, would be produced when 1.0 kg of octane is combusted in a car engine? Leave your answer in 3 significant figures.

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[5]

(ii) From the above information, explain why car-sharing is encouraged.

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[10 marks]

**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

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

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).

HUA YI SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2016

SECONDARY 4E5N
Marking Scheme

SCIENCE (CHEMISTRY/Biology)
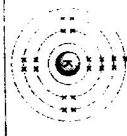
## Paper 1 [20 marks]

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|----|
| B | C | D | D | D | B | B | A | C | C |

| 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|----|----|----|----|----|----|----|----|----|----|
| A | A | D | A | A | D | C | B | C | B |

## Paper 3

## Section A [45 marks]
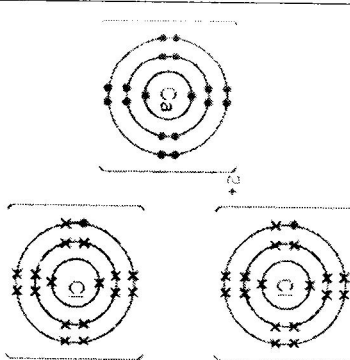
| | | |
|---|---|---|
| 1 | nickel, | |
| | calcium oxide/ calcium carbonate | |
| | limestone / calcium carbonate | 3 |
| 2(a) | all the components have different boiling points. | [3] |
| (b) | cadmium | 1 |
| (c) | test the boiling point. Pure zinc will boil constantly at 908 °C. | 1 |
| (d) | Refining crude oil to different fractions | 1 |
| | Obtaining ethanol from fermented sugars | |
| | Fractional distillation of liquidfied air | |
| | Obtaining nitrogen from Haber process    [any 2] | [4] |
| 3(a) | zinc metal | 2 |
| b | brass alloy | |

| | | |
|---|---|---|
| (c) | Pure zinc is soft because the atoms of the same size are arranged in an orderly and regular arrangement. The layers of atoms slide easily over one another when a force is applied. | 2 |
| | Brass is harder as the atoms added have a different size. This disrupts the orderly arrangement of atoms. | 2 |
| | | [4] |
| 4(a)(i) | $ZnBr_2$ [1] | 1 |
| (ii) | proton number/ atomic number | 1 |
| (b) (i) | 19 | 1 |
| (ii) | 21 | 1 |
| (iii) | 18 | 1 |
| (c)(i) | isotopes | 1 |
| (ii) | They have different number of neutrons. | 1 |
| (iii) |  | 1 |
| | | [8] |
| 5a | A: hydrochloric acid | 1 |
| | B: iron (II) carbonate   (oxidation must be stated) | 1 |
| | C: silver chloride | 1 |
| | D: carbon dioxide | 1 |
| | E: iron (II) chloride  (oxidation must be stated) | 1 |
| | F: iron (II) hydroxide  (oxidation must be stated) | 1 |
| b | $2HCl + FeCO_3 \rightarrow FeCl_2 + CO_2 + H_2O$ | 6 |
| | $FeCl_2 + 2NaOH \rightarrow Fe(OH)_2 + 2NaCl$ | |
| | $HCl + AgNO_3 \rightarrow AgCl (s) + HNO_3 (aq)$ | |
| | $CO_2 + Ca(OH)_2 \rightarrow CaCO_3 + H_2O$ | |
| | | [7] |
| 6a | C, A,D,B | 2 |
| b | | 2 |

| Metal | Name of metal |
|-------|---------------|
| B | • copper/gold/silver/platinum |
| C | • lithium, calcium |

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83

| | | |
|---|---|---|
| c | 2Li (s) + 2H₂O (l) → 2LiOH(aq) + H₂ (g)  (balanced equation 1m; state symbols 1m) | 2 |

| | | |
|---|---|---|
| 7a | Some metals are unreactive | 1 |
| b | To conserve resource as metal ore is a finite resource / To reduce air, water and land pollution as waste material is generated from extraction process. Waste material can leach into the soil and cause land and water pollution. | 1 |
| c | Plastics are non-biodegradable and will lead to increase amount of build up waste. | 1 [6] |

| | | |
|---|---|---|
| 8(a)(i) | No. of moles of HCl = 50/1000 x 0.15 = 0.0075 mol [1]  According to the equation, 2 moles of HCl form 1 mole of MgCl₂  No of moles of MgCl₂ produced = 0.0075/2= 0.00375 mol [1] | 2 |
| (ii) | Mass of MgCl₂ produced = 0.00375 x 95 = 0.356g | 1 |
| (b) | exothermic, heat is lost to the surroundings as heat energy (no marks given without explanation) | 1 [3] |

| | | |
|---|---|---|
| 9a(i) | Fermentation | 1 |
| (ii) | The yeast will denature. | 1 |
| b(i) | Carbon dioxide is bubbled into the universal indicator and [1] it is acidic. [1] | 2 |
| (ii) | [structural diagram] | 1 |
| (iii) | It prevents oxygen/ air from going into the set-up oxidising ethanol into ethanoic acid [1] | 1 [6] |

## Section B [20 marks]

| | | |
|---|---|---|
| 10(a)(i) | Reactant: zinc carbonate and sulfuric acid  (Any appropriate salt and reactant | 2 |
| (ii) | ZnCO₃ + H₂SO₄ → ZnSO₄ + CO₂ + H₂O | 1 |
| (ii) | Excess sodium carbonate is added to a volume of sulfuric acid ;  Filter the excess sodium carbonate  Heat filtrate to saturation  Cool to obtain crystals  Rinse crystals with distilled water and tap dry with filter papers (ECf for wrong reactant used) | 5 |
| (b) | Acids react with metals to form salt, hydrogen gas  Acids react with base to form salt, water. | 2 |

| | | |
|---|---|---|
| 11(a)(i) | Colour of KI changes from colourless to brown. | 1 |
| (ii) | Cl₂ (g) + 2KI (aq) → 2KCl (aq) + I₂ (aq) | 2 |
| (b)(i) | It causes iodide ion to be oxidised to from iodine by losing electrons. | 2 |
| (ii) | [atomic structure diagram] | 2 |
| (iii) | Use powder instead of lumps: increase surface of contact between reacting particles, increasing number of effective collisions. [2] | 2 |
| (iv) | Low amount of energy is required to overcome the intermolecular forces in HCl. [1]  High amount of energy is required to overcome the strong electrostatic forces between Mg2+ and Cl- ions. [1] | 2 |

| | | |
|---|---|---|
| 12(a)(i) | Heat the acid / increase concentration of acid | 1 |
| (ii) | Petroleum is heated.  The fractions have different boiling range due the different molecular size/ mass.  The fraction with the lowest boiling range will come out at the top while the fraction with the highest boiling range will come out at the bottom of the tower. | 4 |
| (iii) | Viscosity increases down the tower. | 1 |
| (b)(i) | no. of moles of octane in 1kg= 1000/ 114 = 8.722 mol  no. of moles of CO₂ =8.722/2 ×16 =69.776 mol  Volume of CO2 produced = 69.776 x 24 = 1674 dm³ | 3 |
| (ii) | lower emission of carbon dioxide, which causes global warming | 2 |

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84

Name: ...................................... (      )      Class: Sec 4A

# Queenstown Secondary School
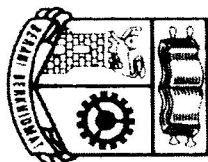
Secondary Four Express
Preliminary Examination 2015
Science (Chemistry / Biology)
5078/01

18 September 2015
Friday

Time :    0800 – 0900 hrs
Duration : 1 hr

Class: Sec 4A
Setter: Mrs Chen Jingyi & Mr Kennard Seah

**READ THESE INSTRUCTIONS FIRST**

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

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 Data Sheet is printed on page 17.
A copy of the Periodic Table is printed on page 18.

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

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

---

1   The table below shows some information regarding two substances **G** and **H**.

| substance | melting point/ °C | boiling point/ °C | solubility in water |
|---|---|---|---|
| G | 150 | 370 | insoluble |
| H | 10 | 190 | soluble |

A mixture of both substances at room temperature needs to be separated to obtain pure samples of **G** and **H**. Which of the following procedures is the **most appropriate**?

A   filtration only

B   distillation only

C   filtration followed by crystallisation

D   add water to mixture followed by filtration

2   An unknown solution **J** forms a white precipitate with aqueous sodium hydroxide. The precipitate dissolves upon adding excess aqueous sodium hydroxide to form a colourless solution. Solution **J** is also known to contain chloride ions.
Which could be a possible cation present in **J**?

A   ammonium ion       B   calcium ion       C   lead(II) ion       D   zinc ion

3   Which of the following diagrams shows $H_2O$ being cooled from 80°C to -1°C?



A          B          C          D
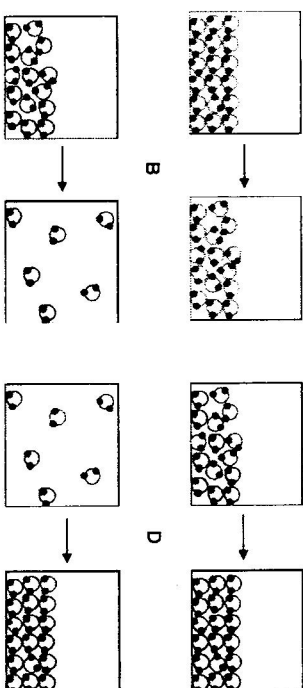
4   Two atoms, $^{55}_{25}Mn$ and $^{56}_{26}Fe$ have the same

  I.    number of protons.
  II.   number of neutrons.
  III.  number of electrons.
  IV.   relative atomic mass.

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

5   Which of the following substance has a low boiling point?

  A  Fe   B  HCN   C  KF   D  PbO

6   What is the total number of electrons used in bonding in the molecule below?

$$O = C = O$$

  A  4   B  8   C  12   D  16

7   What is the percentage composition of carbon in $C_2H_5(NH)COOH$?

  A  15.7%   B  27.0%   C  35.9%   D  40.4%

8   70 cm³ of ammonia gas is reacted with 20 cm³ of hydrogen chloride gas as shown in the equation below.

$$NH_3(g) + HCl(g) \rightarrow NH_4Cl(s)$$
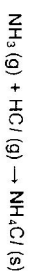
What is the total volume of **unreacted** gas at the end of the reaction?

  A  0 cm³   B  50 cm³   C  70 cm³   D  120 cm³

9   When solid ammonium nitrate is dissolved in water to form a solution, the temperature of the solution decreased.

Which of the following statements correctly explains this?

  I.    Reactants gained heat energy from surroundings.
  II.   The surroundings gained heat from the reactants.
  III.  More energy is absorbed to break bonds than released to form bonds.

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

10  In **Experiment 1**, 3.00 g of copper(II) oxide is reacted with 0.800 mol/dm³ of excess nitric acid. The change in mass of copper(II) oxide was plotted against time.

In **Experiment 2**, the reaction was repeated using 1.00 mol/dm³ of excess nitric acid.

In the graph below, which of the curves correctly represent **Experiments 1 and 2**?
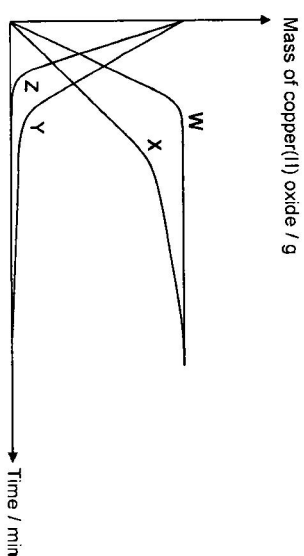


| | experiment 1 | experiment 2 |
|---|---|---|
| A | curve W | curve X |
| B | curve X | curve W |
| C | curve Y | curve Z |
| D | curve Z | curve Y |

11 Which of the following statements correctly describes the redox reaction below?

$$2K + 2H_2O \rightarrow 2KOH + H_2$$

A K was oxidised because it gained electrons.
B K was oxidised because it gained hydrogen.
C $H_2O$ was reduced because it lost electrons.
D $H_2O$ was reduced because it lost oxygen.

12 Sulfuric acid reacted with an unknown solid Q to form a gas which turns damp blue litmus red.

Which is a possible identity for Q?

A ammonium nitrate     C sodium carbonate
B magnesium    D zinc oxide

13 A student managed to prepare a pure sample of a salt without the need to do any form of heating. Which was the salt he prepared?

A copper(II) chloride    C potassium sulfate
B lead(II) sulfate    D zinc nitrate

14 Rubidium is an element found in Group I of the Periodic table.

Which statement about rubidium is likely to be correct?

A It reacts with oxygen in the air to form an acidic oxide.
B It reacts with acid to form a solution which turns damp red litmus blue.
C It reacts with alkali to form a solution which turns damp blue litmus red.
D It reacts with water to form a solution which turns damp red litmus blue.

15 The table below records whether reactions between some metals and their compounds took place.

| metal | chloride of S | chloride of T | chloride of U |
|---|---|---|---|
| S | - | no reaction | reaction occurred |
| T | | | |
| U | no reaction | no reaction | - |

It was later discovered that metal S is actually iron. What could T and U be?

|   | T | U |
|---|---|---|
| A | zinc | sodium |
| B | copper | silver |
| C | magnesium | silver |
| D | copper | zinc |

16 Which of the following metals cannot be extracted by heating with coke?

A copper    B lead    C magnesium    D zinc

17 120 cm³ of air is passed over heated copper metal until no further changes. What is the approximate volume of air left after the reaction?

A 0 cm³    B 24 cm³    C 78 cm³    D 95 cm³

18 Which conditions are required for converting $C_{30}H_{62}$ to ethene and hydrogen?

A Aluminium oxide, high temperature and high pressure.
B Heating with acidified potassium manganate(VII).
C Nickel catalyst and temperature of 200 °C.
D Yeast under anaerobic conditions at 37 °C.

19  Which statement about the molecule shown below is true?



A  It can undergo oxidation with potassium manganate(VII).
B  It can undergo combustion with oxygen gas.
C  It will decolourise aqueous bromine.
D  It has a pH above 7

20  Which of the following molecule is able to undergo addition polymerisation to form a polymer?



21  The figure below shows a portion of an animal cell. X, Y and Z are structures found in the cell.



What are structures X, Y and Z?

|   | X | Y | Z |
|---|---|---|---|
| A | mitochondrion | rough endoplasmic reticulum | vacuole |
| B | chloroplast | golgi apparatus | nucleus |
| C | mitochondrion | smooth endoplasmic reticulum | nucleus |
| D | rough endoplasmic reticulum | smooth endoplasmic reticulum | chloroplast |

**22** A student conducted an experiment using potato strips of equal volume. He placed the potato tubers into a petri dish filled with varying concentrations of sucrose solutions (0.0M to 0.5M). The graph below shows the % change in length of the potato strips, measured and recorded after 30 minutes.
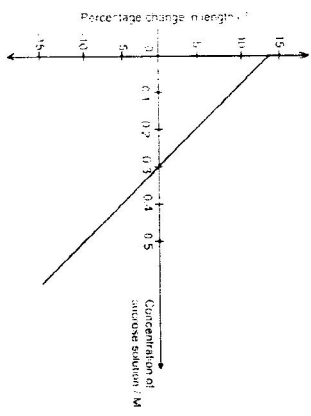


Which concentration of sucrose solution has the same water potential as the cell sap of the potato cells?

A  0.0M sucrose solution

B  0.1M sucrose solution

C  0.3M sucrose solution

D  0.5M sucrose solution

**23** Which of the following is **not** common to carbohydrates, proteins and fats?

A  They are needed to form new cell components.

B  They are made up of repeating units of one type of molecule.

C  They can be broken down to yield energy for cellular activities.

D  They contain carbon, hydrogen and oxygen.

**24** Which of the following graphs illustrates the effect of temperature on a reaction catalysed by amylase?
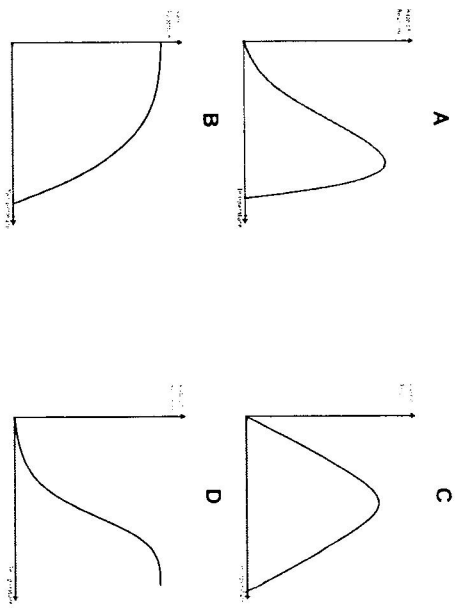


**25** Bioluminescence is the production and emission of light by a living organism, like fireflies. Luciferase is a type of enzyme that is involved in bioluminescence. Luciferase catalyses the reaction between oxygen and a substance called luciferin. The reaction can be represented in the simple equation:
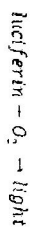
$$luciferin - O_2 \rightarrow light$$

According to the Lock and Key hypothesis, what does the lock and key represent in this reaction?

| | lock | key |
|---|---|---|
| A | luciferin | $O_2$ |
| B | luciferase | $O_2$ |
| C | luciferin | luciferase |
| D | luciferase | light |

**26** Which of the following statements is **true**?

A  The epiglottis is a flap-like tissue that is found below the larynx.

B  Circular muscles contract to widen the lumen of the gut during peristalsis.

C  Fats cannot be emulsified if a person does not have a gall bladder.

D  The larynx connects the buccal cavity to the oesophagus and the trachea.

**27** A certain disease in cows causes their small intestines to become completely smooth. Which of the following is a likely consequence of this disease?

A  constipation

B  reduced carbohydrate digestion

C  reduced protein

D  malnutrition

**28** The photomicrograph below shows the cross-section through a leaf.
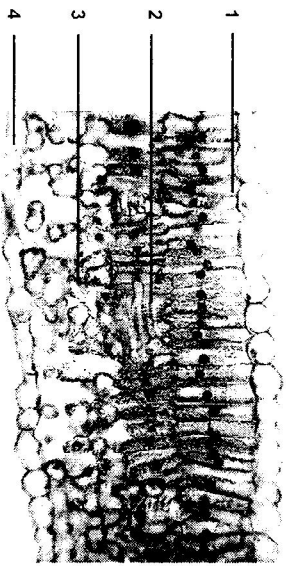


Which of the labelled structures convert light energy into chemical energy?

A  1 and 2

B  1 and 3

C  2 and 3

D  2 and 4

**29** Some insects feed on plant sap using long needle-like mouthparts to obtain sugars.

The diagram below shows an insect feeding from the leaf of a green plant.
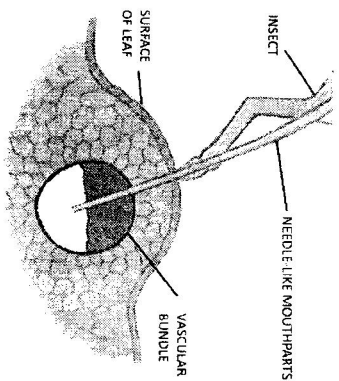


Which part of the plant is the insect feeding from?

A  sieve tube

B  xylem vessel

C  companion cells

D  sieve plates

**30** An athlete ran 2.4 km at sea level one day and at an area with a high altitude on a different day. He found that he had trouble breathing and felt tired more quickly when running at a high altitude. Which of the statements best explains why this happened?

A  The atmospheric pressure at a high altitude is higher and so air enters the lungs more slowly.

B  There is a lower concentration of oxygen in the air at higher altitudes.

C  The concentration of carbon dioxide is higher at higher altitudes.

D  The athlete has less haemoglobin in his red blood cells at higher altitudes.

**31** The graph below shows the pressure changes in the left side of the heart during a single heartbeat. At which point does the bicuspid valve **open**?



Pressure (kPa)

Time (s)

········· Pressure in Left Atrium

— — — Pressure in Left Ventricle
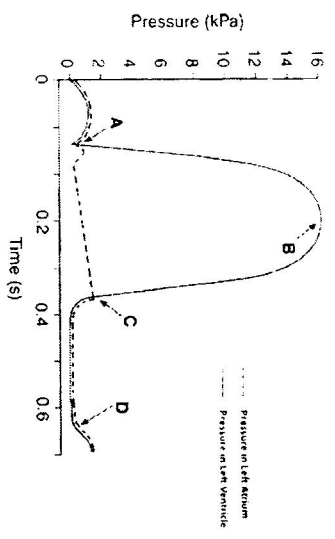
**32** The diagram below shows the human lung.
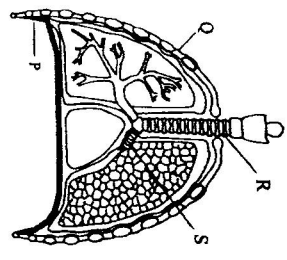


Which of the following correctly identifies structures **P, Q, R** and **S**?

| | P | Q | R | S |
|---|---|---|---|---|
| A | diaphragm | intercostal muscles | trachea | bronchus |
| B | bronchus | trachea | diaphragm | intercostal muscles |
| C | intercostal muscles | bronchus | diaphragm | trachea |
| D | trachea | diaphragm | intercostal muscles | diaphragm |

**33** The diagram below shows part of a man's nervous system, with a reflex arc included. A nerve block is applied at point **X** on the reflex arc, so that nerve impulses cannot pass through point **X**.
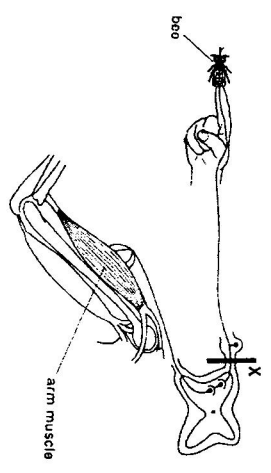


A bee stings the finger, as seen in the diagram. What are the effects of this sting?

| | pain felt by the man | arm movement |
|---|---|---|
| A | yes | no |
| B | no | no |
| C | yes | yes |
| D | no | yes |

**34** The diagram below shows a part of the human eye.
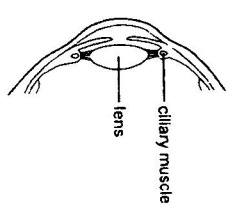


What changes take place in the eye when a person **looks down to read a book** after looking at a distant object?

| | ciliary muscle | lens |
|---|---|---|
| A | contracts | becomes thicker |
| B | contracts | becomes thinner |
| C | relaxes | becomes thicker |
| D | relaxes | becomes thinner |

91

**35** The diagram below shows the flower of a certain plant species.



anther
stigma
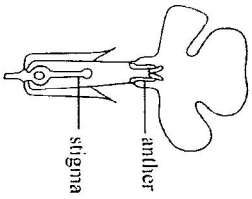
What is this flower's most likely form of pollination?

A insect pollination and self-pollination

B insect pollination and cross-pollination

C wind pollination and self-pollination

D wind pollination and cross-pollination

**36** A woman's menstrual period started on 23ʳᵈ March. Assuming the woman has the average menstrual cycle length, in which week was an egg likely to have been released from the ovary?

| Week | Sun | Mon | Tue | Wed | Thu | Fri | Sat |
|------|-----|-----|-----|-----|-----|-----|-----|
| | | | | | | | March |
| A | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| B | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| C | 19 | 20 | 21 | 22 | 23 | 24 | 25 |
| D | 26 | 27 | 28 | 29 | 30 | 31 | |

**37** Disease **A** in cows is caused by a recessive allele. What is the probability that a diseased offspring is produced when a test cross is carried out on a heterozygous female cow?

A 25%  B 33%  C 50%  D 75%

**38** The diagram below shows the inheritance pattern of a certain disease **X** across three generations of a family.



■ Affected male    □ Unaffected male
● Affected female  ○ Unaffected female
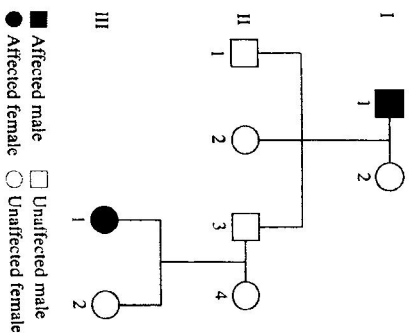
What conclusion about the disease can be drawn from the diagram?

A It is caused by a dominant allele.

B It is caused by a recessive allele.

C It can only be inherited from an affected grandparent.

D It can only be inherited from two unaffected parents.

**39** A particular segment of a DNA strand has the sequence AATTCGCAT. What would be the sequence of nucleotides on the product of replication?

A TTAAGCGTA          C GGCCTAGC

B TTCCGAGTC          D UUAAGCGUA

**40** What causes the **decrease** in oxygen concentration in a lake polluted by sewage?

A A decrease in dissolved nitrate concentration.

B A decrease in the number of producers.

C An increase in the number of consumers.

D An increase in the number of decomposers.

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93

## MARK SCHEME

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

Queenstown Secondary School

19

[Turn over
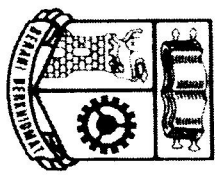
Name:

Index No. _____ Class: _____

# Queenstown Secondary School

Secondary Four Express / Five Normal (Academic)
Preliminary Examination 2015
Science (Chemistry)
5076/03 & 5078/03

Time : 1130 – 1245 hrs
Duration : 1 hr 15 min

01 September 2015
Tuesday

Setter: Ms Amanda Liu

**READ THESE INSTRUCTIONS FIRST**

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 two sections in this paper.
Section A consists of 45 marks. You need to answer all questions.
Section B consists of 20 marks. You are given three questions, and you need to answer any two of them.

**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 Data Sheet is printed on page 12.
A copy of the Periodic Table is printed on page 13.

---

## Section A

Answer **all** the questions.

1    Table 1.1 gives some information on the component gases of clean air in the atmosphere.

**Table 1.1**

| gas | melting point / °C | boiling point / °C |
| --- | --- | --- |
| argon | -189 | -186 |
| carbon dioxide | sublimes at -78 °C | |
| nitrogen | -210 | -196 |
| oxygen | -218 | -183 |
| other noble gases | | |
| water vapour | 0 | 100 |

Separating air into its component gases is an important process in the industries.

Air is first cooled to liquid at -200°C before it is gradually warmed up and separated into its component gases, as illustrated in Fig. 1.2.

stage 1                                    stage 2

air

cooling                                   → nitrogen
                                          → argon
liquid air at                             → oxygen
-200 °C

carbon dioxide and
water removed                    heater

**Fig. 1.2**

(a)    Describe the *arrangement* and *movement* of the particles in liquid air.

..............................................................................................................................

..............................................................................................................................

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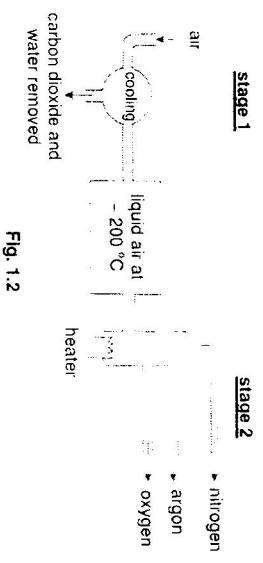
.......................................................................................................................... [2]

(b)    Explain why carbon dioxide and water can be removed when air is compressed and cooled to -200 °C in **stage 1**.

..............................................................................................................................

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

(c) Name the method used to separate the components of liquid air in **stage 2**.

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

(d) Which component will be collected first in **stage 2**? Explain your answer.

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

(e) Arrange the gases collected in **stage 2** in ascending order of volume that they are present in liquid air.

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

(f) The presence of air pollutants can cause adverse effects to health and the environment.

Name **one** gas that is an air pollutant and state its source.

pollutant ..........................................................................................

source ..............................................................................................
[2]

**2** Choose from the following elements to answer the questions below.

| sodium | lead | carbon |
| nitrogen | hydrogen | magnesium |
| copper | sulfur | zinc |

Each element can be used once, more than once or not at all.

(a) Which element(s) forms an acidic oxide?

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

(b) Which element exists as an atom with 6 valence electrons?

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

(c) Which element forms a neutral oxide that exists in liquid state at room temperature?

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

(d) Which element(s) forms an oxide that reacts with both dilute hydrochloric acid and aqueous sodium hydroxide?

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

(e) Which element forms an anion with an electronic configuration of 2.8?

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

(f) Which two metals are found in the alloy brass?

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

**3** An experiment was carried out to measure the rate of reaction between excess powdered calcium carbonate and dilute acids.

(a) In **Experiment 1**, 25.0 cm³ of 1.5 mol/dm³ hydrochloric acid was used.

(i) Complete the equation for the reaction by filling in the missing state symbols.

$$2HCl(\quad) + CaCO_3(\quad) \rightarrow CaCl_2(\quad) + H_2O(\quad) + CO_2(\quad)$$
[1]

(ii) Calculate the total volume of carbon dioxide that is made from this reaction at room temperature and pressure (r.t.p.).
[1]

(b) A further experiment using hydrochloric acid, **Experiment 2**, was carried out.

The results of **Experiments 1** and **2** are shown on the graph.



[3]
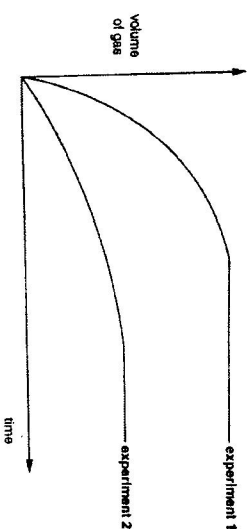
Suggest the concentration and volume of acid used for Experiment 2.

concentration ...................................................... mol/dm³

volume ...................................... cm³ [2]

(c) **Experiment 3** was carried out using 25.0 cm³ of 1.5 mol/dm³ sulfuric acid.

The initial rate of reaction for **Experiment 3** was faster than for the other experiments but the reaction stopped suddenly after only a small amount of gas had been given off.

(i) Name the salt formed in **Experiment 3**. ...................................................... [1]

(ii) Explain why the reaction stops suddenly. ...................................................... [1]

(iii) Name one suitable reagent that can be reacted with dilute sulfuric acid to prepare the above salt in **(c)(i)**. ...................................................... [1]

(d) For all three experiments, Nicholas used the measuring cylinder to measure the volume of acid used.

He used an unknown apparatus to measure the volume of gas.

Identify what the unknown apparatus was and state how he could improve on the accuracy of the measurement of the volume of acid. ...................................................... [2]

4 This question is about halogens.

(a) The table shows data about the melting and boiling points of three halogens, chlorine, iodine and bromine. Complete the table by filling the name of each halogen.

| name of halogen | melting point / °C | boiling point / °C |
| --- | --- | --- |
|  | -7.2 | 58.8 |
|  | 113.8 | 184.5 |
|  | -100.9 | -34.7 |

[1]

(b) Sea water contains potassium chloride.

(i) Chlorine can be produced from sea water by displacement.

Name an element that can displace chlorine.

Give a reason for you choice.

name ......................................................

reason ...................................................... [2]

(ii) Describe a simple test, other than displacement, that can be used to show that sea water contains chloride ions.

test ......................................................

result ...................................................... [2]

**5** Zinc can be extracted from its ore, sphalerite – a zinc sulfide concentrate, ZnS, in the blast furnace through a method similar to the extraction of iron.

**(a)** The hot air in the blast furnace reacts with sphalerite to form zinc oxide and sulfur dioxide. When other raw materials are added, the zinc oxide is then reduced to form zinc. These reactions are represented by the equations below.

**Reaction 1:** $ZnS + 2O_2 \rightarrow 2ZnO + SO_2$

**Reaction 2:** $2ZnO + C \rightarrow 2Zn + CO_2$
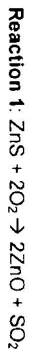
**(i)** State the oxidising and reducing agents in both **reactions 1 and 2**.

**Reaction 1**

oxidising agent ............................... reducing agent ...............................

**Reaction 2**

oxidising agent ............................... reducing agent ...............................

[1]

[1]

**(ii)** Describe a test for sulfur dioxide.

test ...........................................................................................................

result .......................................................................................................

[2]

**(iii)** Suggest a method to remove sulfur dioxide.

...................................................................................................................

[1]

**(b)** It was found that solid zinc oxide had to be melted before it was able to conduct electricity. Explain the difference in electrical conductivity between solid and molten zinc oxide.

...................................................................................................................

...................................................................................................................

...................................................................................................................

...................................................................................................................

[3]

**(c)** When an excess of powdered zinc is added to aqueous copper(II) sulfate, a reaction occurs.

$$Zn\ (s) + CuSO_4\ (aq) \rightarrow ZnSO_4\ (aq) + Cu\ (s)$$

**(i)** State and explain your **observations**.

...................................................................................................................

...................................................................................................................

...................................................................................................................

[3]

**(ii)** Complete the table to show the oxidation states of zinc and copper.

| element | oxidation state in reactants | oxidation state in products |
|---|---|---|
| zinc | | |
| copper | | |

[2]

**(iii)** Using the information in **(c)(ii)**, explain why this is a redox reaction.

...................................................................................................................

...................................................................................................................

[2]

98

6    Read the following article and answer the following questions.

*Source extracted from:*

*http://www.nytimes.com/2008/02/18/us/18sugar.html?fta=y&pagewanted=print*

**It was inside** one of those rooftop dust collectors where the minor explosion occurred weeks before the February 7 blast, which was caused by clouds of tiny sugar dust particles that, when airborne in confined spaces, can ignite like gunpowder.

The refinery was equipped with fans and ducts designed to prevent dust explosions by sucking particles out of the plant and transferring them to dust collectors on the roof, Mr. Selk said.

No one was injured in the earlier explosion. A spokesman for Imperial Sugar, Steve Behm, said it happened about three weeks ago and caused minimal damage that was quickly repaired.

SAVANNAH, Ga. (AP) — Dust that collected in a piece of safety equipment caused a small explosion at a sugar refinery weeks before the deadly blast that killed **nine** workers, a federal investigator said on Sunday.

**By THE ASSOCIATED PRESS**

**Sugar Refinery Had Prior Explosion**

**February 18, 2008**

(a)    Explain why tiny sugar dust particles burn more easily than lumps of sugar crystals.    [2]

(b)    Sugar, $C_6H_{12}O_6$, burns in excess air to form a colourless gas and water, which happened when the explosion occurred.

  (i)    Is this reaction endothermic or exothermic? Explain your answer.    [2]

  (ii)    Describe a test that can be used to confirm the identity of the colourless gas.    [2]

  (iii)    Write a **balanced** chemical equation for the reaction in **(b)**.    [1]

7    (a)    Give the general formula of both the alkane and alkene homologous series.

Explain why the relative molecular mass increases by 14 on moving up from one member of a homologous series to the next higher member.    [2]

(b)    (i)    Construct a table to show the following information about propane and propene.

  •    Draw the **structural formulae** of propane and propene.

  •    State one similarity and one difference between the structures of propane and propene.    [4]

  (iii)    Name a substance that can be used to distinguish between propane and propene. In each case, describe what you would see.    [2]

(c)    Propene can be polymerised.

  (i)    Name the polymer formed.    [1]

  (ii)    This polymer is *non-biodegradable* and needs to be disposed of by other means. Explain why this polymer should not be disposed of by burning.    [1]

(iv)    Sugar is an important condiment used in daily life. In the chemical industry, it can be made into ethanol by process **X**.

State what process **X** is and describe how this is carried out in the industry.

Include a chemical equation for process **X**.    [3]

8    Fig. 8.1 shows the arrangement of electrons in a compound of hydrogen, H, element **Y** and element **Z**. Only outer shell electrons are shown.

This molecule is found in vinegar.
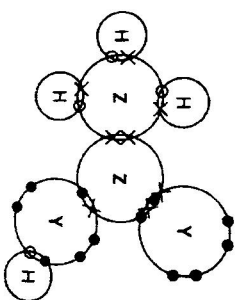


**Fig. 8.1**

(a)    (i)    The molecule in Fig. 8.1 is a **compound**.

Explain, with reference to the diagram, what a compound is.    [1]

  (iii)    Explain, using ideas about structure, why the molecule in Fig 8.1 is a liquid at room temperature and pressure.    [2]

(iii) Elements **Y** and **Z** have atomic numbers between 2 and 11.
Name elements **Y** and **Z**.    [1]

(iv) Using the correct atomic symbols for elements **Y** and **Z**, draw the full structural formula of the molecule.    [1]

(v) Hence, calculate the percentage by mass of hydrogen in the molecule.    [1]

(b) Rust, iron(III) oxide, is formed when steel is exposed to water and oxygen.
The molecule in Fig. 8.1 can help to remove rust.

(i) What type of reaction occurs when the molecule in Fig. 8.1 reacts with iron(III) oxide, rust?    [1]

(ii) Explain, in terms of particles, how warm vinegar can remove rust more readily.    [2]

(iii) Steel is often protected from rusting by coating with zinc. It can be done by dipping steel in molten zinc.
Explain why steel can be protected by coating with zinc.    [1]

---

**Colours of Some Common Metal Hydroxides**

| 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 |

| | | | | | | | | | | | | | | | | | | 4 He helium 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

Row:
| I | II | | | | H hydrogen 1 | | | | | | | | III | IV | V | VI | VII | 0 |

| 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 dm³ at room temperature and pressure (r.t.p.)

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102

# Queenstown Secondary School

### Secondary Four Express / Five Normal (Academic)
### Preliminary Examination 2015
### Science (Chemistry)
### 5076/03 & 5078/03

01 September 2015
Tuesday

Time :   1130 – 1245 hrs
Duration : 1 hr 15 min

Setter: Ms Amanda Liu

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Do not use staples, paper clips, highlighters, glue or correction fluid.

There are two sections in this paper.
Section A consists of 45 marks. You need to answer all questions.
Section B consists of 20 marks. You are given three questions, and you need to answer any two of them.

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A copy of the Data Sheet is printed on page 12.
A copy of the Periodic Table is printed on page 13.

| Examiner's Use | |
|---|---|
| Section A | /45 |
| Section B | /20 |
| **TOTAL** | **/65** |

---

## Section A
**Answer all the questions.**

1   Write your answers in the spaces provided on the question paper.

Table 1.1 gives some information on the component gases of clean air in the atmosphere.

**Table 1.1**

| gas | melting point / °C | boiling point / °C |
|---|---|---|
| argon | -189 | -186 |
| carbon dioxide | sublimes at -78 °C | |
| nitrogen | -210 | -196 |
| oxygen | -218 | -183 |
| other noble gases | | |
| water vapour | 0 | 100 |

Air is first cooled to liquid at -200°C before it is gradually warmed up and separated into its component gases, as illustrated in Fig. 1.2.

Separating air into its component gases is an important process in the industries.



**Fig. 1.2**

(a)   Describe the arrangement and movement of the particles in liquid air.

Particles are closely packed but not orderly arranged.                                      [1]

Particles move freely / slide past each other (throughout the liquid).                      [1]

(b)   Explain why carbon dioxide and water can be removed when air is compressed and cooled to -200 °C in **stage 1**.

At -200°C, carbon dioxide and water will be removed as solid.                               [1]

103

(c) Name the method used to separate the components of liquid air in stage 2. [1]

Fractional distillation

(d) Which component will be collected first in stage 2? Explain your answer. [1]

Nitrogen, as it has the lowest boiling point.

(e) Arrange the gases collected in stage 2 in ascending order of volume that they are present in liquid air. [1]

Argon, oxygen, nitrogen

(f) The presence of air pollutants can cause adverse effects to health and the environment.

Name one gas that is an air pollutant and state its source. [2]

Choose any one:

| pollutant | source |
| --- | --- |
| Carbon monoxide | Incomplete combustion of fuel in cars. |
| Sulfur dioxide | Combustion of fossil fuel in power stations. |
| Nitrogen dioxide | Combustion of fuel in cars at high temperature. |

2 Choose from the following elements to answer the questions below.

| sodium | lead | carbon |
| nitrogen | hydrogen | magnesium |
| copper | sulfur | zinc |

Each element can be used once, more than once or not at all.

(a) Which element(s) forms an acidic oxide? [1]

Carbon, nitrogen, sulfur (any 2 correct answers)

(b) Which element exists as an atom with 6 valence electrons? [1]

Sulfur

(c) Which element forms a neutral oxide that exists in liquid state at room temperature? [1]

Hydrogen

(d) Which element(s) forms an oxide that reacts with both dilute hydrochloric acid and aqueous sodium hydroxide? [1]

Lead / zinc

(e) Which element forms an anion with an electronic configuration of 2.8? [1]

Nitrogen / carbon

(f) Which two metals are found in the alloy brass? [1]

Copper and zinc

3 An experiment was carried out to measure the rate of reaction between excess powdered calcium carbonate and dilute acids.

(a) In Experiment 1, 25.0 cm³ of 1.5 mol/dm³ hydrochloric acid was used.

(i) Complete the equation for the reaction by filling in the missing state symbols. [1]

$2HCl ( aq ) + CaCO_3 ( s ) \rightarrow CaCl_2 ( aq ) + H_2O ( l ) + CO_2 ( g )$

(ii) Calculate the total volume of carbon dioxide that is made from this reaction at room temperature and pressure (r.t.p.). [1]

No. of mol. of HCl = 1.5 x 25/1000 = 0.0375 mol

No. of mol. of $CO_2$ = 0.0375/2 = 0.01875 mol

Volume of $CO_2$ = 0.01875 x 24dm³ = 0.45dm³

(b) A further experiment using hydrochloric acid, Experiment 2, was carried out.

The results of Experiments 1 and 2 are shown on the graph. [1] [1] [1]

Suggest the concentration and volume of acid used for Experiment 2.

concentration <u>0.75</u> mol/dm³

volume <u>25.0</u> cm³    [1]

**(c)** **Experiment 3** was carried out using 25.0 cm³ of 1.5 mol/dm³ sulfuric acid.

**(i)** Name the salt formed in **Experiment 3**. <u>Calcium sulfate</u>    [1]

**(ii)** Explain why the reaction stops suddenly.

As calcium sulfate is <u>insoluble</u>, it coats around calcium carbonate, preventing it from further reaction.    [1]

**(iii)** Name **one** suitable reagent that can be reacted with dilute sulfuric acid to prepare the above salt in **(c)(i)**.

<u>Calcium chloride / Calcium nitrate</u>    [1]

The initial rate of reaction for **Experiment 3** was faster than for the other experiments but the reaction stopped suddenly after only a small amount of gas had been given off.    [1]

**(d)** For all three experiments, Nicholas used the measuring cylinder to measure the volume of acid used.

He used an unknown apparatus to measure the volume of gas.

Identify **what** the unknown apparatus was and **state** how he could improve on the accuracy of the measurement of the volume of acid.    [1]

Unknown apparatus is <u>gas syringe.</u>    [1]

Use a <u>pipette / burette</u> for more accurate measurements.    [1]

---

**4** This question is about halogens.

**(a)** The table shows data about the melting and boiling points of three halogens, chlorine, iodine and bromine. Complete the table by filling the name of each halogen.

| name of halogen | melting point / °C | boiling point / °C |
|---|---|---|
| <u>bromine</u> | -7.2 | 58.8 |
| <u>iodine</u> | 113.8 | 184.5 |
| <u>chlorine</u> | -100.9 | -34.7 |

[1]

**(b)** Sea water contains potassium chloride.

**(i)** Chlorine can be produced from sea water by displacement.

Name an element that can displace chlorine.

*name* <u>Fluorine</u>    [1]

Give a reason for you choice.

*reason* Fluorine, being <u>more reactive</u> than chlorine, <u>displaces chlorine</u> from sea water.    [1]

**(ii)** Describe a simple test, other than displacement, that can be used to show that sea water contains chloride ions.    [1]

*test* To 2cm³ of a sample of sea water, add an equal volume of <u>dilute nitric acid</u>, followed by an equal volume of <u>aqueous silver nitrate</u>.    [1]

*result* <u>White precipitate</u> is observed.    [1]

5 Zinc can be extracted from its ore, sphalerite – a zinc sulfide concentrate, ZnS, in the blast furnace through a method similar to the extraction of iron.

(a) The hot air in the blast furnace reacts with sphalerite to form zinc oxide and sulfur dioxide. When other raw materials are added, the zinc oxide is then reduced to form zinc. These reactions are represented by the equations below.

Reaction 1: $ZnS + 2O_2 \rightarrow ZnO + SO_2$

Reaction 2: $2ZnO + C \rightarrow 2Zn + CO_2$

(i) State the oxidising and reducing agents in both reactions 1 and 2.

Reaction 1

oxidising agent <u>$O_2$ / oxygen</u>          reducing agent <u>ZnS / zinc sulfide</u>          [1]

Reaction 2

oxidising agent <u>ZnO / zinc oxide</u>          reducing agent <u>C / carbon</u>          [1]

(ii) Describe a test for sulfur dioxide.

test Place a piece of filter paper soaked with <u>acidified aqueous potassium manganate(VII)</u> and insert into the mouth of the test tube.          [1]

result Gas evolved turns <u>purple acidified aqueous potassium manganate(VII) colourless.</u>          [1]

(b)

(iii) Suggest a method to remove sulfur dioxide.

<u>Desulfurisation / Pass gas through calcium oxide / hydroxide / carbonate.</u>          [1]

It was found that solid zinc oxide had to be melted before it was able to conduct electricity. Explain the difference in electrical conductivity between solid and molten zinc oxide.

In the solid state, the ions in zinc oxide are <u>held rigidly in fixed positions.</u> The <u>absence of mobile ions</u> prevents the electric current from being carried.          [1]

In the molten state, the <u>presence of mobile ions</u> allows the electric current to be carried.          [1]

(c) When an excess of powdered zinc is added to aqueous copper(II) sulfate, a reaction occurs.

$Zn (s) + CuSO_4 (aq) \rightarrow ZnSO_4 (aq) + Cu (s)$

(i) State and explain your observations.

The <u>blue solution turns colourless</u>, and a <u>red-brown solid</u> is formed. Zinc, being more reactive, displaces copper from copper(II) sulfate.          [2]

(ii) Complete the table to show the oxidation states of zinc and copper.

| element | oxidation state in reactants | oxidation state in products |
|---|---|---|
| zinc | 0 | +2 |
| copper | +2 | 0 |

[1]
[1]

(iii) Using the information in (c)(ii), explain why this is a redox reaction.

<u>Zinc is oxidised</u>, as the oxidation state of zinc increases from <u>0 in Zn to +2 in ZnSO_4.</u>          [1]

<u>Copper(II) sulfate is reduced</u>, as the oxidation state of copper decreases from <u>+2 in CuSO_4 to 0 in Cu.</u>          [1]

## Section B

Answer any **two** questions.

Write your answers on the writing paper provided.

Read the following article and answer the following questions.

**February 18, 2008**

**Sugar Refinery Had Prior Explosion**

**By THE ASSOCIATED PRESS**

SAVANNAH, Ga. (AP) — Dust that collected in a piece of safety equipment caused a small explosion at a sugar refinery weeks before the deadly blast that killed nine workers, a federal investigator said on Sunday.

No one was injured in the earlier explosion. A spokesman for Imperial Sugar, Steve Behm, said it happened about three weeks ago and caused minimal damage that was quickly repaired.

The refinery was equipped with fans and ducts designed to prevent dust explosions by sucking particles out of the plant and transferring them to dust collectors on the roof, Mr. Selk said.

It was inside one of those rooftop dust collectors where the minor explosion occurred weeks before the February 7 blast, which was caused by clouds of tiny sugar dust particles that, when airborne in confined spaces, can ignite like gunpowder.

*Source extracted from:*

*http://www.nytimes.com/2008/02/18/us/18sugar.html?fta=y&pagewanted=print*

(a) Explain why tiny sugar dust particles burn more easily than lumps of sugar crystals.

Tiny sugar dust particles have a <u>larger surface area</u> of contact between reactant particles, leading to <u>more effective collisions</u>, resulting in a <u>faster rate</u> of reaction. [1]

(b) Sugar, $C_6H_{12}O_6$, burns in excess air to form a <u>colourless gas and water</u>, which happened when the explosion occurred. [1]

(i) Is this reaction endothermic or exothermic? Explain your answer.

<u>Exothermic</u>, as heat energy is <u>released</u> to the surroundings. [2]

---

(ii) Describe a test that can be used to confirm the identity of the colourless gas. [1]

Deliver the colourless gas into <u>limewater</u> [1]

If a <u>white precipitate</u> is formed, carbon dioxide is present. [1]

(iii) Write a balanced chemical equation for the reaction in (**b**).

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ [1]

(iv) Sugar is an important condiment used in daily life. In the chemical industry, it can be made into ethanol by process **X**.

State what process **X** is and describe how this is carried out in the industry. Include a chemical equation for process **X**. [1]

<u>Fermentation</u> [1]

The process is carried out using <u>yeast</u> as catalyst, a temperature of <u>37°C</u>, under <u>anaerobic</u> conditions. [1]

$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ [1]

7 (a) Give the general formula of both the alkane and alkene homologous series. [1]

Explain why the relative molecular mass increases by 14 on moving up from one member of a homologous series to the next higher member.

Alkane: $\underline{C_nH_{2n+2}}$; alkene: $\underline{C_nH_{2n}}$ [1]

Each member in the homologous series differs by a $\underline{-CH_2-}$ unit to the next higher member. Hence, the relative molecular mass increases by $12+1\times2 = \underline{14}$ [1]

(b) (i) Construct a table to show the following information about propane and propene. [2]

• Draw the **structural formulae** of propane and propene.

• State one similarity and one difference between the structures of propane and propene. [1]

| | propane | propene |
|---|---|---|
| structural formulae | H H H<br> \|  \|  \|<br>H – C – C – C – H<br> \|  \|  \|<br>H H H | H H H<br> \|  \|  \|<br>H – C = C – C – H<br>     \|<br>     H |
| similarity | Choose any one:<br>• Both propane and propene are <u>hydrocarbons</u> / contains <u>carbon and hydrogen atoms</u> only.<br>• Both propane and propene consists of <u>3 carbon atoms</u>. | |

[1]

**8** Fig. 8.1 shows the arrangement of electrons in a compound of hydrogen, **H**, element **Y** and element **Z**. Only outer shell electrons are shown.

This molecule is found in vinegar.



Fig. 8.1

**(a) (i)** The molecule in Fig. 8.1 is a **compound**.

Explain, with reference to the diagram, what a compound is.

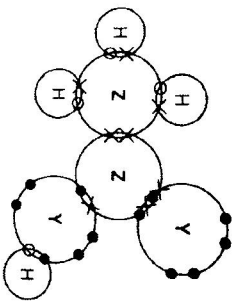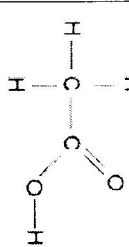A compound is made up of 2 or more different elements chemically combined together. [1]

---

**(c)** Propene can be polymerised.

**(i)** Name the polymer formed.

Polypropene. [1]

**(ii)** This polymer is *non-biodegradable* and needs to be disposed of by burning. Explain why this polymer should not be disposed of by other means.

Incomplete combustion of this polymer leads to the formation of toxic gases such as carbon monoxide. [1]

**(iii)** Name a substance that can be used to distinguish between propane and propene. In each case, describe what you would see.

substance Aqueous bromine

| Choose any one: | Choose any one: |
| --- | --- |
| • Propane is saturated / contains C – C single bond. | • Propane is unsaturated / contains C = C double bond. |
| • Propane consists of 8 hydrogen atoms. | • Propane consists of 6 hydrogen atoms. |

difference [1]

observation with propane No visible reaction [1]

observation with propene The brown aqueous bromine turns colourless immediately. [1]

---

**(ii)** Explain, using ideas about structure, why the molecule in Fig 8.1 is a liquid at room temperature and pressure.

The molecule is a simple covalent molecule. [1]

A small amount of heat energy is required to overcome the weak intermolecular forces of attraction between molecules. [1]

**(iii)** Elements **Y** and **Z** have atomic numbers between 2 and 11.

Name elements **Y** and **Z**. [1]

**Y**: oxygen; **Z**: Carbon

**(iv)** Using the correct atomic symbols for elements **Y** and **Z**, draw the full structural formula of the molecule. [1]



**(v)** Hence, calculate the percentage by mass of hydrogen in the molecule. [1]

$\%H = 4(1)/60 = 6.67\%$

**(b)** Rust, iron(III) oxide, is formed when steel is exposed to water and oxygen. The molecule in Fig. 8.1 can help to remove rust.

**(i)** What type of reaction occurs when the molecule in Fig. 8.1 reacts with iron(III) oxide, rust?

Neutralisation / exothermic reaction [1]

**(ii)** Explain, in terms of particles, how warm vinegar can remove rust more readily.

The higher the temperature, the faster the reactant particles move / the higher the kinetic energy possessed by the reactant particles, leading to more effective collisions, hence resulting in a faster rate of reaction. [1]

**(iii)** Steel is often protected from rusting by coating with zinc. It can be done by dipping steel in molten zinc.

Explain why steel can be protected by coating with zinc.

Zinc, being more reactive than iron in steel, corrodes in place of iron. [1]

## Colours of Some Common Metal Hydroxides

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

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

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

Key
| a | |
|---|---|
| X | a = relative atomic mass<br>X = atomic symbol<br>b = proton (atomic) number |
| b | |

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).

# ST. PATRICK'S SCHOOL
## PRELIMINARY EXAMINATIONS 2015

SUBJECT : SCIENCE(CHEMISTRY)
5076/5078
PAPER 3

LEVEL : SECONDARY 4 EXPRESS
SECONDARY 5 NORMAL

DATE : 27th August 2015

DURATION : 1 Hr 15 Mins

### INSTRUCTIONS TO CANDIDATES

**DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO.**

1. Write your name, class and index number on the Question Paper.

2. This paper consists of **TWO (2) Sections**: **Section A** and **Section B.**

3. Answer **ALL** questions in **Section A** in the spaces provided.

4. Answer **ANY TWO FULL** questions out of 3 in **Section B.**

5. Calculators may be used where necessary. **Where numerical answers are not exact, give answers to three (3) significant figures.**

6. **DO NOT DETACH** any sections from this paper.

**For Examiner's Use Only**

| Section | Paper 1 | | | | |
|---|---|---|---|---|---|
| | A (45 m) (20 m) | B (20 m) | Total (85 m) | Grade | Target Grade |
| Score | | | | | |

This question paper consists of 16 printed pages including a copy of the Periodic Table & Data Sheet

1

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### Section A

Answer all the questions in this section in the spaces provided.
The total mark for this section is 45.

A1 (a) The structure of a compound containing carbon and chlorine is shown below.
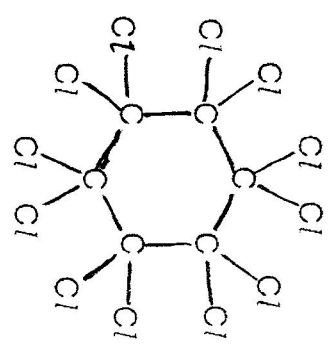
What is the molecular formula of this compound?

.................................................................

(b) The table shows some properties of Group VII elements. Use the information in the table to answer the following questions.

| element | boiling point/°C | density in liquid state/g per cm³ | colour |
|---|---|---|---|
| fluorine | −188 | 1.51 | yellow |
| chlorine | −35 | 1.56 | |
| bromine | −7 | | red-brown |
| iodine | +114 | 4.93 | grey-black |

(i) State the colour of chlorine.

.................................................................

2

111

(ii) Describe the trend in boiling point of the halogens down the group.

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

(c) (i) Write the balanced chemical equation for the reaction of bromine with aqueous potassium iodide. Include the state symbols.

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

(ii) Suggest why bromine does not react with aqueous potassium chloride.

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

(d) Potassium chloride is an ionic substance but iodine is a molecular substance.
How do most ionic and molecular substances differ in their

solubility in water? ........................................................................................

........................................................................................

electrical conductivity? ........................................................................................ [2]

3

---

A2 The structures of some substances containing nitrogen are shown below.

A   B   C

D   E
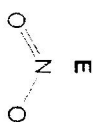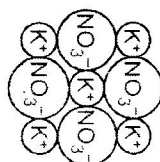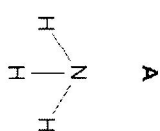
Answer the following questions by choosing from the structures A, B, C, D or E.
You can use each structure once, more than once or not at all.
Which structure represents

(a) an acidic oxide,

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

(b) an ionic structure,

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

(c) a gas which turns damp red litmus paper blue,

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

(d) a compound which is formed under conditions of high temperature and pressure in car engines,

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

(e) a salt,

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

(f) a molecule containing halogen atoms?

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

4

A3  A student compared the rates of thermal decomposition of three metal carbonates. She measured the volume of gas released using the apparatus shown.



heat → metal carbonate

gas syringe
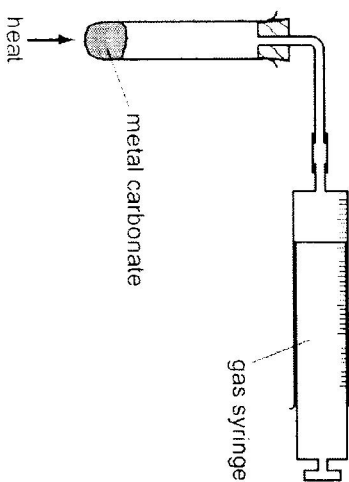
(a)  State one thing that must be kept constant if the three rates are to be compared in a fair way.  [1]

_____

(b)  The graph shows the volume of carbon dioxide released when the three metal carbonates were heated.



volume of carbon dioxide /cm³

calcium carbonate
strontium carbonate
barium carbonate
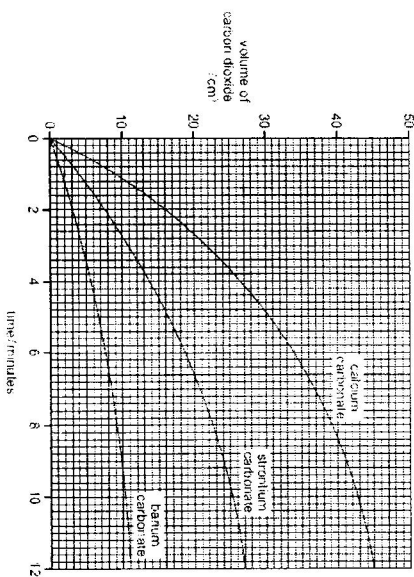
time/minutes

(i)  Which carbonate produced carbon dioxide at the highest rate?  [1]

_____

(ii)  What volume of carbon dioxide was produced by strontium carbonate in twelve minutes?  [1]

_____

(iii)  Calculate the number of moles of carbon dioxide produced in (ii).  [1]

_____

(iv)  How do the rates of the reactions of these three metal carbonates relate to the position of calcium, strontium and barium in the Periodic Table?  [1]

_____

5

6

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113

(c) Describe how hydrochloric acid and limewater can be used to show that carbonate ions are present in calcium carbonate.

_____

_____

_____

_____

[3]

A4  Iron is a metallic element.

(a) State two properties of iron which are different from the properties of Group I elements.

1 _____

2 _____

[2]

(b) The symbols for two isotopes of iron are shown below.

$^{54}_{26}\text{Fe}$  $^{57}_{26}\text{Fe}$

(i) How do these two isotopes differ in their atomic structure?

_____

[1]

(ii) How many electrons are in one $Fe^{3+}$ ion?

_____

[1]

(c) Pure iron rusts very easily.
Describe and explain one method of preventing rusting.

method _____

explain why this method works _____

_____

[2]

A5  (a) The equation shows the extraction of chromium (III) oxide using carbon monoxide.

$$Cr_2O_3 + 3CO \rightarrow 2Cr + 3CO_2$$

Which substance is the oxidising agent? Explain in terms of oxidation state.

_____

_____

[2]

(b) Carbon monoxide is a pollutant gas produced in motor car engines.

(i) State why carbon monoxide is formed.

_____

[1]

(ii) State one harmful effect of carbon monoxide.

_____

_____

[1]

114

**A6** The percentage of oxygen in air can be found using the apparatus shown below.



200 cm³ of air is passed backwards and forwards over the heated copper using the syringes. The copper reacts with oxygen in the air.
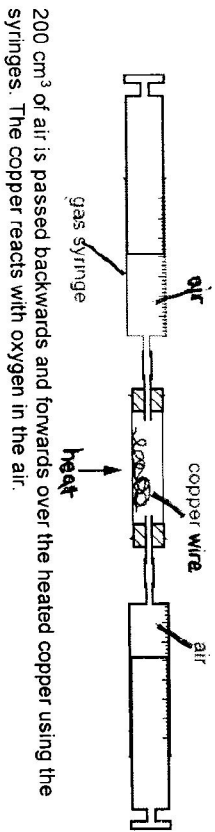
(a) Write a balanced chemical equation for the reaction above. Include state symbols. [1]

(b) How can you tell that the copper wire has reacted? [1]

(c) As the experiment proceeds, suggest the volume of air in the gas syringes remaining, if all $O_2$ is used up. Explain.[ show how you obtain the answer] [3]

(d) Calculate the mass of copper needed needed to produce 8.0 g of copper (II) oxide. [2]

(e) Give one different observation if magnesium ribbon is used instead of copper wire. [1]

9

**A7** The diagram shows the apparatus used to prepare a dry sample of ammonia which is denser than air.
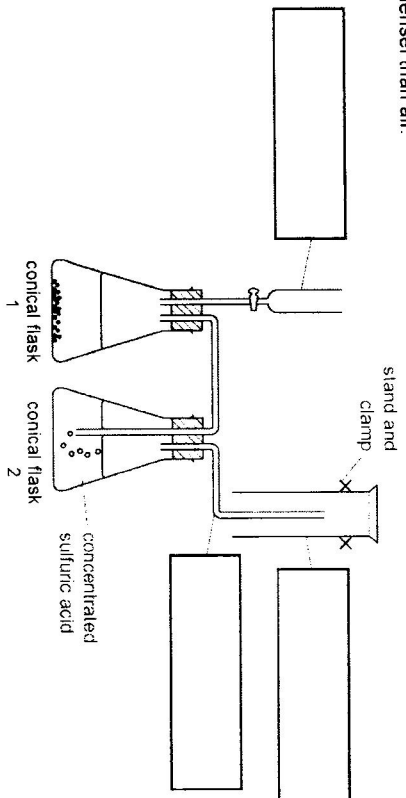


(a) Complete the boxes to name the apparatus.

(b) Identify two mistakes in the apparatus.

(c) Suggest why **conical flask 2** is needed.

10

## Section B

Answer **2 out of 3** questions.
The total mark for this section is 20.

**B1** (a) (i) Ethene, $C_2H_4$, is manufactured by cracking petroleum fractions.
What do you understand by the term 'cracking'? [1]

(ii) Complete the chemical equation for the manufacture of ethene from cracking of dodecane, $C_{12}H_{26}$. [1]

$$C_{12}H_{26} \rightarrow C_2H_4 + \underline{\hspace{3cm}}$$
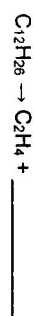
(b) Ethene is an **unsaturated hydrocarbon**. What do you understand by the following terms, **unsaturated** and **hydrocarbon**? [2]

_____

_____

(c) (i) Addition of water to ethene produces ethanol. Write a balanced chemical equation for the reaction. [1]

_____

(ii) Oxidation of ethanol produces a compound with a pH less than 7 Name the compound formed and the oxidising agent for the reaction. [2]

_____

(d) Propene is used to make polypropene.

(i) Name the process of obtaining polypropene from propene. [1]

_____

(ii) Draw the polymer, polypropene with **three** repeating units.
Give the conditions needed for polymerisation of propene to polypropene. [2]

Conditions: _____

**B2** There are four main methods of salt preparation:

- **A** : acid + metal
- **B** : acid + carbonate
- **C** : acid + alkali ( titration)
- **D** : precipitation

(a) Complete the table below by writing the **letter** of the correct method of salt preparation from above. Each method can be used **once only**. [4]

| salt to be prepared | method of preparation |
|---|---|
| copper (II) sulfate | |
| silver chloride | |
| potassium chloride | |
| zinc nitrate | |

(b) Name two suitable reactants to prepare potassium chloride and silver chloride salt. [4]

potassium chloride : _____ and _____

silver chloride: _____ and _____

(c) Write an ionic equation for the salt preparation of silver chloride. Include state symbols. [2]

_____

B3 (a) Two salt solutions, **J** and **K**, were analysed. **J** was aqueous iron(II) sulfate.

The tests on the solutions **K** are given:

| tests | observations |
|---|---|
| 1.Appearance of solution **K** | dark pink liquid |
| 2. To about 1cm³ of solution **K**, an equal volume of aqueous sodium hydroxide was added. | blue ppt formed |
| 3. To solution **K**, aqueous sodium hydroxide and aluminium powder were added. The mixture was heated. | effervescence, pungent gas evolved damp red litmus turns blue |

(i) Identify the gas given off in **test 3** of solution **K**.

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

(ii) What **two** conclusions can you draw about solution **K**?

............................................................................

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

(b) (i) Complete the observations on the solution **J** in the table below.

| tests | observations |
|---|---|
| 1.Appearance of solution **J** | [1] |
| 2. To about 1cm³ of solution **J**, an equal volume of aqueous sodium hydroxide was added, then add excess of aqueous sodium hydroxide. | [2] |
| 3. To about 1cm³ of solution **J**, dilute nitric acid and aqueous silver nitrate were added. | [1] |
| 4. To about 1cm³ of solution **J**, dilute nitric acid and barium nitrate solution were added. | [1] |

(ii) Write the ionic equation of iron (II) sulfate solution with barium nitrate solution. Include the state symbols.

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

**END OF PAPER**

13

14

## Colours of Some Common Metal Hydroxides

| | |
|---|---|
| Calcium hydroxide | White |
| Copper (II) hydroxide | Light blue |
| Iron (II) hydroxide | Green |
| Iron (III) hydroxide | Red-brown |
| Lead (II) hydroxide | White |
| Zinc hydroxide | White |

15

## The Periodic Table of the Elements



16

21 Which statement is not correct?

A Air is a mixture.
B Ammonia is a compound.
C Methane is a compound.
D Sea water is a compound.

22 A sample of a pure compound is heated until it is completely molten and the compound is then allowed to cool until it is completely solid again.
The graph shows how the temperature of the compound changes with time.
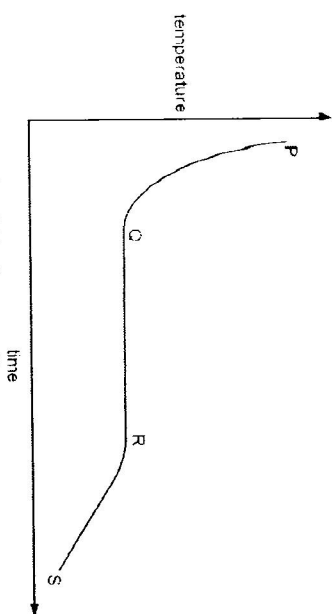


When are liquid and solid both present?

A Q to R
B P to Q and R to S
C P to Q
D R to S

23 What suggests that metal M is not in Group I of the Periodic Table?

A M has a bright, silvery appearance and is a good conductor of electricity.
B M is hard and difficult to cut.
C M produces an alkaline solution when it reacts with water.
D M produces hydrogen gas when it reacts with water.

24 Which particle is found in iodine vapour?

A I
B I⁻
C I⁺
D $I_2$

25 Which solution containing one mole per $dm^3$ of the compound would have the lowest pH?

A ethanoic acid
B hydrochloric acid
C sodium chloride
D sodium hydrogencarbonate

26 An element is in Period 3 and Group VII of the Periodic Table.

Which statement about this element is correct?

A The element will form 1+ ions.
B The element will have 3 electrons in its outer shell.
C The element will have 7 electrons in its outer shell.
D The element will have 7 shells of electrons in its atom.

27. Which molecule has the largest number of electrons involved in covalent bonds?

A $C_2H_4$
B $CO_2$
C $CH_3OH$
D $N_2$

28 Metal A displaced metal B from a solution of its ions. Metal B displaced metal C from a solution of its ions.

What could A, B and C have been?

| | A | B | C |
|---|---|---|---|
| A | Calcium | Silver | Zinc |
| B | Calcium | Zinc | Silver |
| C | Silver | Calcium | Zinc |
| D | Zinc | Silver | Calcium |

29. Which metal can react vigorously with steam but fairly vigorously with cold water?

A calcium
B copper
C iron
D potassium

**30** When a volcano erupts, which gas is produced in significant amounts?

- **A** carbon monoxide
- **B** methane
- **C** carbon dioxide
- **D** sulfur dioxide

**31** A student added 5 g of zinc to 50 cm³ of 1.00 mol/dm³ hydrochloric acid at 20 °C. Hydrogen was produced. The experiment was repeated at 30 °C and 40 °C. In each case the total volume of hydrogen produced was plotted against time.

Which one of the graphs represents the volumes of hydrogen given off in the three experiments?
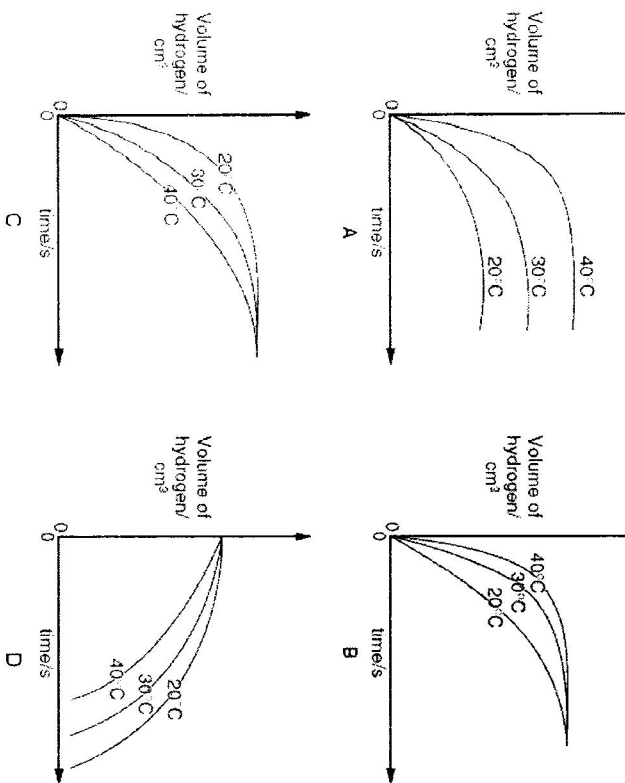


**32** 50 cm³ of 2 mol/dm³ sulfuric acid is reacted with 100 cm³ of sodium hydroxide to form sodium sulfate and water.

$$H_2SO_4 (aq) + 2NaOH (aq) \rightarrow Na_2SO_4 (aq) + 2H_2O (l)$$

What is the concentration of the sodium hydroxide used?

- **A** 2.0 mol/dm³
- **B** 2.5 mol/dm³
- **C** 3.0 mol/dm³
- **D** 4.0 mol/dm³

**33** Which electronic configurations represent three metallic elements in the same period of the Periodic Table?

|   | element 1 | element 2 | element 3 |
|---|---|---|---|
| **A** | 2, 8, 1 | 2, 8, 7 | 2, 8, 8 |
| **B** | 2, 1 | 2, 8, 1 | 2, 8, 8, 1 |
| **C** | 2, 2 | 2, 3 | 2, 4 |
| **D** | 2, 8, 1 | 2, 8, 2 | 2, 8, 3 |

**34** A student mixed together aqueous solutions of Y and Z. A white precipitate formed.

Which could not be Y and Z?

|   | Y | Z |
|---|---|---|
| **A** | hydrochloric acid | silver nitrate |
| **B** | hydrochloric acid | sodium nitrate |
| **C** | sodium sulfate | barium nitrate |
| **D** | sodium chloride | silver nitrate |

35 The scheme shows a sequence of reactions starting from compound Y.

```
        ┌────────────┐
        │ compound Y │
        └────────────┘
              │
              │ excess
              │ HNO₃(aq)
              ▼
  ┌──────┐ + ┌────────────┐
  │ gas  │   │ colourless │
  └──────┘   │ solution   │
             └────────────┘
                    │
                    │ NaOH(aq)
                    ▼
             ┌──────────────────┐
             │ white precipitate│
             │ insoluble in     │
             │ excess NaOH(aq)  │
             └──────────────────┘
```
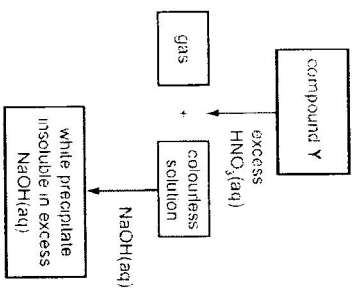
What could the compound Y be?

A   aluminium sulfate
B   calcium carbonate
C   copper(II) carbonate
D   zinc carbonate

36 A liquid can react with sodium carbonate, potassium hydroxide and calcium.

What is the liquid?

A   aqueous ammonia
B   hydrochloric acid
C   ethanol
D   sodium hydroxide

37 Aqueous potassium iodide, KI(aq), can be used as a reducing agent in redox reactions.
Iodide ions are readily ........X........
A positive result for the test is when the aqueous potassium iodide changes
colour from .......Y...... to .......Z....... .

Which words correctly complete gaps X, Y and Z?

| | X | Y | Z |
|---|---|---|---|
| A | oxidised | brown | colourless |
| B | oxidised | colourless | brown |
| C | reduced | brown | colourless |
| D | reduced | colourless | brown |

38 Which statement about the properties of propane, C₃H₈ and hexane, C₆H₁₄ is correct?

A   Propane has a higher boiling point than hexane.
B   Propane has a higher relative molecular mass than hexane.
C   Propane produced more soot than hexane in combustions.
D   Propane is more flammable than hexane.

39 Petroleum is separated into fractions by fractional distillation.

Which fraction distils off at the highest temperature?

A   diesel
B   paraffin (kerosene)
C   lubricating oils
D   petrol (gasoline)

**40** The structural formulae of some organic compounds are shown below.

$$1$$

$$\begin{array}{ccc}
& H & H \\
| & | & \\
H-C- & C- & C-O-H \\
| & | & \\
& H & H
\end{array}$$
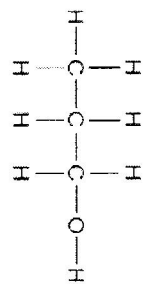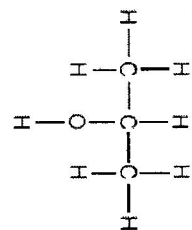
$$2$$
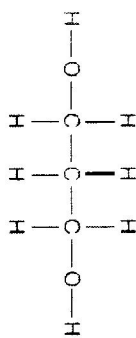
$$3$$
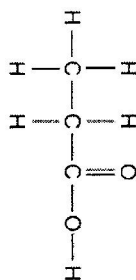
$$4$$

Which compounds are alcohols?

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

**Colours of Some Common Metal Hydroxides**

| | |
|---|---|
| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 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

# Science (Chemistry) Sec 4 E / 5 N level Prelim 2015

## Paper 1

| 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| B | D | B | D | B | C | A | B | A | C |

| 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| D | A | B | B | B | B | B | D | C | C |

## Paper 3 Section A

True / False / Yes / No Dependent Marking for explanation

Wrong spelling of chemical terms (No marks)

Missing units/ Answers not to 3 sf (minus half a mark)

| Qn | Answer | Marks | comments |
| --- | --- | --- | --- |
| A1a | $C_6Cl_{12}$ | 1 | |
| A1bi | green / yellow-green / light green | 1 | |
| A1bii | increases | 1 | |
| A1ci | $Br_2(aq) + 2KI(aq) \rightarrow 2KBr(aq) + I_2(s)$ (1)<br>State symbol (1)<br>State symbol 0 mark if equation wrong | 2 | |
| A1cii | chlorine is more reactive than bromine | 1 | |
| A1d | solubility in water:<br>ionic compounds are soluble and molecular compounds are not soluble (1)<br>**note: both needed for mark**<br>electrical conductivity:<br>ionic compounds conduct electricity when molten / in (aqueous) solution<br>and molecular compounds do not (1)<br>**note: both needed for mark** | 2 | 8 |
| A2a | E / nitrogen (di)oxide / $NO_2$ | 1 | |
| A2b | B / potassium nitrate / $KNO_3$ | 1 | |
| A2c | A / ammonia / $NH_3$ | 1 | 6 |
| A2d | E / nitrogen (di)oxide / $NO_2$ | 1 | |
| A2e | B / potassium nitrate / $KNO_3$ | 1 | |
| A2f | C / $NI_3$ / nitrogen (tri)iodide | 1 | |
| A3a | temperature of Bunsen / distance of Bunsen from the tube / mass of carbonate used | 1 | |
| A3bi | calcium carbonate | 1 | |
| A3bii | 27 cm³ | 1 | |
| A3biii | 27/24000 = 0.00113 mole | 1 | |
| A3biv | calcium faster than strontium which is faster than barium / idea of trend down the group (1)<br>correct trend, i.e. less rapid reaction the further down the group correct trend (1) | 1 | |
| A3c | add acid to carbonate:(1)<br>bubble gas or carbon dioxide (evolved) through limewater / test gas or carbon dioxide with limewater; (1)<br>white ppt seen (1) | 3 | 8 |
| A4a | Any **two** of:<br>high melting / boiling point;<br>high density;<br>form coloured compounds or have coloured ions;<br>form ions of more than one charge / variable valency / variable oxidation state;<br>**allow: hard / hardness; used as catalysts;** | 2 | |
| A4bi | different number of neutrons / different nucleon number | 1 | |
| A4bii | 23 | 1 | |
| A4c | suitable method, e.g. coating with paint / zinc / unreactive metal / plastic / oil / grease / galvanising / sacrificial protection; (1)<br>suitable reason, e.g. stops air / water reaching surface; (1)<br>note: reason must be consequential to the method chosen | 2 | 6 |
| A5a | Oxidising agent: $Cr_2O_3$ / Chromium (III) oxide (1)<br>Oxidation state decreases from<br>+3 to 0 (1) | 2 | 4 |
| A5bi | incomplete combustion / insufficient or limited or not enough oxygen | 1 | |

| | | Marks | |
|---|---|---|---|
| A5bii | Death occurs due to starvation of oxygen / suffocates you /stops red blood cells carrying oxygen / binds with hemoglobin in place of oxygen | 1 | |
| A6a | $2Cu\ (s) + O_2\ (g) \rightarrow 2CuO\ (s)$ | 1 | 8 |
| A6b | pink brown copper turns black | 1 | |
| A6c | Explain: Copper will only react with 21% of oxygen present in Air. (1) <br> $21/100 \times 200 = 42\ cm^3$ oxygen used up (1) <br> $200-42= 158\ cm^3$ (1) | 3 | |
| A6d | $2Cu\ (s) + O_2\ (g) \rightarrow 2CuO\ (s)$ <br> Cu : CuO <br> 2moles: 2 moles <br> 1mole: 1mole (1) <br> 64g: 80 g (1/2) <br> **6.4g**: 8 g (1/2) | 2 | |
| A6e | faster reaction/ white dazzling light seen/ white ash remains instead of black powder | 1 | |
| A7a | thistle funnel, gas jar, delivery tube <br> **All correct (2)** <br> **2 correct (1)** | 2 | 5 |
| A7b | Sulfuric acid should not be used/ CaO should be used (1) <br> gas collection should be done by downward delivery/gas collection should be down using upward air displacement (1) | 2 | |
| A7c | to dry gas/ to place a drying agent | 1 | |
| B1ai | Breaking down large/longer chain alkane molecules into more useful smaller chain molecules. | 1 | 10 |
| B1aii | $C_{10}H_{22}$ <br> allow: reasonable mixtures, e.g. $C_7H_{16}$ + $C_3H_6$ | 1 | |

3

| | | Marks | |
|---|---|---|---|
| B1b | unsaturated: contains double bonds / contains C=C bonds:(1) hydrocarbon: containing carbon and hydrogen **only** (1) | 2 | |
| B1ci | $C_2H_4\ (g) + H_2O\ (g) \rightarrow C_2H_5OH\ (l)$ (1) | 1 | |
| B1cii | Compound formed: ethanoic acid (1) <br> oxidizing agent: potassium manganate(VII) (1) | 2 | |
| B1di | polymerisation | 1 | |
| Bdii | conditions: catalyst (1/2),high temperature and pressure(1/2) <br> [structure drawing] (1) | 2 | |
| B2a | <table><tr><td>Method of preparation</td><td>Salt to be prepared</td></tr><tr><td>B(1)</td><td>copper (II) sulfate</td></tr><tr><td>D(1)</td><td>silver chloride</td></tr><tr><td>C(1)</td><td>potassium chloride</td></tr><tr><td>A(1)</td><td>zinc nitrate</td></tr></table> | 4 | 10 |
| B2b | Potassium chloride: potassium hydroxide (1),hydrochloric acid (1) <br> Silver chloride: silver nitrate (1)/ potassium chloride (1) <br> ammonium chloride <br> sodium chloride <br> hydrochloric acid | 4 | |
| B2c | $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl\ (s)$ (1) <br> State symbols (1) State symbols given marks only if equation is correct | 2 | |

4

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| B3ai | NH₃/ Ammonia | | | | | 1 | 10 |
| B3aii | Metals found in the same region as iron in the Periodic Table/transition metal (1). It is a nitrate (1) Or K contains $Cu^{2+}$ (1) and $NO_3^-$ (1). | | | | | 2 | |

| | | tests | observations | |
|---|---|---|---|---|
| B3bi | | 1.Appearance of solution J | green [1] | 5 |
| | | 2. To about 1cm³ of solution J, an equal volume of aqueous sodium hydroxide was added, then add excess of aqueous sodium hydroxide. | green precipitate (1), insoluble in excess (1) [2] | |
| | | 3. To about 1cm³ of solution J, dilute nitric acid and aqueous silver nitrate were added. | no reaction/no precipitate/no change/no observation/no visible reaction **nothing : incorrect** [1] | |
| | | 4. To about 1cm³ of solution J, dilute nitric acid and barium nitrate solution were added. | white ppt [1] | |

| B3bii | $Ba^{2+}$ (aq) + $SO_4^{2-}$ (aq)→ $BaSO_4$ (s) (1) State symbols mark given only if equation correct (1) | 2 |
|---|---|---|

5

6

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127