<table>
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<th></th>
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<th>Series</th>
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<tbody>
<tr>
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<td>Ahmad Ibrahim Secondary</td>
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<td>SA2</td>
</tr>
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<td>3</td>
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<td>SA2</td>
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</tr>
<tr>
<td>10</td>
<td>Yuhua Secondary</td>
<td>SA2</td>
</tr>
</tbody>
</table>

Need a home tutor? Visit smiletutor.sg
READ THESE INSTRUCTIONS FIRST:
Do not open this booklet until you are told to do so.
Write down your name, class and register number on this page.

You may use an HB pencil for any diagram, graphs, tables or rough working.
Write in dark blue or black pen.
Do not use staples, paper clips, 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 working 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 16.
A copy of the Periodic Table is printed on page 17.
The number of marks is given in brackets [ ] at the end of each question or part question.

<table>
<thead>
<tr>
<th></th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper 1</td>
<td>/20</td>
</tr>
<tr>
<td>Paper 3</td>
<td>/65</td>
</tr>
<tr>
<td>Paper 5</td>
<td>/15</td>
</tr>
<tr>
<td>Total</td>
<td>/100</td>
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</table>

This paper consists of 17 printed pages.

Need a home tutor? Visit smiletutor.sg
Section A
Answer all the questions in the spaces provided.

1 The following are terms used to describe chemical reactions.

<table>
<thead>
<tr>
<th>addition</th>
<th>fermentation</th>
<th>neutralisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>rusting</td>
<td>redox</td>
<td>substitution</td>
</tr>
</tbody>
</table>

Using the terms above, identify the type of reaction that each chemical equation represents.

Each term can only be used once, more than once or not at all.

(a) \( \text{C}_3\text{H}_6 + \text{H}_2 \rightarrow \text{C}_3\text{H}_8 \) .................................................[1]
(b) \( \text{KOH} + \text{HCl} \rightarrow \text{KCl} + \text{H}_2\text{O} \) .................................................[1]
(c) \( \text{H}_2 + \text{F}_2 \rightarrow 2\text{HF} \) .................................................[1]
(d) \( \text{C}_2\text{H}_6 + \text{Cl}_2 \rightarrow \text{C}_2\text{H}_5\text{Cl} + \text{HCl} \) .................................................[1]

2 Two isotopes of sodium are \( ^{22}_{11}\text{Na} \) and \( ^{23}_{11}\text{Na} \).

(a) Complete Table 2.1 about the particles found in one atom of each of these isotopes.

<table>
<thead>
<tr>
<th>Table 2.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>number of</td>
</tr>
<tr>
<td>protons</td>
</tr>
<tr>
<td>( ^{22}_{11}\text{Na} )</td>
</tr>
<tr>
<td>( ^{23}_{11}\text{Na} )</td>
</tr>
</tbody>
</table>

(b) Sodium is a Group I metal.
State two physical properties of Group I, that are not displayed by other metals.

1.................................................................................................................................[2]

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

(c) Sodium reacts with cold water, as shown in the half equation.

\( \text{Na}(s) \rightarrow \text{Na}^+(aq) + e^- \)

State the name of the particle with the symbol \( e^- \).

.................................................................................................................................[1]
3 (a) Sodium chloride and lead(II) chloride are two different salts which require two different methods of preparation.

Fill in the blanks in Table 3.1 to name the possible reactants used to prepare these two different salts.

Table 3.1

<table>
<thead>
<tr>
<th>salt</th>
<th>reactant 1</th>
<th>reactant 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>sodium chloride</td>
<td></td>
<td></td>
</tr>
<tr>
<td>lead(II) chloride</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(b) A practical book gives the following instructions for preparing magnesium nitrate crystals.

Place 100 cm$^3$ of dilute nitric acid in a beaker. Heat the acid until it is almost boiling. Add magnesium powder until no more can dissolve. Filter the mixture. Place the filtrate in an evaporating dish. Place the evaporating dish on a tripod and heat it until the liquid has been reduced to about one-third of its volume. Put the filtrate aside to allow it to cool. Filter off the crystals from the cooled solution and dry them between pieces of filter paper.

State the purpose of the underlined instructions below.

<table>
<thead>
<tr>
<th>instruction</th>
<th>purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>until no more can dissolve</td>
<td></td>
</tr>
<tr>
<td>filter the mixture</td>
<td></td>
</tr>
<tr>
<td>about one-third of its volume</td>
<td></td>
</tr>
</tbody>
</table>
(c) The concentration of magnesium nitrate solution is 0.5 mol/dm³.

(i) Calculate the concentration in g/dm³.

\[ \text{concentration} = \ldots \quad \text{g/dm}^3 \quad [2] \]

(ii) Calculate the volume of the solution that contains 7.40 g of magnesium nitrate.

\[ \text{volume} = \ldots \quad \text{cm}^3 \quad [2] \]

4 Fig. 4.1 shows some of the stages in the manufacture of a fertiliser, ammonium sulfate.

In reaction vessel 1, nitrogen gas and hydrogen gas react to produce ammonia, which enters reaction vessel 4 through connecting pipe B. Sulfuric acid is made from sulfur dioxide in two stages. Ammonia and sulfuric acid will then react in the reaction vessel 4 to form ammonium sulfate.

![Fig. 4.1](image)

(a) (i) Write a balanced chemical equation, for the reaction that takes place in reaction vessel 1.

........................................................................................................................................[1]
(ii) Calculate the volume of hydrogen needed to produce 900 dm³ of ammonia gas, at room temperature and pressure, for the manufacture of ammonium sulfate.

\[ \text{volume of hydrogen needed} = \ldots \ldots \ldots \ldots \text{dm}^3 \] [2]

(b) (i) From which connecting pipe would a major leak cause a decrease in the pH value of rain? Explain your answer.

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

(ii) State one effect on the environment from the decrease in the pH value of rain.

........................................................................................................................................[1]
5 (a) The diagram shows the cycle of changes when iron is extracted and then rusts.

![Diagram: Iron Cycle]

Identify the change that involves oxidation and the change that involves reduction. Give reasons for your answers.

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

(b) One of the methods of rust prevention is by spraying the metal surface with a layer of oil.

(i) Explain how this method prevents rusting.

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

(ii) Anti-rust spray can also be applied to surfaces to prevent rusting. The figure below shows the active ingredient in a bottle of anti-rust spray.

![Anti-rust spray]

Anti-rust spray
Active ingredient: Tannic acid, Zinc powder

Explain how the anti-rust spray helps to prevent rusting.

…………………………………………………………………………………………………………………………….[2]
Fig. 6.1 shows the reactions of some substances.

(a) Name the substances P, Q, R and S.

P: .................................................................

Q: .................................................................

R: .................................................................

S: ................................................................. [4]

(b) Write the chemical equation for the formation of S from Q.

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

c) State the colour of solution U.

.............................................................................................................[1]
Aldehydes are a homologous series of organic compounds like alkanes and alkenes. Table 7.1 shows the names, formulae and boiling points of three aldehydes.

Table 7.1

<table>
<thead>
<tr>
<th>name</th>
<th>formula</th>
<th>boiling point (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>methanal</td>
<td>HCHO</td>
<td>-19</td>
</tr>
<tr>
<td>ethanol</td>
<td>CH₃CHO</td>
<td>20</td>
</tr>
<tr>
<td>propanal</td>
<td>C₂H₅CHO</td>
<td>49</td>
</tr>
</tbody>
</table>

(a) Use the information in Table 7.1 to give two pieces of evidence that suggest that these aldehydes are a homologous series.

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

(b) Predict the name, formula and boiling point of the next member of this homologous series.

name: ...........................................................................................................
formula: .................................................................................................
boiling point: ............................................................................................[3]

(c) In some countries, ethanol is made from glucose for use as a fuel.

The flowchart summarises the production process for ethanol.

![Flowchart]

(i) Name the processes that take place at stage 1 and 2.

stage 1: ....................................................................................................
stage 2: ....................................................................................................[2]
(ii) Write a balanced chemical equation for the reaction in stage 1.
......................................................................................................................................................[1]

(iii) State two conditions for the reaction to occur in stage 1.
......................................................................................................................................................
......................................................................................................................................................[2]
Fluorine is an element in Group VII.

A jet of fluorine gas is aimed at a piece of filter paper soaked in a solution of potassium bromide.

The solution on the filter paper quickly turns brown.

(a) Explain why the solution turns brown. Include an equation to support your answer.

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

(b) 50 cm³ of fluorine gas reacts with excess water to give oxygen and hydrogen fluoride, HF, which is weakly acidic. The chemical equation is given below.

$$2F_2 (g) + 2H_2O (l) \rightarrow O_2 (g) + 4HF (aq)$$

(i) Universal Indicator can be used to determine when the reaction is completed. State the possible colour changes as the reactants react until the reaction is completed.

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

(ii) Calculate the mass of oxygen gas produced at room temperature and pressure. [The volume of one mole of any gas is 24 dm³ at room temperature and pressure.]

mass of oxygen gas = ………………….[2]
(c) (i) Draw a ‘dot and cross’ diagram to show the arrangement of the outer shell electrons in one molecule of fluorine.

(ii) Fluorine can be liquified and has a low boiling point. Explain why the boiling point of fluorine is low.

..............................................................................................................................................
..............................................................................................................................................
..............................................................................................................................................
..............................................................................................................................................
..............................................................................................................................................[2]
The following set-up is used to investigate the effects of particle size on the rate of reaction. Small lumps of zinc carbonate were added to excess hydrochloric acid. The time taken for the reaction to complete is 5 minutes.

(a) (i) Sketch a labelled graph to show the progress of this reaction.

(ii) With reference to the graph that you had sketched, explain the progress of the reaction.

...........................................................................................................................................
...........................................................................................................................................
...........................................................................................................................................
...........................................................................................................................................
...........................................................................................................................................
...........................................................................................................................................
...........................................................................................................................................
...........................................................................................................................................
...........................................................................................................................................[3]
(b) The experiment was repeated but with powdered zinc carbonate.

(i) Sketch on the same axes in (a)(i), the new graph that you would expect for the experiment with powdered zinc carbonate. Label this graph $X$. [1]

(ii) Use the collision theory to explain your graph.

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

(c) Sketch a different experimental set up that can be used to determine the rate of reaction. [2]
10  (a) Cracking involves a breakdown of large hydrocarbon molecules into smaller ones. During cracking, molecules of octane, C\textsubscript{8}H\textsubscript{18}, produce two different products.

(i) Complete the equation to show the formula of product X.

\[
\text{C}_8\text{H}_{18} \rightarrow \text{C}_4\text{H}_{10} + 2 \text{ ________ (product X)}
\]

(ii) State the name and draw the structural formula of product X in the box below.

Name of product X: ______________

(iii) Describe a chemical test to distinguish between butane and product X and give the results of the test.

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

(b) Propene is a hydrocarbon that can be polymerised. The structure of propene is shown below.

\[
\begin{array}{c}
\text{H} \\
\text{C} \equiv \text{C} \\
\text{H}
\end{array}
\]

(i) Use the structure of propene to explain how it can form a polymer.

…………………………………………………………………………………………..
…………………………………………………………………………………………..
…………………………………………………………………………………………..[2]
(ii) State the name of the polymer formed.

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

(iii) Draw the structure of the polymer which is formed.
(Show at least three repeat units.)
## Colours of Some Common Metal Hydroxides

<table>
<thead>
<tr>
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<th>Colour</th>
</tr>
</thead>
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<tr>
<td>calcium hydroxide</td>
<td>white</td>
</tr>
<tr>
<td>copper(II) hydroxide</td>
<td>light blue</td>
</tr>
<tr>
<td>iron(II) hydroxide</td>
<td>green</td>
</tr>
<tr>
<td>iron(III) hydroxide</td>
<td>red-brown</td>
</tr>
<tr>
<td>lead(II) hydroxide</td>
<td>white</td>
</tr>
<tr>
<td>zinc hydroxide</td>
<td>white</td>
</tr>
</tbody>
</table>
The Periodic Table of Elements

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<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
<th>VII</th>
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<td>C</td>
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<td></td>
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<td></td>
<td>97</td>
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<td>Cf</td>
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<td>Es</td>
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<td>100</td>
<td>Fm</td>
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<tr>
<td></td>
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<td>Md</td>
<td></td>
<td>102</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>103</td>
<td>Lr</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).
2019 4E5NA Prelim Exam  
Science Chemistry Solutions

**MCQ**

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

**Paper 3**

**Section A**

<table>
<thead>
<tr>
<th>No.</th>
<th>Answers</th>
<th>Marks</th>
<th>Marker’s Report</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(a)</td>
<td>addition</td>
<td>[1] well answered</td>
<td></td>
</tr>
<tr>
<td>(b)</td>
<td>neutralisation</td>
<td>[1] well answered</td>
<td></td>
</tr>
<tr>
<td>(c)</td>
<td>redox</td>
<td>[1] Some students wrote substitution, could have confused with substitution of halogens</td>
<td></td>
</tr>
<tr>
<td>(d)</td>
<td>substitution</td>
<td>[1] quite a number wrote as fermentation</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No.</th>
<th>2(a)</th>
<th>number of protons</th>
<th>electrons</th>
<th>neutrons</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Na</td>
<td>$^{11}_{11}$Na</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Na</td>
<td>$^{23}_{11}$Na</td>
<td>11</td>
<td>11</td>
<td>12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[1] all three must be correct

[1] all three must be correct

<table>
<thead>
<tr>
<th></th>
<th>2(b)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>soft metals or can be easily cut</td>
<td>any 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>low bp/mp</td>
<td>[2]</td>
<td>many gave general physical properties shown by all metals such as good electrical conductors, high density, high melting and boiling points</td>
</tr>
<tr>
<td></td>
<td>low density explosive when in contact with water</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 2(c)

| electron |

### 3(a)

Sodium hydroxide and hydrochloric acid (accept any other possible and safe reactions)

| 1m for 2 correct answers |

| some gave salt and acid |

| Lead(II) nitrate and sodium chloride / hydrochloric acid (accept any other possible reactants) |

| 1 |

| some gave insoluble salt with soluble salt |

| 3(b) Until no more can dissolve |

To ensure that all the nitric acid has reacted
Filter the mixture
To separate the unreacted excess magnesium
About one-third of its volume
To obtain a saturated magnesium nitrate solution for crystallisation

| many mentioned to dissolve all the magnesium oxide |

| some were not specific and just mentioned residue/filtrate |

| some mentioned concentrated instead of saturation |

### 3(c)(i)

0.5 \times (24 + 2[14+3(16)])

\[ = 74 \text{ g/dm}^3 \]

| 1 |

| 1 |

| many were unable to calculate Mr of magnesium nitrate accurately as the chemical formula is incorrect |

### 3(c)(ii)

\[ 74 \text{ g rep } 1\text{dm}^3 \]

\[ \frac{1}{74} \times 7.4 = 0.1 \text{ dm}^3 \]

\[ = 100 \text{ cm}^3 \]

| 1 |

| 1 |

| most are not able to understand question |

### 4(a)(i)

\[ \text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3 \]

| 1 |

| Balancing was poorly done |

### 4(a)(ii)

At r.t.p. vol ratio = mol ratio

\[
\begin{align*}
\text{NH}_3 : \text{H}_2 \\
\text{Mol} : & : 2 : 3 \\
\text{Vol} : & : \frac{900}{2} \times 3 \\
\therefore \text{vol of H}_2 \text{ gas required} & : 1350 \text{ dm}^3
\end{align*}
\]

| 1 |

| 1 |

| marks were given for ecf |
| 4(b)(i) | Pipe C or Vessel 2  
Sulfur trioxide is an acidic gas / acidic oxide  
which will dissolve in rain / react with water in the air to form acid rain  
- must mention both | [1] | many wrote Pipe D which was not acceptable as sulfuric acid will not be able to react with rain.  
a number mentioned Pipe B as they were confused with meaning of decrease in pH value |
| 4(b)(ii) | Acid rain decreases the pH of the soil which affects crops yield / crops cannot grow well.  
*Must mention what happens to the soil that will affect the crop yield*  
*OR* Acid rain can corrode (any one of) limestone structures / stonework / metal structures  
*Must mention what happens to the type of buildings* – limestone or metals  
*OR* Acid rain decreases the the pH of the water and kills the fish in the ponds / rivers  
*Must mention what happens to the water that will affect the marine life* | [1] |  |
| 5(a) | oxidation: rusting  
reason: gain in oxygen  
reduction: extraction  
reason: loss in oxygen | [1] | some did not identify the change  
[4] |  |
| 5(b)(i) | oil prevents the metal inside to come into contact with water and oxygen | [1] | most only mention contact with water or oxygen only instead of both  |
| 5(b)(ii) | Anti rust paint contains zinc which is a more reactive metal than iron  
so zinc corrodes in place of iron | [1] | only a few were able to identify that zinc was more reactive than iron  
some mentioned about tannic acid reacting with zinc  |
| 6(a) | P: copper  
Q: copper(II) oxide  
R: hydrogen  
S: copper(II) nitrate  
-1 overall if chemical formulas are given | 1m each only names are accepted | many still missed out on (II) |
| 6(b) | CuO + 2HNO₃ → Cu(NO₃)₂ + H₂O | [1] | well answered |
| 6(c) | dark blue | [1] |
| 7(a) | -one member differ from the next by a CH₂  
-same functional group, CHO  
-gradual change in their boiling point (physical property)  
-same general formula, CₙH₂ₙ₊₁CHO | any 2 | most were able to give at least 1 |
| 7(b) | Name: butanal  
formula: C₅H₁₀CHO / C₄H₈O  
boiling point: any reasonable value above 49 | [1] | well answered |
| 7(c)(i) | Stage 1: fermentation  
Stage 2: fractional distillation | [1] | Stage 1 well answered  
Stage 2 some were confused and mentioned distillation |
| 7(c)(ii) | C₅H₁₀O₆ → 2CO₂ + 2C₂H₆OH | [1] | some were confused with glucose formula |
| 7(c)(iii) | yeast, temperature of 37 °C, absence of oxygen | [1] | well answered |
| 8(a) | Fluorine has displaced bromine from potassium bromide as it is more reactive and bromine which is brown is formed  
2KBr + F₂ → 2KF + Br₂ | [1] | equation badly written, missing out on the F₂, Br₂ |
| 8(b)(i) | Use Universal Indicator, initial colour will be green (neutral), when reaction is completed, colour is yellow/orange (weak acid) | [1] | very few mentioned bout colour change |
| 8(b)(ii) | 2F₂ (g) + 2H₂O (l) → O₂ (g) + 4HF (aq)  
\[ F₂ : O₂ \]  
\[ 2 : 1 \]  
\[ 50 \text{ cm}³ : 25 \text{ cm}³ \]  
no of moles of O₂ ≠ 25/24000 = 0.00104167  
mass of O₂ = 0.00104167 X (16x2)  
= 0.0333g | [1] | poorly answered with many not understanding the question |
<table>
<thead>
<tr>
<th>Question</th>
<th>Description</th>
<th>Correct Answer</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>8(c)(i)</td>
<td>Consists of covalent bonds</td>
<td>Little energy is needed to overcome the weak intermolecular forces of attraction between the molecules.</td>
<td>1m correct bonding</td>
</tr>
<tr>
<td>8(c)(ii)</td>
<td>Graph sloping downwards flat towards the end with correct axes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9(a)(i)</td>
<td>Graph sloping downwards flat towards the end with correct axes</td>
<td>some gave the wrong curve some gave a line with constant slope -allow for ecf</td>
<td></td>
</tr>
<tr>
<td>Question</td>
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<td>Mark</td>
<td>Comments</td>
</tr>
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<td>----------</td>
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<td>----------</td>
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<tr>
<td>9(a)(ii)</td>
<td>Initially, gradient is the steepest, rate of reaction fastest as there are highest concentration of reactants. As reaction progresses, rate of reaction decreases, gradient decreases as the concentration of the reactants decreases. Reaction stops when all zinc carbonate has been used up, gradient zero, at 5 mins onwards</td>
<td>1</td>
<td>most are unable to give an accurate description</td>
</tr>
<tr>
<td>9(b)(i)</td>
<td>Faster reaction. New curve below original</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>9(b)(ii)</td>
<td>When powdered, surface area of zinc carbonate increases so there is greater chance of effective collision leading to increase in speed of reaction</td>
<td>1</td>
<td>some left out the term effective</td>
</tr>
<tr>
<td>9(c)</td>
<td>Rough sketch with labels</td>
<td>1</td>
<td>quite a number left out the stopwatch and the syringe</td>
</tr>
</tbody>
</table>
| 10(a)(i) | C₂H₄ | [1] | some gave the wrong formula as they did not see the 2
| (ii)- Ethene |  | [1] | well answered
|  |  | [1] |  
| 10(a)(iii) | -use aqueous bromine.  
|  | -bubble butane and ethene into 2 separate test tubes containing -  
|  | aqueous bromine.  
|  | -test tube with butane remains reddish brown  
|  | -test tube with ethene turn from reddish brown to colourless rapidly | [1] | colour changes were not specific  
|  |  | [1] | some mentioned that butane and ethene changed colour instead of the aqueous bromine
| 10(b)(i) | -one of the bonds in each double bond breaks  
|  | -each monomer forms single bonds with 2 other monomers  
|  | polymer is formed | [1] | most were not able to give a complete answer
|  |  | [1] | well answered
| 10(b)(ii) | poly(propene) |  |  
| 10(b)(iii) |  | 1m for 3 sets shown  
|  | 1m for connection between 3 sets |  | most left out the last CH₃
BARTLEY SECONDARY SCHOOL

O-LEVEL PRELIMINARY EXAMINATIONS

SCIENCE (CHEMISTRY/BIOLOGY) 5078/01
Sec 4 Express/ 5 Normal (Academic)
Paper 1 Multiple Choice 23 September 2019

1 hour

Additional Materials: Multiple Choice Answer Sheet

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A copy of the Periodic Table is printed on page 18.

This document consists of 18 printed pages.

Set by: YBH, LMY

BSS/2019 Preliminary Examination /4E5N Sc(C/B) P1

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<td>1214</td>
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5 What ions are produced by iron(III) sulfate, Fe₂(SO₄)₃?

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6 The elements W, X and Y have consecutive, increasing atomic numbers. If element Y is a noble gas, what is the chemical nature and chemical formula of the compound formed between W and X?

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<tr>
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<td>WX₂</td>
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<tr>
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<td>W₂X</td>
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</tbody>
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<td>soft</td>
<td>poor</td>
</tr>
<tr>
<td>B</td>
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<td>low</td>
<td>soft</td>
<td>good</td>
</tr>
<tr>
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<td>soft</td>
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</tr>
<tr>
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<td>high</td>
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What conclusion can be drawn from the experiment?

A Neutralisation has taken place.
B The reaction is exothermic.
C The mixture takes in heat from the surroundings.
D The thermometer is a good heat conductor.

10 The diagram shows the trend of a property of the elements in Period 3 of the Periodic Table.

Which is the property?
A charge of their ions
B number of valence electrons
C proton number
D relative atomic mass
11 The diagram shows the structure of pure copper.

Which statement explains why pure copper sheets are easily bent.

A The atoms have spaces for them to move in between when a force is applied.
B The atoms are soft and easily bent.
C The layers of atoms can slide past one another.
D The atoms have weak intermolecular forces.

12 Sulfur dioxide is a pollutant that dissolves in rainwater to produce acid rain. In order to remove the sulfur dioxide from the waste gases produced from a power station, the waste gases are first passed through a scrubber which showers water down on them. The mixture produced then flows out of the scrubber and is then mixed with a powdered compound to neutralize it.

Which compound will not be able to neutralize the aqueous mixture of sulfur dioxide?

A calcium carbonate
B carbon dioxide
C magnesium oxide
D zinc oxide

13 What is true about the substance that has the chemical formula, C₂H₅NHCOOH?

A It consists of 8 elements.
B It has 12 atoms within a molecule.
C It is a mixture.
D It is a covalent compound.

14 A polymer has a structure as shown.

\[ \text{CH}_3 \quad \text{CH} \quad \text{CH}_2 \quad \text{CH} \quad \text{CH}_2 \quad \text{CH} \quad \text{CH}_3 \]

Which statement is true about the polymer?

A It is formed from the polymerisation of C₂H₄ monomers.
B It is likely a solid at room temperature and pressure.
C It is soluble in water.
D It turns bromine solution from brown to colourless.
15 A mixture containing 2 moles of ethene and 7 moles of oxygen is ignited in a sealed container at 100 °C. The chemical equation representing the reaction is shown below.
\[ \text{C}_2\text{H}_4 (g) + 3\text{O}_2 (g) \rightarrow 2\text{CO}_2 (g) + 2\text{H}_2\text{O} (g) \]
What is the total number of moles of gases at the end of the reaction?
A 4 moles  
B 8 moles  
C 9 moles  
D 13 moles

16 Aqueous potassium iodide is a reducing agent. Potassium manganate(VII) solution is an oxidising agent.

If solution X shows no reaction with aqueous potassium iodide but turns acidified potassium manganate(VII) solution from purple to colourless, which statement is true of solution X?
A X is a reducing agent.  
B X is an oxidising agent.  
C X is both an oxidising and a reducing agent.  
D X is neither an oxidising nor a reducing agent.

17 Which statement about organic compounds is true?
A Alkanes burn in air to form oxygen and water.
B All alcohols have the same structural formula.
C Methane is a gas at room temperature.
D Organic compounds consist of hydrogen and carbon atoms only.

18 Which statement correctly describes the use of each fraction obtained from the fractional distillation of petroleum?
A Bitumen is used to make polishes.
B Diesel is used to surface roads.
C Kerosene is used as a fuel for aeroplanes.
D Petroleum gas is used as a petrochemical feedstock to make other substances.
19 Olive oil is described as polyunsaturated and is healthy for consumption. What makes the oil polyunsaturated?

A It contains many C-C bonds.
B It contains many C-H bonds.
C It contains many C=C bonds.
D It contains many C=O bonds.

20 Poly(ethene) can be manufactured by the processes shown below.

Which diagram illustrates the change in molecular sizes correctly?

A

B

C

D
### Colours of Some Common Metal Hydroxides

<table>
<thead>
<tr>
<th>Metal Hydroxide</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>calcium hydroxide</td>
<td>white</td>
</tr>
<tr>
<td>copper(II) hydroxide</td>
<td>light blue</td>
</tr>
<tr>
<td>iron(II) hydroxide</td>
<td>green</td>
</tr>
<tr>
<td>iron(III) hydroxide</td>
<td>red-brown</td>
</tr>
<tr>
<td>lead(II) hydroxide</td>
<td>white</td>
</tr>
<tr>
<td>zinc hydroxide</td>
<td>white</td>
</tr>
</tbody>
</table>
### The Periodic Table of Elements

<table>
<thead>
<tr>
<th>Group</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
<th>VII</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Li</td>
<td>4</td>
<td>Be</td>
<td>5</td>
<td>B</td>
<td>6</td>
<td>C</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>lithium</td>
<td></td>
<td>beryllium</td>
<td></td>
<td>boron</td>
<td></td>
<td>carbon</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Na</td>
<td>12</td>
<td>Mg</td>
<td>13</td>
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<tr>
<td></td>
<td>sodium</td>
<td></td>
<td>magnesium</td>
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<td></td>
</tr>
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<td>23</td>
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<tr>
<td></td>
<td>potassium</td>
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<td>38</td>
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**Key**
- Proton (atomic number)
- Atomic symbol
- Relative atomic mass
- Name

**Lanthanoids**
- La
- Ce
- Pr
- Nd
- Pm
- Sm
- Eu
- Gd
- Tb
- Dy
- Ho
- Er
- Tm
- Yb
- Lu

**Actinoids**
- Ac
- Th
- Pa
- U
- Np
- Pu
- Am
- Cm
- Bk
- Cf
- Es
- Fm
- Md
- No
- Lr

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

O-LEVEL PRELIMINARY EXAMINATIONS

SCIENCE (PHYSICS/CHEMISTRY) 5076/01
Sec 4 Express/ 5 Normal (Academic)
Paper 1 Multiple Choice 23 September 2019
1 hour

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BSS/2019 Preliminary Examination /4E5N Sc(P/C) P1

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B The reaction is exothermic.
C The mixture takes in heat from the surroundings.
D The thermometer is a good heat conductor.

30 The diagram shows the trend of a property of the elements in Period 3 of the Periodic Table.

Which is the property?

A charge of their ions
B number of valence electrons
C proton number
D relative atomic mass
31 The diagram shows the structure of pure copper.

Which statement explains why pure copper sheets are easily bent.

A The atoms have spaces for them to move in between when a force is applied.
B The atoms are soft and easily bent.
C The layers of atoms can slide past one another.
D The atoms have weak intermolecular forces.

32 Sulfur dioxide is a pollutant that dissolves in rainwater to produce acid rain. In order to remove the sulfur dioxide from the waste gases produced from a power station, the waste gases are first passed through a scrubber which showers water down on them. The mixture produced then flows out of the scrubber and is then mixed with a powdered compound to neutralize it.

Which compound will not be able to neutralize the aqueous mixture of sulfur dioxide?

A calcium carbonate
B carbon dioxide
C magnesium oxide
D zinc oxide

33 What is true about the substance that has the chemical formula, C₂H₅NHCOOH?

A It consists of 8 elements.
B It has 12 atoms within a molecule.
C It is a mixture.
D It is a covalent compound.

34 A polymer has a structure as shown.

Which statement is true about the polymer?

A It is formed from the polymerisation of C₂H₄ monomers.
B It is likely a solid at room temperature and pressure.
C It is soluble in water.
D It turns bromine solution from brown to colourless.
35 A mixture containing 2 moles of ethene and 7 moles of oxygen is ignited in a sealed container at 100 °C. The chemical equation representing the reaction is shown below.

\[ \text{C}_2\text{H}_4 \ (g) \ + \ 3\text{O}_2 \ (g) \ \rightarrow \ 2\text{CO}_2 \ (g) \ + \ 2\text{H}_2\text{O} \ (g) \]

What is the total number of moles of gases at the end of the reaction?

A 4 moles  
B 8 moles  
C 9 moles  
D 13 moles

36 Aqueous potassium iodide is a reducing agent. Potassium manganate(VII) solution is an oxidising agent.

If solution X shows no reaction with aqueous potassium iodide but turns acidified potassium manganate(VII) solution from purple to colourless, which statement is true of solution X?

A X is a reducing agent.  
B X is an oxidising agent.  
C X is both an oxidising and a reducing agent.  
D X is neither an oxidising nor a reducing agent.

37 Which statement about organic compounds is true?

A Alkanes burn in air to form oxygen and water.  
B All alcohols have the same structural formula.  
C Methane is a gas at room temperature.  
D Organic compounds consist of hydrogen and carbon atoms only.

38 Which statement correctly describes the use of each fraction obtained from the fractional distillation of petroleum?

A Bitumen is used to make polishes.  
B Diesel is used to surface roads.  
C Kerosene is used as a fuel for aeroplanes  
D Petroleum gas is used as a petrochemical feedstock to make other substances.
39  Olive oil is described as polyunsaturated and is healthy for consumption.
What makes the oil polyunsaturated?
A  It contains many C-C bonds.  
B  It contains many C-H bonds.  
C  It contains many C=C bonds.  
D  It contains many C=O bonds.

40  Poly(ethene) can be manufactured by the processes shown below.

\[
\text{cracking} \quad \text{naphtha} \quad \text{polyme}risation \quad \text{ethene} \quad \text{poly(ethene)}
\]

Which diagram illustrates the change in molecular sizes correctly?

A  

\[
\text{molecular size}
\]

\[
\text{start} \quad \text{start} \quad \text{finish} \quad \text{finish}
\]

B  

\[
\text{molecular size}
\]

\[
\text{start} \quad \text{start} \quad \text{finish} \quad \text{finish}
\]

C  

\[
\text{molecular size}
\]

\[
\text{start} \quad \text{start} \quad \text{finish} \quad \text{finish}
\]

D  

\[
\text{molecular size}
\]

\[
\text{start} \quad \text{start} \quad \text{finish} \quad \text{finish}
\]
**Colours of Some Common Metal Hydroxides**

<table>
<thead>
<tr>
<th>Metal Hydroxide</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>calcium hydroxide</td>
<td>white</td>
</tr>
<tr>
<td>copper(II) hydroxide</td>
<td>light blue</td>
</tr>
<tr>
<td>iron(II) hydroxide</td>
<td>green</td>
</tr>
<tr>
<td>iron(III) hydroxide</td>
<td>red-brown</td>
</tr>
<tr>
<td>lead(II) hydroxide</td>
<td>white</td>
</tr>
<tr>
<td>zinc hydroxide</td>
<td>white</td>
</tr>
</tbody>
</table>
The Periodic Table of Elements

<table>
<thead>
<tr>
<th></th>
<th>I</th>
<th>II</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>O</td>
<td>F</td>
</tr>
<tr>
<td>12</td>
<td>Mg</td>
<td>Na</td>
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<td>15</td>
<td>P</td>
<td>C</td>
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<td>16</td>
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<td>Cl</td>
</tr>
<tr>
<td>18</td>
<td>Ar</td>
<td>Ne</td>
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<td>Br</td>
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<td>Kr</td>
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<td>Rh</td>
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<td>45</td>
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<td>Pd</td>
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<tr>
<td>46</td>
<td>Pd</td>
<td>Ag</td>
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<tr>
<td>47</td>
<td>Ag</td>
<td>Cd</td>
</tr>
<tr>
<td>48</td>
<td>Cd</td>
<td>In</td>
</tr>
<tr>
<td>49</td>
<td>In</td>
<td>Sn</td>
</tr>
<tr>
<td>50</td>
<td>Sn</td>
<td>Sb</td>
</tr>
<tr>
<td>51</td>
<td>Sb</td>
<td>Te</td>
</tr>
<tr>
<td>52</td>
<td>Te</td>
<td>I</td>
</tr>
<tr>
<td>53</td>
<td>I</td>
<td>Xe</td>
</tr>
<tr>
<td>54</td>
<td>Xe</td>
<td>Cs</td>
</tr>
<tr>
<td>55</td>
<td>Cs</td>
<td>Ba</td>
</tr>
<tr>
<td>56</td>
<td>Ba</td>
<td>La</td>
</tr>
<tr>
<td>57</td>
<td>La</td>
<td>Ce</td>
</tr>
<tr>
<td>58</td>
<td>Ce</td>
<td>Pr</td>
</tr>
<tr>
<td>59</td>
<td>Pr</td>
<td>Nd</td>
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<td>60</td>
<td>Nd</td>
<td>Pm</td>
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<td>61</td>
<td>Pm</td>
<td>Sm</td>
</tr>
<tr>
<td>62</td>
<td>Sm</td>
<td>Eu</td>
</tr>
<tr>
<td>63</td>
<td>Eu</td>
<td>Gd</td>
</tr>
<tr>
<td>64</td>
<td>Gd</td>
<td>Tb</td>
</tr>
<tr>
<td>65</td>
<td>Tb</td>
<td>Dy</td>
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<tr>
<td>66</td>
<td>Dy</td>
<td>Ho</td>
</tr>
<tr>
<td>67</td>
<td>Ho</td>
<td>Er</td>
</tr>
<tr>
<td>68</td>
<td>Er</td>
<td>Tm</td>
</tr>
<tr>
<td>69</td>
<td>Tm</td>
<td>Yb</td>
</tr>
<tr>
<td>70</td>
<td>Yb</td>
<td>Lu</td>
</tr>
<tr>
<td>87</td>
<td>Fr</td>
<td>Ra</td>
</tr>
</tbody>
</table>

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).
BARTLEY SECONDARY SCHOOL
O-LEVEL PRELIMINARY EXAMINATIONS

SCIENCE

Sec 4 Express / 5 Normal (Academic)
Paper 3 Chemistry

16 Sep 2019
1 hour 15 minutes

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

READ THESE INSTRUCTIONS FIRST

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

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 15.
A copy of the Periodic Table is printed on page 16.

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

<table>
<thead>
<tr>
<th>Section A</th>
<th>Section B</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This document consists of 15 printed pages and 1 blank page.
Need a home tutor? Visit smiletutor.sg
Section A

Answer all the questions in the spaces provided.

1. The diagrams below show the particles present in three types of substances.

substance A  
substance B  
substance C

Choose the substance, A, B or C, that shows the following properties.

(a) breaks down chemically to form two elements __________________
(b) consists of molecules of a pure halogen __________________
(c) is a pure compound __________________
(d) shows variable boiling points __________________

2. The table below shows the symbols of some isotopes of elements in the Periodic Table.

<table>
<thead>
<tr>
<th>isotope name</th>
<th>carbon-13</th>
<th>fluorine-21</th>
<th>magnesium-25</th>
<th>neon-22</th>
<th>strontium-92</th>
<th>iodine-129</th>
</tr>
</thead>
<tbody>
<tr>
<td>isotope symbol</td>
<td>$^{13}_{6}$C</td>
<td>$^{21}_{9}$F</td>
<td>$^{25}_{12}$Mg</td>
<td>$^{22}_{10}$Ne</td>
<td>$^{92}_{36}$Sr</td>
<td>$^{129}_{53}$I</td>
</tr>
</tbody>
</table>

(a) What is an isotope?

______________________________________________________________________________
______________________________________________________________________________[1]

(b) Which two isotopes shown above have the same number of neutrons?

________________________________ and _________________________________________[1]
(c) Give the symbol of another isotope of carbon that is used to standardise the relative atomic mass, $A_r$, of an element.

_________________________________________________________________[1]

(d) Why are magnesium and strontium placed in the same group in the Periodic Table?

_________________________________________________________________[1]

(e) Which isotope belongs to a non-metal from Period 5?

_________________________________________________________________[1]

(f) Why is neon-22 an unreactive isotope?

_________________________________________________________________[1]

3 The table below shows properties of two oxides, $X_2O$ and $ZO_2$.

<table>
<thead>
<tr>
<th>formula of oxide</th>
<th>melting point / °C</th>
<th>boiling point / °C</th>
<th>solubility in water</th>
</tr>
</thead>
<tbody>
<tr>
<td>$X_2O$</td>
<td>722</td>
<td>1302</td>
<td>soluble</td>
</tr>
<tr>
<td>$ZO_2$</td>
<td>-15</td>
<td>68</td>
<td>insoluble</td>
</tr>
</tbody>
</table>

(a) Name the type of chemical bond within the substance $X_2O$.

_________________________________________________________________[1]

(b) The oxide, $ZO_2$, is believed to be carbon dioxide gas.

(i) Describe the test for carbon dioxide gas and the observation that is expected.

_________________________________________________________________[2]

(ii) Draw a ‘dot and cross’ diagram to show the arrangement of all the electrons in a molecule of carbon dioxide.
Two spheres, A and B, of equal mass were hung on either side of a beam balance in a laboratory. Spheres A and B are made of either similar or different materials. Each sphere was immersed in two separate liquids X and Y in separate beakers at the same time for a fixed period. The spheres were then removed from both liquids and dripped dry while they were still hung on the beam balance. Observations about both spheres were made and recorded at the end of the experiment.

In the table below, circle the correct observation made at the end of each experiment.

<table>
<thead>
<tr>
<th>metal A</th>
<th>metal B</th>
<th>liquid X</th>
<th>liquid Y</th>
<th>observation at end of experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>iron</td>
<td>iron</td>
<td>water</td>
<td>water</td>
<td>sphere A heavier/ both have same mass / sphere B heavier</td>
</tr>
<tr>
<td>magnesium</td>
<td>magnesium</td>
<td>water</td>
<td>dilute hydrochloric acid</td>
<td>sphere A heavier/ both have same mass / sphere B heavier</td>
</tr>
<tr>
<td>iron</td>
<td>steel</td>
<td>dilute hydrochloric acid</td>
<td>dilute hydrochloric acid</td>
<td>sphere A heavier/ both have same mass / sphere B heavier</td>
</tr>
<tr>
<td>zinc</td>
<td>zinc</td>
<td>dilute hydrochloric acid</td>
<td>water</td>
<td>sphere A heavier/ both have same mass / sphere B heavier</td>
</tr>
<tr>
<td>copper</td>
<td>zinc</td>
<td>dilute hydrochloric acid</td>
<td>dilute hydrochloric acid</td>
<td>sphere A heavier/ both have same mass / sphere B heavier</td>
</tr>
<tr>
<td>carbon</td>
<td>carbon</td>
<td>dilute hydrochloric acid</td>
<td>water</td>
<td>sphere A heavier/ both have same mass / sphere B heavier</td>
</tr>
</tbody>
</table>
The table shows the number of protons, electrons and neutrons in seven particles, \( A, B, C, D, E, F \) and \( G \).

<table>
<thead>
<tr>
<th>particles</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>electrons</td>
<td>neutrons</td>
<td>protons</td>
</tr>
<tr>
<td>A</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>B</td>
<td>15</td>
<td>16</td>
<td>15</td>
</tr>
<tr>
<td>C</td>
<td>17</td>
<td>18</td>
<td>17</td>
</tr>
<tr>
<td>D</td>
<td>17</td>
<td>20</td>
<td>17</td>
</tr>
<tr>
<td>E</td>
<td>18</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>F</td>
<td>18</td>
<td>22</td>
<td>18</td>
</tr>
<tr>
<td>G</td>
<td>18</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

(a) (i) Identify the two particles which have the same mass number.

__________________________ and ____________________________ [1]

(ii) Do the particles named in (i) belong to the same element? Explain your answer.

______________________________________________________________ [1]

(b) Identify the particle that belongs to a Group 0 element.

_________________________________________________________________ [1]

(c) Which particle has a charge of +2?

_________________________________________________________________ [1]
The figure below describes reactions involving carbon dioxide and a black solid Q.

(a) Identify the substances, Q, R, S, T, U and V.

Q ______________________
R ______________________
S ______________________
T ______________________
U ______________________
V ______________________

[6]

(b) Instead of using aqueous sodium hydroxide, name another chemical substance you can use to confirm the identity of the cation of salt U.

_________________________________________________________________

[1]
(c) Write the ionic equation representing the reaction between salt U and sodium hydroxide solution to form the green precipitate, W.

_________________________________________________________________[1]

Sugar cane juice is used for the manufacture of ethanol which can be consumed as wine. The ethanol can also be concentrated to make fuel for use in vehicles.

(a) What physical process is used to increase the concentration of ethanol?

_________________________________________________________________[1]

(b) (i) Name the process used to manufacture ethanol from cane sugar.

_________________________________________________________________[1]

(ii) State two conditions required for the process named in (b)(i).

_________________________________________________________________[1]

(c) Draw the structural formula of ethanol.

_________________________________________________________________[1]

(d) (i) Explain why wine tastes sour if it is left uncovered for many days.

_________________________________________________________________[2]

(ii) Describe a test to verify that the change in (d)(i) has taken place.

_________________________________________________________________[2]
Excess aqueous potassium hydroxide is added dropwise to a lump of ammonium chloride solid in a conical flask as shown in the diagram below.

(a) Name the gas produced in the reaction.
_________________________________________________________________ [1]

(b) Complete and label the diagram to show how the gas produced in (a) can be collected and measured. [2]

(c) What are two ways of increasing the rate of reaction without affecting the final volume of the gas collected.

_________________________________________________________________
_________________________________________________________________ [2]

(d) What difference in observation would you make if the ammonium chloride is replaced with sodium chloride?
_________________________________________________________________ [1]
Section B

Answer any two questions in this section.

Write your answers in the spaces provided.

9

10 g of calcium carbonate was added to 1 mol/dm³ hydrochloric acid in a conical flask. The carbon dioxide gas released was collected in a measuring cylinder using the downward displacement of water method.

(a) Write a balanced chemical equation that represents the reaction between hydrochloric acid and calcium carbonate, including the state symbols.

_________________________________________________________________ [2]

(b) (i) Calculate the number of moles in 10 g of calcium carbonate.

number of moles of calcium carbonate = __________ [1]

(ii) Calculate the number of moles of the hydrochloric acid that reacted completely with 10 g of calcium carbonate.

number of moles of hydrochloric acid = __________ [1]

(iii) Calculate the volume of the 1 mol/dm³ hydrochloric acid that reacted completely with 10 g of calcium carbonate.

volume of hydrochloric acid = __________ [1]

(c) The experiment was repeated using an excess of a different amount of calcium carbonate in the same 1 mol/dm³ hydrochloric acid. The volume of carbon dioxide gas produced was measured over a period of time.

The graph on page 10 shows the volume of carbon dioxide gas produced at regular time intervals.

Study the graph and answer the questions that follow.
(i) What volume of carbon dioxide measured at room temperature and pressure was formed at the end of the reaction?  
________________________________________________________________________________________________________________________________________________________[1]

(ii) When did the reaction stop?  
________________________________________________________________________________________________________________________________________________________[1]

(iii) What was the average speed of reaction at the first 1.5 minutes?  
________________________________________________________________________________________________________________________________________________________[1]

(iv) Using your understanding of the Kinetic Particle Theory, explain why the reaction slowed down towards the end of the experiment.  
________________________________________________________________________________________________________________________________________________________[2]

10 Copper reacts with dilute nitric acid to form the products as shown in the chemical equation below.

\[
\text{Cu(s) + 4HNO}_3(\text{aq}) \rightarrow \text{Cu(NO}_3)_2(\text{aq}) + 2\text{NO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})
\]

(a) (i) State the oxidation number of copper before the reaction occurs.  
________________________________________________________________________________________________________________________________________________________[1]

(ii) Calculate the oxidation number of copper in copper(II) nitrate, Cu(NO_3)_2.  
________________________________________________________________________________________________________________________________________________________[1]

(iii) Is copper oxidised, reduced, or neither oxidised nor reduced? Explain your answer using oxidation numbers.  
________________________________________________________________________________________________________________________________________________________[1]

(b) Describe what is observed if a sample of copper(II) nitrate solution is added to excess aqueous ammonia.  
________________________________________________________________________________________________________________________________________________________[1]
(c) Copper(II) nitrate crystals, \( \text{Cu(NO}_3\text{)}_2 \), can also be prepared in the laboratory using an insoluble base mixed with dilute nitric acid.

(i) Name a suitable insoluble base that can be used for this reaction.

______________________________________________________________________ [1]

(ii) Describe how a sample of dry pure copper(II) nitrate crystals can be prepared in the laboratory using the insoluble base and aqueous nitric acid.

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________ [5]

11 Perfume is a mixture of essential oils dissolved in a solvent. One of the essential oils used in making perfume is called myrcene.

The structural formula of a molecule of myrcene is shown below.

(a) Explain why myrcene is a hydrocarbon.

______________________________________________________________________ [1]

(b) An experiment is carried out using two samples of myrcene.

(i) The first sample is tested with a few drops of aqueous bromine.

What change if any, will be observed?

______________________________________________________________________ [1]
(ii) Hydrogen gas was passed through the second sample of myrcene in an addition reaction before being tested with aqueous bromine.

What change if any, will be observed?

____________________________________________________________________________________[1]

(iii) Explain the difference in observations between both samples.

____________________________________________________________________________________[1]

(c) Explain why myrcene is a liquid and not a solid at room temperature.

____________________________________________________________________________________[2]

(d) Myrcene can be cracked to form smaller molecules.

(i) State the conditions for cracking.

____________________________________________________________________________________[1]

(ii) Name an element that may be obtained from the cracking process.

____________________________________________________________________________________[1]

(iii) The chemical equation below shows an example of a cracking process of myrcene.

\[ C_{10}H_{18} \rightarrow X + C_8H_{12} \]

Name substance \( X \).

____________________________________________________________________________________[1]

(e) The structural formula of an addition polymer is shown below.

\[
\begin{array}{cccc}
| & H & Cl & H & Cl \\
| & I & I & I & I \\
- C - & C - & C - & C - \\
| & I & I & I & I \\
CH_3 & H & CH_3 & H \\
\end{array}
\]

Draw the structure of its monomer.

____________________________________________________________________________________[1]
### Colours of Some Common Metal Hydroxides

<table>
<thead>
<tr>
<th>Compound</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>calcium hydroxide</td>
<td>white</td>
</tr>
<tr>
<td>copper(II) hydroxide</td>
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<td>green</td>
</tr>
<tr>
<td>iron(III) hydroxide</td>
<td>red-brown</td>
</tr>
<tr>
<td>lead(II) hydroxide</td>
<td>white</td>
</tr>
<tr>
<td>zinc hydroxide</td>
<td>white</td>
</tr>
<tr>
<td>Group</td>
<td>Periodic Table of Elements</td>
</tr>
<tr>
<td>-------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>I</td>
<td>H</td>
</tr>
<tr>
<td>II</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
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<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).
Marking Scheme_v1
(Erratum: v1 used in Chem/Bio and Bio/Chem, not the final edition of P1)

BSS/ 2019 Preliminary Examination/ 4E/5N ScChem

<p>| | | | | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>D</td>
<td>2</td>
<td>A</td>
<td>3</td>
<td>D</td>
<td>4</td>
<td>A</td>
<td>5</td>
<td>C</td>
<td>6</td>
</tr>
<tr>
<td>11</td>
<td>C</td>
<td>12</td>
<td>B</td>
<td>13</td>
<td>D</td>
<td>14</td>
<td>B</td>
<td>15</td>
<td>C</td>
<td>16</td>
</tr>
</tbody>
</table>

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Marking Scheme
BSS/ 2019 Preliminary Examination/ 4E/5N ScChem

Paper 3, Section A

1a  B  [1]
b  A  [1]
c  B  [1]
d  C  [1]

2a  It is an atom of an element with the same proton number but different number of neutrons [1]
b  fluorine -21 and neon-22 ; both correct [ 1]
c  $^{12}_6$C  [1]
d  Both have two valence electrons [1]
e  iodine-129 [1] ; don’t penalise if only ‘iodine’ written
f  neon has a full (or complete) structure on the outer electron shell that makes it stable [1]

3a  ionic bond [1]
bii  pass the gas into limewater[1]; a white ppt will form [1]
ii  correct bonding between atoms of one carbon and two oxygen elements [1]
correct electronic configurations for 2 oxygen and 1 carbon atoms [1]

4.

<table>
<thead>
<tr>
<th>metal A</th>
<th>metal B</th>
<th>liquid X</th>
<th>liquid Y</th>
<th>observation</th>
</tr>
</thead>
</table>

1

Need a home tutor? Visit smiletutor.sg
<table>
<thead>
<tr>
<th>iron</th>
<th>steel</th>
<th>dilute hydrochloric acid</th>
<th>dilute hydrochloric acid</th>
<th>sphere A heavier/ both have same mass / sphere B heavier</th>
</tr>
</thead>
<tbody>
<tr>
<td>zinc</td>
<td>zinc</td>
<td>dilute hydrochloric acid</td>
<td>water</td>
<td>sphere A heavier/ both have same mass / sphere B heavier</td>
</tr>
<tr>
<td>copper</td>
<td>zinc</td>
<td>dilute hydrochloric acid</td>
<td>dilute hydrochloric acid</td>
<td>sphere A heavier/ both have same mass / sphere B heavier</td>
</tr>
<tr>
<td>carbon</td>
<td>carbon</td>
<td>dilute hydrochloric acid</td>
<td>water</td>
<td>sphere A heavier/ both have same mass / sphere B heavier</td>
</tr>
</tbody>
</table>

5ai F and G [1]
ii no, because different proton number [1]
b F [1]
c G [1]

6a Q: carbon
R: carbon monoxide
S: iron
T: sulfuric acid
U: iron(II) sulfate
V: barium sulfate [1] each

b.` aqueous ammonia or ammonia solution [1]
c. Fe^{2+} (aq) + 2OH^- (aq) → Fe(OH)_2 (s) [1] [zero if states not given]

7a fractional distillation [1]
bi fermentation [1]
ii 37°C; yeast [1]
c correct structural formula of ethanol [1]
di ethanol in wine changes to form ethanoic acid. [1]
ocxidation of ethanol occurs in the presence of air and bacteria [1]
ii Put litmus paper (or Universal indicator) [1]
Blue litmus turns red [1] (UI turns from green to yellow)

8a ammonia [1]
b labelled diagram of gas syringe [1]
Diagram showing tight–fitting plunger that could move within graduated vessel [1]
c raise temperature; reduce size of ammonium chloride solid; increase concentration of potassium hydroxide [2] for 3 correct; [1] for 1 or 2 correct
d no reaction; or no gas is formed [1]

Section B

9a \[2\text{HCl} (aq) + \text{CaCO}_3 (s) \rightarrow \text{CaCl}_2 (aq) + \text{CO}_2 (g) + \text{H}_2\text{O} (l)\]
Correct symbols; balanced equation; states [2] for all 3 correct; [1] for 2 or less
b (i) number of mole of \(\text{CaCO}_3\) = \(\frac{10g}{100}\) = 0.1 mol [1]
(ii) number of mol of \(\text{HCl}\) = 0.2 mol [1]; allow ecf from (i)
(iii) volume of \(\text{HCl}\) = \(\frac{0.2}{1}\) = 0.2 dm\(^3\) [1]; -1m for no unit; allow ecf from (ii)
ci 70 cm\(^3\) [1]; -1m for no unit
ii between 4.6 and 4.8 min [1]
iii 50/1.5 = 33.33 cm\(^3\) [1]
= 33.3 cm\(^3\)/min [3sf]
iv concentration of the acid decreases as the acid is used up/less particles within the same volume [1] less effective collisions taking place per unit time [1]

10a (i) oxidation number of copper was zero before reaction [1]
(ii) oxidation number of copper was +2 after reaction [1]
(iii) copper is oxidised as its oxidation number increases. [1]
b a dark blue solution is seen [1]
ci  copper (II) oxide; copper (II) hydroxide  [1]

ii - add excess base to nitric acid
- filter to remove excess base as residue
- heat to saturation point
- cool
- decant/ filter / scoop up crystals with filter papers
- dry between filter papers  [5] for any 5 ans; give marks even if prior steps are skipped

11a  It is a compound which consists of carbon and hydrogen atoms only  [1]

bi  brown aqueous bromine becomes colourless  [1]

ii  bromine remains brown  [1]

iii  sample one is an alkene but sample two is an alkane  [1]

c  myrcene comprises non-metals only and so it is a covalent compound.  [1]

presence of weak intermolecular forces of attraction  [1]
little energy required; low melting point and therefore a liquid at room temp  [1]

di  high temp; aluminium oxide or silicon dioxide as catalyst [1]

ii  hydrogen  [1]

iii  ethene  [1]

iv  [1]

\[
\begin{array}{ccc}
\text{H} & \text{Cl} \\
\text{C} & \text{H}_3 & \text{F} \\
\text{C} & \text{C} \\
\end{array}
\]
Need a home tutor? Visit smiletutor.sg
DATE : 30 Aug 2019
DURATION : 1 hour

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Write your name, class and register number on the work you hand in.
Do not use 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 2B pencil on the OTAS sheet.

Read the instructions on the OTAS sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done on the question paper.
A copy of the Periodic Table is printed on page 18.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of 18 printed pages.
1. The cover-plates were removed from the gas jars in the apparatus shown below. It was seen that after several days, the colour of the gas was the same in both jars.

What is the best explanation for this?

A. Both gases contain equal numbers of molecules.
B. Both gases have equal densities.
C. Oxygen and fluorine molecules are moving rapidly in all directions.
D. Oxygen and fluorine molecules diffuse at the same rate.

2. Hydrogen chloride is very soluble in water whereas chlorine is only slightly soluble in water. In what order should the pieces of apparatus shown be joined together in order to collect pure, dry chlorine from a sample of damp chlorine containing a small amount of hydrogen chloride?

A. 1, 2, 3, 4
B. 1, 2, 3, 5
C. 1, 3, 2, 4
D. 1, 3, 2, 5
3 The boiling points of various gases found in the air are shown below.

<table>
<thead>
<tr>
<th>gas</th>
<th>boiling point / °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>argon</td>
<td>-186</td>
</tr>
<tr>
<td>carbon dioxide</td>
<td>-78</td>
</tr>
<tr>
<td>nitrogen</td>
<td>-198</td>
</tr>
<tr>
<td>oxygen</td>
<td>-183</td>
</tr>
</tbody>
</table>

If the air is cooled, the first substance to condense is water.
If the temperature is lowered further, what is the next substance to condense?

A argon  
B carbon dioxide  
C nitrogen  
D oxygen

4 The following reaction can be used to prepare lead(II) iodide.

\[ \text{Pb(NO}_3\text{)}_2(\text{aq}) + 2\text{KI(}aq\text{)} \rightarrow 2\text{KNO}_3(\text{aq}) + \text{PbI}_2(\text{s}) \]

Which method is used to separate lead(II) iodide from the above mixture?

A crystallization  
B distillation  
C filtration  
D sublimation

5 Hexasulfur was prepared by M.R. Engel in 1891 by reacting concentrated hydrochloric acid with thiosulfate, HS$_2$O$_3^-$ . It is orange-red and forms a rhombohedral crystal. It has a formula of S$_6$.

What can you deduce from the information given above?

A Hexasulfur contains only one element.  
B Hexasulfur is a compound which contains 6 atoms.  
C Hexasulfur is a compound which contains 6 elements.  
D Hexasulfur is a mixture which contains 6 elements.

6 Three elements, X, Y and Z, have consecutive, increasing proton numbers. If element X is in Group IV, what will be the symbol for the ion of element Z in its compounds?

A $Z^{2-}$  
B $Z^-$  
C $Z^+$  
D $Z^{2+}$
7 Element X has 7 protons. Element Y has 8 more protons than X.

Which statement about element Y is not correct?
A Y has more electron shells than X.
B Y has the same number of valence electrons as X.
C Y is in the same group of the Periodic Table as X.
D Y is in the same period of the Periodic Table as X.

8 Which statement about both chlorine atoms and chloride ions is correct?
A They are chemically identical.
B They are isotopes of chlorine.
C They have the same number of protons.
D They have the same physical properties.

9 The following diagram shows the structure of one molecule of a substance.
10 A student thinks that element Q is a metal because it has a high melting point and a high boiling point. What other properties could element Q have to show that it is a metal?

1 Q conducts electricity when solid.
2 Q forms an acidic oxide, QO₂.
3 Q is malleable.

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

11 Liquid X reacts with solid Y to form a gas. Which two diagrams show suitable methods for investigating the speed of reaction?

A 1 and 3  
B 1 and 4  
C 2 and 3  
D 2 and 4
12 The table gives information about the reactivity of three metals P, Q and R.

<table>
<thead>
<tr>
<th>metal</th>
<th>reaction with air</th>
<th>reaction with steam</th>
<th>reaction with dilute hydrochloric acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>burns with sparks</td>
<td>forms an oxide</td>
<td>forms hydrogen</td>
</tr>
<tr>
<td>Q</td>
<td>slowly forms an oxide</td>
<td>no reaction</td>
<td>no reaction</td>
</tr>
<tr>
<td>R</td>
<td>slowly forms an oxide</td>
<td>no reaction</td>
<td>forms hydrogen</td>
</tr>
</tbody>
</table>

What is the order of reactivity of P, Q and R?

<table>
<thead>
<tr>
<th></th>
<th>most reactive</th>
<th>least reactive</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>P</td>
<td>Q</td>
</tr>
<tr>
<td>B</td>
<td>P</td>
<td>R</td>
</tr>
<tr>
<td>C</td>
<td>Q</td>
<td>R</td>
</tr>
<tr>
<td>D</td>
<td>R</td>
<td>Q</td>
</tr>
</tbody>
</table>

13 A steel works and a chemical works are built near to a city. The limestone buildings in the city begin to crumble.

Which gas is most likely to cause this damage?

A carbon dioxide
B carbon monoxide
C nitrogen
D sulfur dioxide

14 Limestone, CaCO₃, decomposes when heated as shown in the equation.

$$\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$$

What is the mass of limestone needed to produce 84 kg of calcium oxide?

A 150 kg
B 280 kg
C 840 kg
D 1000 kg
The reaction between bromine and iodide ions is shown in the equation.

\[ \text{Br}_2 + 2\text{I}^- \rightarrow \text{I}_2 + 2\text{Br}^- \]

What happens during this reaction?

A  Bromine molecules are the oxidising agent.
B  Bromine molecules are oxidised to bromide ions.
C  Iodide ions are reduced to iodine molecules.
D  Iodide ions gain electrons.

The curve X below represents the results of the reaction between 1.0 g of granulated zinc and an excess of acid at 30 °C.

Which of the following changes will produce curve Y?

A  0.5 g of granulated zinc at 30 °C
B  0.5 g of powdered zinc at 50 °C
C  1.0 g of granulated zinc at 30 °C
D  1.0 g of powdered zinc at 50 °C
17 Dissolving ammonium nitrate in water is endothermic. Which graph shows how the temperature alters as the ammonium nitrate is added to the water and the solution is left to stand?

A  
B  
C  
D  

18 Lead(II) sulfate is insoluble in water. What should be added to sulfuric acid to prepare lead(II) sulfate?

A lead(II) carbonate  
B lead(II) chloride  
C lead(II) nitrate  
D lead(II) oxide  

19 Which statement about the homologous series of alcohols is not true?

A Alcohols can be oxidized to acids.  
B All alcohols can be made by the fermentation of sugars and carbohydrates.  
C Complete combustion of alcohols produces carbon dioxide and water only.  
D The relative molecular mass of each member differs from the next member by 14.

[Turn over

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20 A hydrocarbon \( Y \) with a relative molecular mass of 28 quickly decolourises aqueous bromine in bright sunlight.

What is \( Y \) likely to be?
The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).
DATE : 29 August 2019
DURATION : 1 hour 15 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on the work you hand in.
You may use a 2B pencil for any diagrams, graphs, tables or rough working.
Write in dark blue or black pen.
Do not use paper clips, 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 working 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.
Section A (45 marks)

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

1. From the list below, choose the most suitable answer. Each substance can be used only once or not at all.

   - carbon dioxide
   - chlorine
   - potassium chloride
   - carbon monoxide
   - nitrogen
   - argon
   - sodium oxide
   - brass
   - water

Which substance

(a) can conduct electricity in the aqueous and molten states;  
   .......................................................................................................................... [1]

(b) is the most abundant in air;  
   .......................................................................................................................... [1]

(c) produces a black solid when added to potassium iodide;  
   .......................................................................................................................... [1]

(d) is a monoatomic element;  
   .......................................................................................................................... [1]

(e) does not contain a fixed percentage composition of its constituents?  
   .......................................................................................................................... [1]
The group numbers of the elements A, B, C and D are given in Table 2.1.

<table>
<thead>
<tr>
<th>element</th>
<th>group number</th>
<th>period number</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>I</td>
<td>2</td>
</tr>
<tr>
<td>B</td>
<td>IV</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>VI</td>
<td>3</td>
</tr>
<tr>
<td>D</td>
<td>VIII</td>
<td>4</td>
</tr>
</tbody>
</table>

Using the information given, answer the following questions.

(a) Using the electronic structure, explain why element C is a non-metal.

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

(b) Identify element B.

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

(c) Which element conducts electricity at room temperature in both solid and liquid states?

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

(d) Showing all electrons, draw a ‘dot and cross’ diagram to show the bonding in the compound formed between A and C.

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

(e) Does the compound formed in (d) have a high or low melting point? Explain your answer.

.................................................................................................................................................. [2]
Small pieces of five metals are added to aqueous solutions of the five metal nitrates. The results are recorded in Table 3.1.

✓ indicates reaction takes place
X indicates no reaction takes place

Table 3.1

<table>
<thead>
<tr>
<th>solution</th>
<th>copper, Cu</th>
<th>magnesium, Mg</th>
<th>nickel, Ni</th>
<th>silver, Ag</th>
<th>tin, Sn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cu(NO₃)₂</td>
<td>X</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
<td>✓</td>
</tr>
<tr>
<td>Mg(NO₃)₂</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Ni(NO₃)₂</td>
<td>X</td>
<td>✓</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>AgNO₃</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
<td>✓</td>
</tr>
<tr>
<td>Sn(NO₃)₂</td>
<td>X</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

(a) Place the five metals in order of reactivity.

Most reactive: .................................................................

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

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

Least reactive: ...............................................................

[2]

(b) Give two observations to be made when magnesium is added to aqueous copper(II) nitrate.

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

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

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

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

[2]

(c) When a metal M is added to iron(II) nitrate, a colourless solution is obtained and the oxidation state of M changes from 0 to +2.

(i) Suggest what metal M might be.

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

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

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

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

[1]

(ii) Write a balanced equation for the reaction between M and iron(II) nitrate. Use the letter M in your equation.

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

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

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

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

[1]
(iii) Explain, in terms of oxidation states, why this reaction is considered to be a redox reaction.

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

4 (a) Ammonium phosphate, \((\text{NH}_4)_3\text{PO}_4\), can be prepared by adding 25.0 cm\(^3\) of 0.5 mol/dm\(^3\) of aqueous ammonium hydroxide, \(\text{NH}_4\text{OH}\), to 33.5 cm\(^3\) of dilute phosphoric acid, \(\text{H}_3\text{PO}_4\).

\[3 \text{NH}_4\text{OH (aq)} + \text{H}_3\text{PO}_4 (aq) \rightarrow (\text{NH}_4)_3\text{PO}_4 (aq) + 3 \text{H}_2\text{O (l)}\]

(i) Calculate the number of moles of ammonium hydroxide used.

\[
\text{number of moles} = \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots [1]
\]

(ii) Calculate the number of moles of phosphoric acid required.

\[
\text{number of moles} = \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots [1]
\]

(iii) Calculate the concentration of the phosphoric acid used.

\[
\text{concentration of phosphoric acid} = \ldots \ldots \ldots \ldots \text{mol/dm}^3 \quad [2]
\]

(b) (i) Ammonium phosphate is used as a fertiliser in soils. However it is not advisable to add the fertiliser to acidic soils that has been treated with calcium hydroxide.

Explain why with the help of a balanced equation.

........................................................................................................................................
(ii) Write an ionic equation, including state symbols, for the reaction between ammonium hydroxide and phosphoric acid.

5 Cold packs are used to reduce swelling, inflammation and pain by removing the heat. A list of chemicals from a science laboratory is shown below:

ammonium chloride  dilute hydrochloric acid  water
anhydrous sodium carbonate  sodium hydroxide

(a) From the list of chemicals provided above, select a pair of chemicals that can be used for making a cold pack in a science laboratory.

(b) Explain your answer in (a) and state the type of energy change.

6 P, Q, R and S are samples of water taken from different places thought to be polluted. Tables 6.1 and 6.2 show the observations made when each sample of water is tested.

<table>
<thead>
<tr>
<th>tests for sulfate ions</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>add a few drops of dilute hydrochloric acid, then add several drops of aqueous barium chloride</td>
<td>sample P: white ppt formed, sample Q: no visible reaction, sample R: white ppt formed, sample S: no visible reaction</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>tests for chloride ions</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>add a few drops of dilute nitric acid, then add several drops of aqueous silver nitrate</td>
<td>sample P: no visible reaction, sample Q: white ppt formed, sample R: white ppt formed, sample S: no visible reaction</td>
</tr>
</tbody>
</table>

Use the results of the tests to help you answer the following questions.

(a) Which water sample is polluted with both sulfate and chloride ions?
(b) One of the samples is known to contain only ammonium sulfate.

(i) Which sample is it?

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

(ii) Give a reason for your answer.

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

(c) Which sample appears to be the least polluted?

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

7 A series of experiments were carried out to compare the rates of the reaction of hydrochloric acid with marble (calcium carbonate) under different conditions. In each experiment, excess marble was reacted with 25 cm$^3$ of acid. The conditions for each experiment were shown in Table 7.1.

<table>
<thead>
<tr>
<th>experiment</th>
<th>marble</th>
<th>acid concentration (mol/dm$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>large chips</td>
<td>0.1</td>
</tr>
<tr>
<td>B</td>
<td>large chips</td>
<td>0.2</td>
</tr>
<tr>
<td>C</td>
<td>small chips</td>
<td>0.1</td>
</tr>
<tr>
<td>D</td>
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<td>0.2</td>
</tr>
<tr>
<td>E</td>
<td>powder</td>
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</table>

The gas given off was collected and its total volume was measured every 15 seconds for 6 minutes. The results obtained were plotted as shown in Fig. 7.2.

(a) Write an equation for the reaction which occurred.
For each of the experiments A to D, state which of the curves I to IV corresponds to the results obtained in Fig. 7.2.

Experiment A: curve ……………………..
Experiment B: curve ……………………..
Experiment C: curve ……………………..
Experiment D: curve ……………………..

Sketch the result obtained for experiment E in Fig. 7.2 and label it with “V.”

State one condition which must be kept constant during the experiments.

A chemical process is carried out by oil companies to produce high grade petrol (an eight carbon hydrocarbon). The process is carried out by using aluminium oxide catalyst.

(i) A typical reaction for this process is:

\[ \text{C}_{16}\text{H}_{34} \rightarrow \text{C}_{8}\text{H}_{18} + 2\text{C}_{4}\text{H}_{8} \]

Name this chemical process.

(ii) Describe a simple chemical test to distinguish between the two products shown in the equation.
(b) Table 8.1 shows some of the products obtained by using this process for 100 g of different fractions under the same conditions.

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<tr>
<th>fraction</th>
<th>products obtained / g per 100 g of ‘fraction’ used</th>
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<td></td>
<td>hydrogen methane ethene petrol</td>
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<td>1 15 30 23</td>
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<tr>
<td>diesel</td>
<td>0 6 20 17</td>
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</table>

(i) Which fraction is the best source for petrol?

(ii) Another typical reaction for this process in order to produce ethene is shown below. Complete the equation.

\[ C_{18}H_{38} \rightarrow 6C_2H_4 + \text{__________} \]

(c) Ethene undergoes polymerisation to form poly(ethene) which is a non-biodegradable polymer.

(i) Explain the meaning of the term “non-biodegradable”.

(ii) In the space below, draw 2 repeat units of poly(ethene).
Section B
Answer **any two** questions in this section.
Write your answer in the spaces provided.

9 A colourless gas X with an empirical formula CH₂ produces a neutral organic liquid W of molecular mass 46 upon hydration (addition of steam).

X reacts with (i) hydrogen to give a gas Y of molecular mass 30 and (ii) bromine to give a liquid Z of molecular mass 188.

(a) Give the names and molecular formulae of compounds W, X, Y and Z.

W: .................................................................

X: .................................................................

Y: .................................................................

Z: ................................................................. [4]

(b) Write a balanced equation for the hydration of X and briefly describe how this reaction could be carried out in the laboratory.

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

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

(c) Describe, with a balanced equation, one reaction of W other than combustion.

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

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

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

(d) 0.42 g of W is vaporized by heating to 100°C at room temperature and pressure. Calculate the volume occupied by the vapour under these conditions.

volume of W = ......................... dm³ [2]
Thermal decomposition of compounds breaks them down into smaller substances when sufficient heat is applied.

(a) Air bags are used to protect passengers in a car during an accident. When the crash sensor detects an impact, it causes a mixture of chemicals to be heated to a high temperature. Reactions take place which produce nitrogen gas. The nitrogen fills the air bag. This is shown in Fig. 10.1.

![Fig. 10.1](image)

The mixture of chemicals contains solid sodium azide, NaN₃ which decomposes to form sodium and nitrogen as follows:

\[ \ldots \text{NaN}_3 (\ldots) \rightarrow \ldots \text{Na} (\ldots) + \ldots \text{N}_2 (\ldots) \]

(i) Balance the chemical equation and complete the state symbols in the chemical equation above. [2]

(ii) Draw the electronic structure of nitrogen gas. Show outer electrons only.
(iii) An air bag consists of 130 g of sodium azide. When the sodium azide decomposed, 60 dm$^3$ of nitrogen was obtained at room temperature and pressure.

Show, using calculations, if the thermal decomposition of sodium azide has been efficient in producing nitrogen to fill up the air bag.

(b) A student used the apparatus in Fig. 10.2 to investigate what happens when liquid paraffin is heated to a high temperature.

Liquid paraffin contains alkanes. The most abundant alkane has a chemical formula of C$_{20}$H$_{42}$.

Name the reaction shown in Fig. 10.2. Describe, with the aid of a chemical equation, what happens to the alkane molecules in the reaction.
Bromine, chlorine and iodine belong to the same group of elements.

(a) (i) What is the name given to this group of elements?

(ii) A student was asked to perform the following experiments to show the trend in the reactivity of the above three elements.

Experiment 1: bromine solution + aqueous potassium iodide

Experiment 2: chlorine solution + aqueous potassium bromide

Experiment 3: iodine solution + aqueous potassium chloride

Describe, with balanced equations, what you will observe in the three experiments.

(iii) Using your answer in (a)(ii), arrange the elements in order of increasing reactivity and explain how reactivity changes when going down the group.

(b) (i) State the reagents used to prepare magnesium chloride.

(ii) Describe how dry crystals of magnesium chloride is produced in the laboratory.
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The volume of one mole of any gas is 24 dm$^3$ at room temperature and pressure (r.t.p.).
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Paper 1

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Paper 3

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<td>(e) brass</td>
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<td>(c) A</td>
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<td>(d) <img src="Image" alt="Diagram" /></td>
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<td>(e) High melting point.</td>
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<td>It is an <strong>ionic compound</strong> with <strong>giant ionic structure</strong>. A lot of energy is needed to overcome the <strong>strong electrostatic forces of attraction</strong> between the oppositely charged ions.</td>
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<td></td>
</tr>
</tbody>
</table>

Need a home tutor? Visit smiletutor.sg
(ii) \( M + Fe(NO_3)_2 \rightarrow Fe + M(NO_3)_2 \)

(iii) Oxidation state of \( M \) increases from 0 in \( M \) to +2 in \( M(NO_3)_2 \). Hence \( M \) is oxidised. Oxidation state of \( Fe \) decreases from +2 in \( Fe(NO_3)_2 \) to 0 in \( Fe \). Hence \( Fe \) is reduced. There is both oxidation and reduction taking place at the same time. Hence this is a redox reaction.

4
(a) \( 25/1000 \times 0.5 = 0.0125 \)

(ii) \( NH_4OH : H_3PO_4 \)

\[
\begin{align*}
3 & : 1 \text{ (from equation)} \\
0.0125 & : 0.00417
\end{align*}
\]

(iii) Concentration = \( \text{Mole/vol} = 0.00417 / (33.5/1000) \)

\[= 0.124 \text{ mol/dm}^3\]

(b) \( 2(NH_4)_3PO_4 + 3Ca(OH)_2 \rightarrow Ca_3(PO_4)_2 + 6NH_3 + 6H_2O \)

Ammonium phosphate will react with calcium hydroxide instead of fertilizing the soil.

(ii) \( H^+ (aq) + OH^- (aq) \rightarrow H_2O (l) \)

5
(a) Ammonium chloride and water

(b) Heat is taken in from the surroundings when dissolving ammonium chloride in water. It is an endothermic process.

6
(a) \( R \)

(b) (i) \( P \)

(ii) \( P \) forms white precipitate when barium chloride is added, indicating that sulfate ions are present. \( P \) has no visible reaction when silver nitrate is added, indicating the absence of chloride ions.

(c) \( S \)

7
(a) \( CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O \)

(b) Experiment A: curve I

Experiment B: curve III

Experiment C: curve II

Experiment D: curve IV

(c) \[
\text{Volume of gas/ cm}^3 \]

\[
\text{Time/ s}
\]

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### Question 8

<table>
<thead>
<tr>
<th>Part</th>
<th>Description</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>(i) Cracking</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(ii) Test: Add aqueous bromine</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Result with C₈H₁₈: No reaction with aqueous bromine</td>
<td>½</td>
</tr>
<tr>
<td></td>
<td>Result with C₄H₈: Decolourises aqueous bromine</td>
<td>½</td>
</tr>
<tr>
<td>(b)</td>
<td>(i) Paraffin</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(ii) C₁₈H₃₈ → 6C₂H₄ + C₆H₁₄</td>
<td>1</td>
</tr>
</tbody>
</table>

(c) “Non-biodegradable" means that the polymer cannot be broken down into simpler substances by air and bacteria. | 1 |

#### Diagram

![Diagram of C3H6 molecule](image)

### Question 9

<table>
<thead>
<tr>
<th>Part</th>
<th>Description</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>W: ethanol, C₂H₅OH</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>X: ethene, C₂H₄</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Y: ethane, C₂H₆</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Z: dibromoethane, C₂H₄Br₂</td>
<td>1</td>
</tr>
<tr>
<td>(b)</td>
<td>C₂H₄ + H₂O → C₂H₅OH</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Conditions: 300°C, 60 atm, phosphoric (V) acid as catalyst</td>
<td>1</td>
</tr>
<tr>
<td>(c)</td>
<td>C₂H₅OH + O₂ → CH₃COOH + H₂O</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Ethanol can be oxidised by atmospheric oxygen or by potassium manganate(VII) to ethanoic acid.</td>
<td>1</td>
</tr>
<tr>
<td>(d)</td>
<td>Number of mole of W, C₂H₅OH = 0.42/ (2x12+5+16+1) = 0.00913</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Volume of W, C₂H₅OH = 0.00913 x 24 = 0.219 dm³</td>
<td>1</td>
</tr>
</tbody>
</table>

### Question 10

<table>
<thead>
<tr>
<th>Part</th>
<th>Description</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>(i) 2NaN₃(s) → 2Na(s) + 3N₂(g)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>(ii) <img src="image" alt="Diagram of nitrogen molecule" /></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>(iii) Number of moles of NaN₃ = 130/(23+3x14) = 2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>NaN₃ : N₂ = 2 : 3</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Volume of N₂ that should be produced from 130 g of NaN₃ = 3 x 24 = 72 dm³</td>
<td>1</td>
</tr>
</tbody>
</table>
The volume of nitrogen gas produced is 60 dm$^3$ instead of 72 dm$^3$. Hence the thermal decomposition of sodium azide has not been efficient.

(b) The reaction is cracking.
\[ C_{20}H_{42} \rightarrow 10C_2H_4 + H_2 \]
Under heat and catalyst, the alkane molecules are cracked into smaller ones which are more useful.

<table>
<thead>
<tr>
<th>11 (a)(i) Halogens</th>
</tr>
</thead>
<tbody>
<tr>
<td>(ii) Experiment 1: reddish-brown solution decolourises and purple/black solid seen formed. Br$\textsubscript{2}$ (aq) + 2KI (aq) → 2KBr (aq) + I$\textsubscript{2}$ (s)</td>
</tr>
<tr>
<td>Experiment 2: reddish-brown solution formed. Cl$\textsubscript{2}$ (aq) + 2KBr (aq) → 2KCl (aq) + Br$\textsubscript{2}$ (l)</td>
</tr>
<tr>
<td>Experiment 3: No reaction \textit{(no need state symbols for equations)}</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>11 (b)(i) hydrochloric acid and magnesium/ magnesium carbonate/ magnesium oxide/ magnesium hydroxide</th>
</tr>
</thead>
<tbody>
<tr>
<td>(ii) Add excess magnesium/ magnesium carbonate/ magnesium oxide/ magnesium hydroxide to hydrochloric acid. Filter to remove excess magnesium/ magnesium carbonate/ magnesium oxide/ magnesium hydroxide as the residue. Heat filtrate to obtain a saturated solution of magnesium chloride. Cool to form crystals of magnesium chloride. Dry magnesium chloride crystals in between 2 pieces of filter papers.</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

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CHANGKAT CHANGI SECONDARY SCHOOL

Preliminary Examination 2019

Subject : Science (Chemistry)
Paper No : 5078/01
           5076/01
Level : Secondary 4 Express/
       Secondary 5 Normal Academic
Date : 04 September 2019
Duration : 1 hour
Setter : Ms Marie Lee

INSTRUCTIONS TO CANDIDATES
Do not open this booklet until you are told to do so.
Write your name, class and register number in the spaces at the top of this page.

MULTIPLE CHOICE QUESTIONS [ 40 MARKS ]
Answer all questions. For each question, there are four possible answers A, B, C and D. Choose one correct answer and shade the correct answer in soft pencil on the OTAS provided.

A copy of the Periodic Table can be found on page 9.

<table>
<thead>
<tr>
<th>For Examiners' Use</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper 1</td>
<td>/ 40</td>
</tr>
<tr>
<td>Personal Target</td>
<td>Actual Grade</td>
</tr>
<tr>
<td>Parent’s / Guardian’s signature</td>
<td></td>
</tr>
</tbody>
</table>

[ Turn over

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MULTIPLE CHOICE QUESTIONS (40 marks)

1. A student measures 2.0 g of calcium carbonate and adds it to 20 cm³ of dilute hydrochloric acid at different temperatures. He measures the time taken for the reaction to stop. Which of the following apparatus is needed for the experiment?

<table>
<thead>
<tr>
<th>electronic balance</th>
<th>stopwatch</th>
<th>filter funnel</th>
<th>measuring cylinder</th>
<th>thermometer</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>B</td>
<td>✓</td>
<td>×</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>C</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>D</td>
<td>×</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

2. Which changes occur when a liquid at 50°C becomes a gas at 120°C?

<table>
<thead>
<tr>
<th>attractive forces between particles</th>
<th>separation of particles</th>
<th>energy of particles</th>
</tr>
</thead>
<tbody>
<tr>
<td>A decrease</td>
<td>decreases</td>
<td>increases</td>
</tr>
<tr>
<td>B decreases</td>
<td>increases</td>
<td>increases</td>
</tr>
<tr>
<td>C increases</td>
<td>decreases</td>
<td>decreases</td>
</tr>
<tr>
<td>D increases</td>
<td>increases</td>
<td>decreases</td>
</tr>
</tbody>
</table>

3. Which diagram represents the arrangement of particles in a gas?

A

B

C

D

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4. A beaker contains a mixture of ethanol and water. Which method could be used to separate the mixture of ethanol and water and the corresponding purity check for the separated ethanol?

<table>
<thead>
<tr>
<th>method of separation</th>
<th>purity check</th>
</tr>
</thead>
<tbody>
<tr>
<td>A filtration</td>
<td>observe the colour and scent</td>
</tr>
<tr>
<td>B fractional distillation</td>
<td>observe the colour and scent</td>
</tr>
<tr>
<td>C fractional distillation</td>
<td>measure the boiling point</td>
</tr>
<tr>
<td>D simple distillation</td>
<td>measure the boiling point</td>
</tr>
</tbody>
</table>

5. The diagram shows the result of a chromatogram obtained from two mixtures, X and Y.

Which of the substance(s) is/are present in mixture X but not in mixture Y?

A. Q and S only  
B. R and T only  
C. S only  
D. T only

6. Which statement(s) about isotopes of the same element is/are correct?

I. They are atoms which have the same chemical properties because they have the same number of electrons in their outer shell.

II. They are atoms which have the same number of electrons and neutrons but different number of protons.

III. They are atoms which have the same number of electrons and protons but different number of neutrons.

A. I and II  
B. I and III  
C. II only  
D. III only
7. Which diagram shows a positively-charged ion?

A

B

C

D

8. When substance X and substance Y are heated together, substance Z is produced. The chemical equation of the reaction is as follows:

\[ X + Y \rightarrow 2Z \]

A molecule of Z has the following structure:

Which of the following statements is true about X, Y and Z?

A. X can be either an element or compound.
B. Z is a mixture of X and Y.
C. Z is an ionic compound with chemical formula \( X_2Y_2 \).
D. Z has similar chemical properties as compared to X and Y.

9. When sodium is added to water, a gas is produced. Which of the following is true when potassium is added to water instead?

A. No gas is produced.
B. The reaction is slower.
C. More energy is given out.
D. A smaller volume of gas is produced compared to gas produced for sodium.

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10 When copper (II) nitrate is heated, it decomposes to form copper (II) oxide, nitrogen dioxide gas and oxygen gas. The chemical equation of the decomposition of copper (II) nitrate is as follows:

$$2\text{Cu(NO}_3\text{)}_2 (s) \rightarrow 2\text{CuO}(s) + 4\text{NO}_2(g) + \text{O}_2(g)$$

What is the mass of copper (II) nitrate that has decomposed if 4.0g of copper (II) oxide is produced?

A 12.6 g  
B 9.4 g  
C 18.8 g  
D 6.3 g

11 Many countries have taken measures to ensure that the amount of sulfur in unleaded petrol and diesel fuels are kept low.

Which of the following could be the reason for such measures?

A To reduce the amount of fuel used in motor vehicles.  
B To increase the acidity of the rain.  
C To reduce incomplete combustion.  
D To prevent the pH of soil from decreasing.

12 Fresh distilled water has a pH value of 7.0. However after it was left standing in the open for a short time, the pH was observed to drop below 7.0.

Which of the following ions caused the drop in pH value?

A ammonium ion, $\text{NH}_4^+$  
B chloride ion, $\text{Cl}^-$  
C hydrogen ion, $\text{H}^+$  
D hydroxide ion, $\text{OH}^-$
13 Lead (II) carbonate reacts with both nitric acid and sulfuric acid. In what ways are the two reactions the same?

I Water is formed.
II A gas is produced.
III A white precipitate is obtained.

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

14 Excess calcium carbonate was added into 100 cm$^3$ of 1.0 mol/dm$^3$ of hydrochloric acid. The curve $Y$ represents the results obtained when the volume of gas collected was plotted against time.

The experiment was repeated using different volumes and concentrations of hydrochloric acid. Which change could produce curve $Z$?

A 50 cm$^3$ of 1.0 mol/dm$^3$ hydrochloric acid
B 25 cm$^3$ of 1.0 mol/dm$^3$ hydrochloric acid
C 50 cm$^3$ of 2.0 mol/dm$^3$ hydrochloric acid
D 25 cm$^3$ of 2.0 mol/dm$^3$ hydrochloric acid
Experiment | X | Y | Z
---|---|---|---
Does the metal liberate hydrogen from dilute hydrochloric acid? | yes | no | yes
Is the metal oxide reduced by heating with carbon? | yes | yes | no

| most reactive | least reactive |
---|---|
A | X | Z | Y |
B | Y | X | Z |
C | Z | X | Y |
D | Z | Y | X |

16 The chart below shows four iron plates under different conditions.

| plate 1 | plate 2 |
---|---|
Exposed to moisture only, wrapped with a copper foil | Exposed to air and moisture, kept in a beaker with a drying agent.

| plate 3 | plate 4 |
---|---|
Exposed to air and moisture beside a solution of sodium chloride. | Exposed to moisture, kept in an air-tight jar.

Which of these plates will corrode the fastest?

A. plate 1
B. plate 2
C. plate 3
D. plate 4
The table below shows information about the exhaust fumes produced from car engines that run on petrol and diesel respectively.

<table>
<thead>
<tr>
<th>Type of engine</th>
<th>Concentration of carbon monoxide present</th>
<th>Concentration of nitrogen oxides present</th>
<th>Concentration of sulfur dioxide present</th>
</tr>
</thead>
<tbody>
<tr>
<td>petrol engine</td>
<td>high</td>
<td>low</td>
<td>low</td>
</tr>
<tr>
<td>diesel engine</td>
<td>low</td>
<td>high</td>
<td>high</td>
</tr>
</tbody>
</table>

Which statement can be inferred using the data in the table?

A Burning petrol contributes less towards the formation of acid rain.
B Burning petrol generates more heat in the combustion engine.
C Cars running on diesel produce fumes that are less sooty.
D Cars running on diesel do not contribute to air pollution.

Which of the processes is different from the others in terms of energy changes?

A forming of bonds
B combustion
C neutralisation
D photosynthesis

The diagram shows the structure of a polymer.

Which monomer is used to manufacture the polymer?
Which of the following is true of the oxidation of ethanol?

A  Carbon dioxide is produced.
B  It can also be used in the detection of alcohol content in drivers.
C  There is a decrease in the oxidation states of the elements in ethanol.
D  The product has the functional group \(-\text{C}=\text{O}\).

--End of Paper--
The Periodic Table of Elements

<table>
<thead>
<tr>
<th>Group</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
<th>VII</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Key</td>
<td>proton (atomic) number</td>
<td>atomic symbol</td>
<td>name</td>
<td>relative atomic mass</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Li</td>
<td>4 Be</td>
<td>5 B</td>
<td>6 C</td>
<td>7 N</td>
<td>8 O</td>
<td>9 F</td>
<td>10 Ne</td>
<td>2 He</td>
</tr>
<tr>
<td></td>
<td>7 Li</td>
<td>9 Be</td>
<td>11 B</td>
<td>12 C</td>
<td>14 N</td>
<td>16 O</td>
<td>19 F</td>
<td>10 Ne</td>
</tr>
<tr>
<td>11 Na</td>
<td>12 Mg</td>
<td>13 Al</td>
<td>14 Si</td>
<td>15 P</td>
<td>16 S</td>
<td>17 Cl</td>
<td>18 Ar</td>
<td>4 He</td>
</tr>
<tr>
<td>23 K</td>
<td>24 Ca</td>
<td>25 Sc</td>
<td>26 Ti</td>
<td>27 V</td>
<td>28 Cr</td>
<td>29 Mn</td>
<td>30 Fe</td>
<td>31 Co</td>
</tr>
<tr>
<td>39 K</td>
<td>40 Ca</td>
<td>41 Sc</td>
<td>42 Ti</td>
<td>43 V</td>
<td>44 Cr</td>
<td>45 Mn</td>
<td>46 Fe</td>
<td>47 Co</td>
</tr>
<tr>
<td>55 Cs</td>
<td>56 Ba</td>
<td>57 Fr</td>
<td>58 Ra</td>
<td>59 Ac</td>
<td>60 Pa</td>
<td>61 U</td>
<td>62 Np</td>
<td>63 Pu</td>
</tr>
<tr>
<td>133 La</td>
<td>134 Ce</td>
<td>135 Pr</td>
<td>136 Nd</td>
<td>137 Pm</td>
<td>138 Sm</td>
<td>139 Eu</td>
<td>140 Gd</td>
<td>141 Tb</td>
</tr>
<tr>
<td>157 Dy</td>
<td>158 Ho</td>
<td>159 Er</td>
<td>160 Tm</td>
<td>161 Yb</td>
<td>162 Lu</td>
<td>163 Hf</td>
<td>164 Ta</td>
<td>165 W</td>
</tr>
<tr>
<td>178 Np</td>
<td>179 U</td>
<td>180 Pu</td>
<td>181 Am</td>
<td>182 Cm</td>
<td>183 Bk</td>
<td>184 Cf</td>
<td>185 Es</td>
<td>186 Fm</td>
</tr>
<tr>
<td>232 Ac</td>
<td>233 Th</td>
<td>234 Pa</td>
<td>235 U</td>
<td>236 Np</td>
<td>237 Pu</td>
<td>238 Am</td>
<td>239 Cm</td>
<td>240 Bk</td>
</tr>
</tbody>
</table>

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).
Candidate Name

CHANGKAT CHANGI SECONDARY SCHOOL

Preliminary Examination 2019

Subject : Science (Chemistry)
Paper No : 5076/03, 5078/03
Level : Secondary 4 Express/ 5 Normal Academic
Date : 30 August 2019
Duration : 1 hour 15 mins
Setter : Ms Marie Lee

INSTRUCTIONS TO CANDIDATES
Do not open this booklet until you are told to do so.
Write your name, class and register number in the spaces at the top of this page.

Section A [ 45 MARKS ]
Answer all questions. Write your answers in the spaces provided on the question paper.

Section B [ 20 MARKS ]
Answer any two questions. Write your answers in the spaces provided on the question paper.

A copy of the Periodic Table can be found on page 12.

For Examiners’ Use

<table>
<thead>
<tr>
<th></th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section A</td>
<td>/ 45</td>
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<tr>
<td>Section B</td>
<td></td>
</tr>
<tr>
<td></td>
<td>/ 10</td>
</tr>
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<td>/ 10</td>
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<td>/ 65</td>
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</tr>
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<td>Actual Grade</td>
<td></td>
</tr>
<tr>
<td>Parent’s / Guardian’s signature</td>
<td></td>
</tr>
</tbody>
</table>

This Question Paper consists of 12 printed pages.

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Section A [45 marks]
Answer all the questions in this section in the spaces provided.

1. Table 1.1 shows some information about six particles.

<table>
<thead>
<tr>
<th>Particle</th>
<th>Number of protons in particle</th>
<th>Number of neutrons in particle</th>
<th>Number of electrons in particle</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>37</td>
<td>48</td>
<td>37</td>
</tr>
<tr>
<td>B</td>
<td>53</td>
<td>74</td>
<td>54</td>
</tr>
<tr>
<td>C</td>
<td>92</td>
<td>143</td>
<td>92</td>
</tr>
<tr>
<td>D</td>
<td>92</td>
<td>143</td>
<td>89</td>
</tr>
<tr>
<td>E</td>
<td>92</td>
<td>146</td>
<td>92</td>
</tr>
<tr>
<td>F</td>
<td>94</td>
<td>150</td>
<td>92</td>
</tr>
</tbody>
</table>

(a) What is the nucleon number for particle A?

(b) Explain why particle B is a negative ion.

c) Which two atoms are isotopes of the same element?

2. Magnesium reacts with sulfur to form the compound, magnesium sulfide.

(a) Suggest two physical properties of magnesium sulfide.

(b) Explain, in terms of electrons, how a magnesium atom reacts with a sulfur atom to make a magnesium ion and a sulfide ion.
3 When solutions are mixed, precipitates are sometimes formed.

(a) Barium carbonate is an insoluble compound. It is formed as a precipitate when solutions of barium chloride and sodium carbonate are mixed.

When solutions of potassium chloride and sodium sulfate are mixed, no precipitate is formed.

Complete Table 3.1 to show the colour and name of the precipitates formed from mixing solutions of some compounds, if any.

<table>
<thead>
<tr>
<th></th>
<th>sodium carbonate solution</th>
<th>sodium sulfate solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barium chloride solution</td>
<td>white precipitate of barium carbonate</td>
<td></td>
</tr>
<tr>
<td>Calcium chloride solution</td>
<td></td>
<td>white precipitate of calcium sulfate</td>
</tr>
<tr>
<td>Potassium chloride solution</td>
<td>no precipitate</td>
<td></td>
</tr>
</tbody>
</table>

(b) When solutions of lead (II) nitrate and potassium bromide are mixed, a precipitate of lead(II) bromide and a solution of potassium nitrate are produced.

The equation for the reaction is

$$\text{Pb(NO}_3\text{)}_2 (\text{aq}) + \text{KBr (aq)} \rightarrow \text{PbBr}_2 (\text{s}) + \text{KNO}_3 (\text{aq})$$

Complete the equation with the correct numbers and state symbols.

(c) In order to prepare a pure, dry sample of lead (II) bromide, a student carried out the following steps:

Steps:
- The mixture was filtered,
- The residue was washed with distilled water, and
- The solid was left in a warm place for several hours.

(i) Explain why the student filtered the mixture.

........................................................................................................................................................................
...........................................................................................................................................................................
(ii) Explain why the student washed the residue.

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

4 A sample of 25.0 cm$^3$ of 0.500 mol/dm$^3$ of aqueous ammonium nitrite, NH$_4$NO$_2$, is heated and nitrogen gas is produced as shown below.

\[
\text{NH}_4\text{NO}_2(aq) \rightarrow \text{N}_2(g) + 2\text{H}_2\text{O}(l)
\]

(a) Describe how you could show that aqueous ammonium nitrite contains ammonium ions.

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

(b) (i) Calculate the number of moles of ammonium nitrite in 25.0 cm$^3$ of 0.500 mol/dm$^3$ in its aqueous solution.

…………………………... moles [1]

(ii) A sample of 25.0 cm$^3$ of 0.500 mol/dm$^3$ aqueous ammonium nitrite is heated and nitrogen gas is produced accordingly to the chemical equation given above. Calculate the volume of nitrogen gas formed, measured at room temperature and pressure.

volume of nitrogen gas = …………………... [2]
(iii) Calculate the relative molecular mass of ammonium nitrite and hence calculate the concentration of 0.500 mol/ dm³ ammonium nitrite solution in g/ dm³.

Relative molecular mass of ammonium nitrite is …………………… [1]
Concentration of ammonium nitrite is ……………………….. g/ dm³ [1]

(c) (i) State two chemicals that can be used to produce aqueous ammonium nitrite.

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

(ii) State the preparation method that can be used to produce ammonium nitrite salt.

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

(d) (i) Ammonium nitrate, NH₄NO₃, decomposes when heated, in a similar way to ammonium nitrite, with water as one of the two products. Write a balanced chemical equation for this reaction.

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

(ii) Describe a chemical test for nitrate ion and state the results with ammonium nitrate.

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

results with ammonium nitrate
......................................................................................................................... [1]
Fluorine, chlorine, bromine and iodine are halogens in Group VII of the Periodic Table.

(a) With reference to the atomic structure, explain why fluorine, chlorine, bromine and iodine are in Group VII of the Periodic Table.

(b) With reference to the atomic structure, describe and explain the trend in the reactivity of the elements in Group VII as it goes down the group.

Fig 6.1 shows a sequence of reactions involving elements from Group VII.

(a) Identify the following:

W ........................................
X ........................................
Y ........................................
Z ........................................

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(b) Write a chemical equation, including state symbols, for the reaction between salt solution $Y$ and chlorine gas.

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

7 Haematite, a common ore used for the extraction of iron, contains the compound, iron(III) oxide. Iron is produced in the blast furnace by heating a mixture of iron(III) oxide, coke and limestone with air. Fig. 7.1 gives the outline of a blast furnace in which iron is extracted from its ore.

![Diagram of a blast furnace](image)

Fig 7.1

(a) Describe how carbon dioxide is produced under high heat in the blast furnace.

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

(b) The chemical equation for the production of iron in the blast furnace is shown.

$$\text{Fe}_2\text{O}_3 (s) + 3\text{CO (g)} \rightarrow 2\text{Fe (l)} + 3\text{CO}_2 (g)$$

(i) State the oxidation state of iron in $\text{Fe}_2\text{O}_3$.

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

[ Turn over

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(ii) Explain, in terms of oxidation state, whether iron (III) oxide is oxidised or reduced.
........................................................................................................................................... [2]

(c) State a reason for the presence of nitrogen gas in the blast furnace.
........................................................................................................................................... [1]

8 Cinnamic acid is found in plants called balsams. The structure of cinnamic acid is shown below.

(a) Cinnamic acid is an unsaturated compound.
What is meant by the term “unsaturated”?
........................................................................................................................................... [1]

(b) Describe a chemical test to show that cinnamic acid is unsaturated.
chemical test
........................................................................................................................................... [1]
result with cinnamic acid
........................................................................................................................................... [1]
Section B [20 marks]
Answer any two questions in this section. Write your answers in the spaces provided.

9 (a) Aqueous iron (II) sulfate can react with magnesium metal but not copper.

(i) Explain why copper is unable to react with aqueous iron (II) sulfate.

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

(ii) Write the ionic equation for the reaction between aqueous iron (II) sulfate and magnesium.

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

(iii) Explain two observations that can be made when magnesium reacts with aqueous iron (II) sulfate.

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

(b) When acidified potassium manganate (VII) was added to aqueous iron (II) sulfate, aqueous iron (III) sulfate was formed.

State the observation for this reaction.
........................................................................................................................................................................... [1]

(c) Describe how a student can confirm the presence of iron (II) and sulfate ions in the solution.

iron (II) ion: ..................................................................................................................................................
...........................................................................................................................................................................

sulfate ion: ..................................................................................................................................................
........................................................................................................................................................................... [2]

(d) Comment on the electrical conductivity of aqueous iron (II) sulfate, giving a reason for your answer.

...........................................................................................................................................................................
........................................................................................................................................................................... [2]
Air is a mixture of gases which consists of nitrogen, oxygen, carbon dioxide and a small percentage of argon, water vapour and other gases.

(i) Classify the gases in air by writing the chemical formula of any two elements and two compounds in Table 10.1 below.

<table>
<thead>
<tr>
<th>Chemical formulae of two elements found in air</th>
<th>Chemical formulae of two compounds found in air</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(ii) Describe two differences between elements and compounds.

(iii) In another similar experiment, the total volume of air in the apparatus before heating is 150 cm³. At the end of the experiment, the volume of gas remaining is 125 cm³.

Use this information to calculate the percentage of oxygen in this sample of air.

Other than clear air, the atmosphere also contains a large number of pollutants including sulfur dioxide, oxides of nitrogen, methane and chlorofluorocarbons (CFCs).

Carbon dioxide, methane and CFCs are greenhouse gases.

(i) Explain one effect of an increase in the atmospheric concentration of carbon monoxide.

(ii) Other than the production of carbon monoxide gas in the blast furnace, state one source of this gas and explain why it is produced.
Alcohols form a homologous series.

(a) State two general properties of a homologous series.

(b) X is an alcohol containing two carbon atoms in its molecule.

(i) Complete Table 11.1 by naming, drawing the full structural formula and stating the chemical formula of X.

<table>
<thead>
<tr>
<th>Name of X</th>
<th>Structural formula of X</th>
<th>Chemical formula of X</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(ii) State the chemical equation for the reaction between X and atmospheric oxygen.

(iii) A solution of X can be made by fermentation of glucose. Describe how this process is completed in the laboratory, using appropriate apparatus.

(iv) X is commonly used in Brazil as a fuel for vehicles. Suggest a reason why X can be used for this purpose.

--End of Paper--
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CCSS: 2019 Sec 4 and 5 Preliminary Examinations 2019

Paper 1

<table>
<thead>
<tr>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>Q5</th>
<th>Q6</th>
<th>Q7</th>
<th>Q8</th>
<th>Q9</th>
<th>Q10</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>B</td>
<td>A</td>
<td>C</td>
<td>C</td>
<td>B</td>
<td>A</td>
<td>A</td>
<td>C</td>
<td>B</td>
</tr>
<tr>
<td>Q11</td>
<td>Q12</td>
<td>Q13</td>
<td>Q14</td>
<td>Q15</td>
<td>Q16</td>
<td>Q17</td>
<td>Q18</td>
<td>Q19</td>
<td>Q20</td>
</tr>
<tr>
<td>D</td>
<td>C</td>
<td>C</td>
<td>D</td>
<td>C</td>
<td>C</td>
<td>A</td>
<td>D</td>
<td>B</td>
<td>B</td>
</tr>
</tbody>
</table>

Paper 3

Section A

<table>
<thead>
<tr>
<th>1</th>
<th>(a)</th>
<th>85</th>
</tr>
</thead>
<tbody>
<tr>
<td>(b)</td>
<td>Particle B is in Group VII which is a non-metal, which takes in one electron to form negative ions with noble gas structure.</td>
<td>1</td>
</tr>
<tr>
<td>(c)</td>
<td>C and E</td>
<td>1</td>
</tr>
</tbody>
</table>

2 (a) Magnesium sulfide has a high melting and boiling point/ able to conduct electricity in molten and aqueous state/ soluble in water, insoluble in organic solvents. | 2 |
(Any of the 2 above)

(b) Magnesium atom will give out two electrons to form a positive magnesium ion. [1]
Sulfur atom will take in two electrons to form a negative sulfide ion to obtain a noble gas structure. [1]

<table>
<thead>
<tr>
<th>3</th>
<th></th>
<th>sodium carbonate solution</th>
<th>sodium sulfate solution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Barium chloride solution</td>
<td>white precipitate of barium carbonate</td>
<td>white precipitate of barium sulfate</td>
</tr>
<tr>
<td></td>
<td>Calcium chloride solution</td>
<td>white precipitate of calcium carbonate</td>
<td>white precipitate of calcium sulfate</td>
</tr>
<tr>
<td>Potassium chloride solution</td>
<td>No precipitate</td>
<td>No precipitate</td>
<td></td>
</tr>
<tr>
<td>(b) 1 Pb(NO₃)₂ (aq) + 2 KBr (aq) → PbBr₂ (s) + 2KNO₃ (aq)</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[1] For balanced chemical equation</td>
<td>[1] For correct state symbols</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(c) (i) To remove potassium nitrate solution from lead (II) bromide. | 1 |
(ii) To wash away any potassium nitrate or impurities that may still remain on lead(II) bromide. | 1 |

4 (a) Add sodium hydroxide and warm. If the gas produced turns moist red litmus blue, ammonia gas is produced. Therefore, ammonium ions are present in ammonium nitrite. | 2 |
(b) (i) \( \frac{25}{1000} \times 0.500 = 0.0125 \) moles [1]

(b) (ii) \( \text{NH}_4\text{NO}_3 \Rightarrow \text{N}_2 \text{ (g)} + 2\text{H}_2\text{O (l)} \)

1 mole \[x\] mole

\[
\begin{align*}
1 \text{ mol} & = 24 \text{ dm}^3 \\
0.0125 \text{ mol} & \times \text{ dm}^3 \\
x & = 0.3 \text{ dm}^3
\end{align*}
\]
Volume of nitrogen = 0.300 dm\(^3\) (3 sf) (No units, no marks) [1]

(b) (iii) Relative molecular mass of \( \text{NH}_4\text{NO}_3 \)

\[
= 14 + 4 + 14 + 32 = 64
\]

Concentration = \( 64 \times 0.500 = 32\text{/dm}^3 \) [1]

*Working must be shown for the marks to be awarded.* [1]

(c) (i) Ammonium hydroxide and nitric acid [1]

(ii) Titration method [1]

(d) (i) \( \text{NH}_4\text{NO}_3 \Rightarrow \text{N}_2\text{O} + 2\text{H}_2\text{O} \) [1]

(ii) Add sodium hydroxide, aluminium foil to the solution. Warm gently.

Warm gently. [1]

If gas produced turns moist red litmus paper blue, ammonia gas is produced. Nitrate ion is present. [1] [2]

5 (a) They have seven valence electrons. [1]

(b) As the elements goes down the group, the reactivity of the elements decreases. [1]

As the elements goes down the group, the atomic size of the element becomes bigger. [1]

Therefore, there is less tendency for the nucleus to gain or attract electrons to form negative ions. [1] [3]

6 (a) W: Silver, Ag
X: Silver iodide, AgI
Y: Sodium iodide, NaI

(b) \( 2 \text{NaI (aq)} + \text{Cl}_2(g) \Rightarrow 2 \text{NaCl(aq)} + \text{I}_2 (aq) \) [2]

[1]: Balanced chemical equations

[1]: Correct state symbols

7 (a) Carbon dioxide is formed when coke is burnt in hot air [1]
and when limestone is decomposed at high temperature. [1] [2]
\[
\text{Fe}_2\text{O}_3 + 3\text{CO} \Rightarrow 2\text{Fe} + 3\text{CO}_2
\]

(b) (i) +3 [1]

(ii) The oxidation state of iron has decreased and thus, it is reduced. [1]

The oxidation state of iron has decreased from +3 in iron (III) oxide to
Section B

9 (a) (i) Copper is less reactive than iron and loses electrons less readily. [1]
Therefore, copper is unable to react and displace iron from aqueous iron(II) sulfate. [1] [2]
(ii) $Mg(s) + Fe^{2+}(aq) \rightarrow Mg^{2+}(aq) + Fe(s)$ [1]
(iii) Green solution fades and might turn colourless. [1]
Grey solid deposits formed. [1]
Magnesium dissolves and becomes smaller in size. [1]
(Any two) [2]

(b) Purple acidified potassium manganate(VII) solution turns colourless / decolourises. [1]

(c) Add aqueous sodium hydroxide to the solution.
Green precipitate formed if Fe$^{2+}$ ions are present. [1]
Add dilute nitric acid, followed by aqueous barium nitrate to the solution
White precipitate formed if SO$_4^{2-}$ ions are present. [1] [2]

(d) Aqueous iron(II) sulfate can conduct electricity [1]
due to the presence of free mobile ions (Fe$^{2+}$ and SO$_4^{2-}$) to carry charges. [1] [2]

10 (a) (i) Chemical formula of two elements found in air
Chemical formula of two compounds found in air
$N_2$, $O_2$, Ar, Ne
(Any two)
$CO_2$, $H_2O$ [2]

(ii) A compound is made up of two or more different elements chemically combined but an element is made up of only one type of atoms. [1]
A compound can only be broken down into simpler type of matter by chemical means but elements cannot be broken down into simpler matter by physical or chemical means. [1]

(iii) $150-125 = 25cm^3$ [1]
$(25/150) \times 100 = 16.7\%$ [1] [2]
(b) (i) Carbon monoxide will bind more strongly with haemoglobin [1] than oxygen preventing the oxygen from being absorb to the body which causes death. [1]

(ii) In the car engine when the fuel undergoes incomplete combustion [1] because of insufficient supply of oxygen, [1] carbon monoxide is produced. [2]

11 (a) (i) Members of the same homologous series have similar chemical properties [1]
The members display a gradual change in their physical properties as the number of carbon atoms increases in their molecules. [1]

(ii) \( C_{n}H_{2n+1}OH \) [1]

(b) (i) | Name of X | Structural formula of X | Chemical formula of X |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ethanol</td>
<td><img src="image" alt="ethanol structure" /></td>
<td>( C_{2}H_{5}OH )</td>
</tr>
</tbody>
</table>

(ii) \( CH_{3}CH_{2}OH (l) + 2[O] \rightarrow CH_{3}COOH (aq) + H_{2}O (l) \) [1]

(iii) Yeast is added to a solution of glucose in a conical flask. [1]

Temperature of the mixture is kept at 37°C [1]
The conical flask is connected through a delivery tube to a test tube with limewater to prevent oxygen in air from entering the conical flask. [1]

(iv) \( X \) can be burnt \text{exothermically} to produce heat to power the vehicles. [1]
READ THESE INSTRUCTIONS FIRST

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

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

Read the instructions on the answer sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 10.
The use of an approved scientific calculator is expected, where appropriate.

Setter: Mdm Yogeswari
21 Bromine is a liquid at 20 °C.

What is the melting point and boiling point for bromine?

<table>
<thead>
<tr>
<th></th>
<th>melting point/ °C</th>
<th>boiling point/°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>-22</td>
<td>-3</td>
</tr>
<tr>
<td>B</td>
<td>-8</td>
<td>-33</td>
</tr>
<tr>
<td>C</td>
<td>-7</td>
<td>59</td>
</tr>
<tr>
<td>D</td>
<td>25</td>
<td>103</td>
</tr>
</tbody>
</table>

22 A label is missing from a bottle of colourless solution Q.

In order to identify the solution two chemical tests are carried out.

  test 1: When magnesium is added to solution Q, bubbles of colourless gas is given off which extinguishes a lighted splint with a pop sound.
  test 2: 1 cm³ of nitric acid is added to another sample of Q. The a few drops of silver nitrate solution is added. A white precipitate is formed.

What is Q?
A calcium hydroxide
B hydrochloric acid
C iron(II) carbonate
D zinc(II) hydroxide

23 An element Y has two isotopes, $^{238}\text{Y}$ and $^{235}\text{Y}$.

How does $^{238}\text{Y}$ differ from $^{235}\text{Y}$?

A It has 3 more neutrons and 3 more electrons.
B It has 3 more neutrons.
C It has 3 more protons and 3 more electrons.
D It has 3 more protons.
24 Substance X contains one of the three substances P, R or S.

Two chromatograms of the four substances were obtained using different solvents. The diagram below shows the results obtained.

What does X contain?

A P only
B R only
C either P or R
D either R or S

25 Which of the following changes will result in the particles moving at a higher speed?

A $\text{Br}_2 (g) \rightarrow \text{Br}_2 (l)$
B $\text{I}_2 (g) \rightarrow \text{I}_2 (s)$
C $\text{H}_2\text{O} (l) \rightarrow \text{H}_2\text{O} (s)$
D $\text{CO}_2 (s) \rightarrow \text{CO}_2 (g)$
26 The diagrams below show atoms of different elements represented by \( \square \), \( \bigcirc \) and \( \bullet \).

![Diagrams I, II, III, IV]

Which diagram shows a pure compound and a mixture of elements respectively?

<table>
<thead>
<tr>
<th></th>
<th>pure compound</th>
<th>mixture of elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>III</td>
<td>I</td>
</tr>
<tr>
<td>B</td>
<td>III</td>
<td>II</td>
</tr>
<tr>
<td>C</td>
<td>IV</td>
<td>I</td>
</tr>
<tr>
<td>D</td>
<td>IV</td>
<td>II</td>
</tr>
</tbody>
</table>

27 A newly discovered element, Xylonium (Xy), is placed in Group II of the Periodic Table. Which is the correct chemical formula for its sulfate?

A \( \text{Xy}_2\text{SO}_4 \)
B \( \text{Xy}(\text{SO}_4)_2 \)
C \( \text{Xy}_2(\text{SO}_4)_2 \)
D \( \text{XySO}_4 \)

28 The table below shows the melting point and the electrical conductivity when in molten state and in solid state of substances A, B, C and D.

Which substance best represents a compound formed between a metal and non-metal?

<table>
<thead>
<tr>
<th></th>
<th>melting point</th>
<th>conducts electricity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>when in solid state</td>
</tr>
<tr>
<td>A</td>
<td>Low</td>
<td>Good</td>
</tr>
<tr>
<td>B</td>
<td>High</td>
<td>Poor</td>
</tr>
<tr>
<td>C</td>
<td>Low</td>
<td>Poor</td>
</tr>
<tr>
<td>D</td>
<td>High</td>
<td>Poor</td>
</tr>
</tbody>
</table>
29  Ethane burns completely in oxygen as shown in the equation.

\[ 2C_2H_6 (g) + 7O_2 (g) \rightarrow 4CO_2 (g) + 6H_2O (l) \]

If 15 cm\(^3\) of ethane is burnt in excess oxygen, calculate the volume of the carbon dioxide obtained at the end of the reaction, measured at room temperature and pressure.

A  20.0 cm\(^3\)  
B  30.0 cm\(^3\)  
C  40.0 cm\(^3\)  
D  50.0 cm\(^3\) 

30  The reaction between hydrochloric acid and magnesium is shown.

\[ 2HCl + Mg \rightarrow MgCl_2 + H_2 \]

Which volume of 1.0 mol/dm\(^3\) hydrochloric acid is needed to react completely with 2.4 g of magnesium?

A  10 cm\(^3\)  
B  20 cm\(^3\)  
C  100 cm\(^3\)  
D  200 cm\(^3\) 

31  The following equation shows the reaction of zinc sulfide forming zinc and sulfur in the extraction of zinc from its ore.

\[ ZnS \rightarrow Zn + S \]

Which statement about this reaction is correct?

A  Zinc gains electrons to form zinc ions.  
B  Zinc loses electrons to form zinc ions.  
C  Zinc ions gain electrons to form zinc atoms.  
D  Zinc ions lose electrons to form zinc atoms.
32 Which oxide reacts with both acids and alkalis?
A carbon monoxide
B sulfur dioxide
C lead(II) oxide
D calcium oxide

33 Which element can only be extracted by electrolysis?
A lead
B silver
C sodium
D zinc

34 Which process is exothermic?
A burning petrol in a car engine
B cracking of petroleum fractions
C fractional distillation of petroleum
D melting bitumen for roads
The air taken from a newly discovered planet contains the following gases.

<table>
<thead>
<tr>
<th>gas</th>
<th>concentration (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>carbon dioxide</td>
<td>20</td>
</tr>
<tr>
<td>hydrogen</td>
<td>40</td>
</tr>
<tr>
<td>ammonia</td>
<td>10</td>
</tr>
<tr>
<td>oxygen</td>
<td>30</td>
</tr>
</tbody>
</table>

The apparatus below was set up with a 100 cm³ sample of the air taken from the planet in the graduated tube. The volume of the sample was measured at regular time intervals until no further change in volume took place.

What is the volume of gas left in the tube?

A  20 cm³  
B  30 cm³  
C  70 cm³  
D  80 cm³  

Substance Y turns a solution of acidified potassium manganate (VII) from purple to colourless.

What must solution Y contain?

A  an alkali  
B  an ammonium salt  
C  a reducing agent  
D  an oxidising agent
Some metals will react with the solutions of the salts of another metal. The following ionic equations illustrate the reactions of metals copper, iron, zinc and Y.

\[
\begin{align*}
Cu + Y^{2+} & \rightarrow \text{no reaction} \\
Fe + Cu^{2+} & \rightarrow Fe^{2+} + Cu \\
Y + Zn^{2+} & \rightarrow Y^{2+} + Zn \\
Zn + Cu^{2+} & \rightarrow Zn^{2+} + Cu \\
Zn + Fe^{2+} & \rightarrow Zn^{2+} + Fe \\
Zn + Y^{2+} & \rightarrow \text{no reaction}
\end{align*}
\]

From the ionic equations, deduce the correct order of reactivity of the metals.

<table>
<thead>
<tr>
<th>most reactive</th>
<th></th>
<th>least reactive</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Cu, Fe, Zn, Y</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Y, Fe, Zn, Cu</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Y, Zn, Fe, Cu</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Zn, Y, Cu, Fe</td>
<td></td>
</tr>
</tbody>
</table>

38 Which compound is unsaturated and reacts with sodium carbonate?
Calcium carbonate is placed in a flask on weighing balance and dilute hydrochloric acid is added. The total mass of the flask and its content is recorded every 200 seconds.

At which time is the reaction the fastest?

A 100 s
B 200 s
C 400 s
D 800 s

A mixture of chlorine and excess propane was exposed to bright light. When the light was switched on, the mixture in the flask began to bubble, giving off a colourless gas.

What is the colourless gas?

A chlorine  B hydrogen
C hydrogen chloride  D propane
The volume of one mole of any gas is 24 dm$^3$ at room temperature and pressure (r.t.p.)
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, graphs, tables or rough working.
Write in dark blue or black pencil.
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 working or if you do not use appropriate units.

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

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 15.
A copy of the Periodic Table is printed on page 16.

Marks Obtained

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper 3 Sect A</td>
<td></td>
</tr>
<tr>
<td>Paper 3 Sect B</td>
<td>B</td>
</tr>
<tr>
<td>Total</td>
<td></td>
</tr>
</tbody>
</table>

Name of Setter: Mdm Yogeswari
This paper consists of 16 printed pages.
Section A (45 marks)

Answer ALL the questions in the spaces provided in this section.

1. Table 1.1 lists the number of protons, neutrons and electrons in several different particles.

<table>
<thead>
<tr>
<th>particle (not chemical symbols)</th>
<th>number of protons</th>
<th>number of neutrons</th>
<th>number of electrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>D</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>E</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>F</td>
<td>8</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>G</td>
<td>8</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>H</td>
<td>9</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

Which of the particles, C, D, E, F, G and H in Table 1.1, fit into each of the following descriptions:

(a) an atom with mass number of 18

(b) an atom with 5 electrons in its outer shell

(c) an ion of a metal

(d) atoms of isotopes of the same element

(e) a negatively charged ion

[Total: 5]
Table 2.1 gives the melting points and boiling points of Group I and Group VII elements.

<table>
<thead>
<tr>
<th></th>
<th>element</th>
<th>melting point/ °C</th>
<th>boiling point/ °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>lithium</td>
<td>180</td>
<td>1330</td>
</tr>
<tr>
<td></td>
<td>sodium</td>
<td>97.8</td>
<td>890</td>
</tr>
<tr>
<td></td>
<td>potassium</td>
<td>64</td>
<td>774</td>
</tr>
<tr>
<td>Group VII</td>
<td>chlorine</td>
<td>-101</td>
<td>-35</td>
</tr>
<tr>
<td></td>
<td>bromine</td>
<td>-7</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>iodine</td>
<td>114</td>
<td>184</td>
</tr>
</tbody>
</table>

(a) (i) The trends in melting points and boiling points for elements in Group I differ from those in Group VII. Describe the trend down each group.

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

(ii) Describe two other trends down Group VII.

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

(b) (i) All of the elements in Group VII are diatomic. Explain the meaning of diatomic.

................................................................................................................................................
................................................................................................................................................[1]
(ii) Draw a “dot and cross” diagram to show the bonding in a chlorine molecule.

Show the outer electrons only.

(c) (i) Sodium and chlorine react together to form sodium chloride.

Draw the “dot and cross” diagram to show the bonding in sodium chloride.

(ii) Explain why sodium chloride can conduct electricity in molten and aqueous state but not in solid state.

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

[Total: 11]
The boxes in Fig 3.1 contain descriptions of five different substances K, L, M, N and O.

A solid, **K**, which melts on heating to a yellow liquid that cannot be made into a simpler substance.

**Fig 3.1**

A chemical reaction takes places and heat is liberated when this white solid, **L**, is formed.

When this blue liquid, **M**, is distilled, a colourless liquid is collected.

A white solid, **N**, that can be separated into two different substances by adding water and filtering.

A colourless substance, **O**, with a fixed melting point and a fixed boiling point.

Decide whether each substance should be classified as an element, compound, mixture or either an element or compound. Show your decision by putting a tick (✓) in one box correct box for each substance in Table 3.1.

<table>
<thead>
<tr>
<th>substance</th>
<th>element</th>
<th>compound</th>
<th>mixture</th>
<th>either an element or a compound</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[5]

[Total: 5]
4 Salts can be prepared by using reactions of acids.

(a) The table shows some names and formulae of salts.

Complete the Table 4.1 by filling in the missing information.

Table 4.1

<table>
<thead>
<tr>
<th>name of salt</th>
<th>formula of salt</th>
<th>name of acid used to make the salt</th>
<th>name of the other compound used to make the salt</th>
</tr>
</thead>
<tbody>
<tr>
<td>potassium sulfate</td>
<td>K₂SO₄</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sodium chloride</td>
<td>NaCl</td>
<td>hydrochloric acid</td>
<td></td>
</tr>
<tr>
<td>magnesium nitrate</td>
<td>Mg(NO₃)₂</td>
<td>nitric acid</td>
<td></td>
</tr>
<tr>
<td>copper(II) sulfate</td>
<td></td>
<td>sulfuric acid</td>
<td>copper(II) oxide</td>
</tr>
</tbody>
</table>

(b) Write a balanced chemical equation for the reaction between copper(II) oxide and sulfuric acid.

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

(c) Describe how to obtain pure, dry crystals of copper(II) sulfate from the resulting solution in the reaction in (b).

………………………………………………………………………………………………[2]
(d) Name two salts that are prepared by precipitation.

……………………………………………… [2]
……………………………………………… [Total: 11]

5 Poisonous oxides of nitrogen and carbon monoxide are released from car exhausts and cause major pollution issues.

(a) State one harmful effect of each pollutant on human health.

(i) oxides of nitrogen

…………………………………………………………………………………………… [1]
…………………………………………………………………………………………… [Total: 1]

(ii) carbon monoxide

…………………………………………………………………………………………… [1]
…………………………………………………………………………………………… [Total: 1]

(b) The harmful gases are converted to less harmful ones before they are released from car exhausts as shown in the chemical equation below.

………CO + ……. NO → ……CO₂ + ….. N₂

(i) Balance the chemical equation above. [1]

(ii) State which substance is reduced and give the reason for your answer.

substance reduced …………………………………………………………………………[2]

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

………………………………………………………………………………………...[2]
[Total: 5]
Fig 6.1 below shows some reactions of an aqueous salt, F.

Name the substances F, G, H, J and K.

F: ........................................
G: ........................................
H: ........................................
J: ........................................
K: ........................................

[5]
[Total: 5]
The properties of a substance make it suitable for particular tasks. Complete Table 7.1 by naming a suitable substance for each task.

<table>
<thead>
<tr>
<th>task</th>
<th>substance needed.</th>
</tr>
</thead>
<tbody>
<tr>
<td>repairing road surfaces</td>
<td></td>
</tr>
<tr>
<td>lowering the acidity of the soil</td>
<td></td>
</tr>
<tr>
<td>making margarine from vegetable oils</td>
<td></td>
</tr>
</tbody>
</table>

[3]

[Total: 3]
Section B (20 marks)

Answer any two questions in this section.

8. (a) Explain, including relevant chemical equations, how iron is extracted from its ore in a blast furnace.

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

(b) Iron from blast furnaces is usually mixed with other elements to form alloys.

Name one of these alloys and give a reason why this alloy is preferred to iron from blast furnaces.

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

(c) Calculate the mass in grams, and the volume in dm³, measured in room temperature and pressure, of carbon dioxide formed in producing 10 000 g of iron.

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

[Total: 10]
9 (a) Crude oil is separated into several useful substances in a fractionating tower. Describe the separation process.

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

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

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

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

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

(b) Organic compounds are placed in an homologous series.

(i) Give two characteristics of an homologous series.

……………………………………………………………………………………………

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

(ii) Write the general formula for the homologous series of alkanes.

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

(iii) Name and write the chemical formula of the first member of the homologous series of alkanes.

………………………………………………………………………………………………………..……[2]
(c) The alkenes include ethene, \( \text{C}_2\text{H}_4 \). This compound undergoes addition polymerization to form addition polymers.

(i) Draw the structural formula of ethene.

(ii) Draw two repeating units of the addition polymer formed by ethene.
10 (a) (i) Explain how coating iron with paint prevents iron from rusting.

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(ii) A student wants to investigate if salt water speeds up the rusting process. Describe a laboratory investigation that can be used to decide if salt water speeds up rusting.
You are provided with the two iron nails.
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..................................................................................................................................................[4]
(b) Iron reacts with steam to form the dark brown solid Fe₃O₄ and a colourless gas.

(i) Write a balanced chemical equation for this reaction

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

(ii) Describe a positive test to identify the colourless gas.

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

[Total: 10]
DATA SHEET

Colours of Some Common Metal Hydroxides

<table>
<thead>
<tr>
<th>Metal Hydroxide</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>calcium hydroxide</td>
<td>white</td>
</tr>
<tr>
<td>copper(II) hydroxide</td>
<td>light blue</td>
</tr>
<tr>
<td>iron(II) hydroxide</td>
<td>green</td>
</tr>
<tr>
<td>iron(III) hydroxide</td>
<td>red-brown</td>
</tr>
<tr>
<td>lead(II) hydroxide</td>
<td>white</td>
</tr>
<tr>
<td>zinc hydroxide</td>
<td>white</td>
</tr>
</tbody>
</table>
The Periodic Table of the Elements

<table>
<thead>
<tr>
<th>Group</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
<th>VII</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Li</td>
<td>3</td>
<td>Be</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Na</td>
<td>11</td>
<td>Mg</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>19</td>
<td>Ca</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rb</td>
<td>37</td>
<td>Sr</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cs</td>
<td>55</td>
<td>Ba</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fr</td>
<td>87*</td>
<td>Ra</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ra</td>
<td>88*</td>
<td>Ac</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

Key:
- 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.
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Fuchun Secondary School
Secondary 4 Express
Science Chemistry (5076)
Prelim Examination 2019

Marking Scheme

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>C</td>
<td>11</td>
<td>C</td>
</tr>
<tr>
<td>2</td>
<td>B</td>
<td>12</td>
<td>C</td>
</tr>
<tr>
<td>3</td>
<td>B</td>
<td>13</td>
<td>C</td>
</tr>
<tr>
<td>4</td>
<td>B</td>
<td>14</td>
<td>A</td>
</tr>
<tr>
<td>5</td>
<td>D</td>
<td>15</td>
<td>C</td>
</tr>
<tr>
<td>6</td>
<td>A</td>
<td>16</td>
<td>C</td>
</tr>
<tr>
<td>7</td>
<td>D</td>
<td>17</td>
<td>C</td>
</tr>
<tr>
<td>8</td>
<td>B</td>
<td>18</td>
<td>C</td>
</tr>
<tr>
<td>9</td>
<td>B</td>
<td>19</td>
<td>A</td>
</tr>
<tr>
<td>10</td>
<td>D</td>
<td>20</td>
<td>C</td>
</tr>
</tbody>
</table>

Section A  Answer  marks  Markers report
A1a  G  1
A1b  E  1
A1c  D  1
A1d  F,G  1
A1e  H  1
A2ai  Down group I, melting point and boiling point decreases.
Down group VII, melting point and boiling point increases.  1
A2a ii  Down the group,
The density increases,
The color darkens
The reactivity decreases  Any
2m
A2b i  Two atoms chemically bonded together  1  Badly done
A2b ii  Covalent bond sharing of two electrons
Correct number of unshared electrons for chlorine atoms
Outer shells only – penalise 1m  1
1
1
A2b ii  Correct charge and electrons for Na ion
Correct charge and electrons for Cl ion
All shells must be drawn – penalise 1m  1
1

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<table>
<thead>
<tr>
<th>A2bii</th>
<th>In solid state, the ions are <strong>held together by strong electrostatic forces of attraction</strong> in a giant lattice structure. They cannot conduct electricity. In aqueous and molten state, the <strong>ions are mobile</strong> and can conduct electricity.</th>
<th>1</th>
<th>Wrong keywords such as electrons and atoms were used instead of ions.</th>
</tr>
</thead>
</table>
| A3    | K: element  
L: compound  
M: mixture  
N: Mixture  
O: Either an element or compound | 1 x 5 | Many students gave “potassium” and “sodium” as answers. They also gave examples of other salts instead of reagents. |
| A4a   | Potassium sulfate: sulfuric acid, potassium hydroxide, (do not accept potassium)  
Sodium chloride: Sodium hydroxide/sodium carbonate  
Magnesium nitrate: magnesium  
Copper(II) sulfate: CuSO₄ | 1 | Badly done. Many students forgot their insoluble salts and gave even hydroxides observed in QA as answers. |
| A4b   | CuO + H₂SO₄ → CuSO₄ + H₂O | 2 |  |
| A4c   | **Evaporate/heat the solution till saturation**  
**Leave it to cool and crystallise.**  
**Collect the crystals by filtration, rinse with little deionised water.**  
**Press dry between sheets of filter paper.** | 1 | Badly done. Students need to know the steps of salt prep. |
|       | 1 |  |
| A4d   | Any 2 insoluble salt,  
**Lead chloride**, silver chloride,  
**Barium sulfate**, lead sulfate, calcium sulfate  
Or any carbonate other than SPA carbonates.  
Must be name and not chemical formula | 1 x 2 | Badly done. Many students forgot their insoluble salts and gave even hydroxides observed in QA as answers. |
<p>| A5ai  | Respiratory problems /breathing difficulties | 1 |  |
| A5aii | Combines with haemoglobin in blood and prevent oxygen from being transported around the body, leading to brain damage or death | 1 | For CO, improper answers such as “fuse with blood cells” or “reduce amount of haemoglobin” were unacceptable. |</p>
<table>
<thead>
<tr>
<th>A5b</th>
<th>$2\text{CO} + 2\text{NO} \rightarrow 2\text{CO}_2 + \text{N}_2$</th>
<th>1</th>
</tr>
</thead>
</table>
| A5bii | Substance reduced: NO  
Reason: NO is reduced as it loses oxygen to form N$_2$.  
Starting and ending species with reason must be given | 1 | They could recognise what species is reduced but cannot explain.  
Quoted wrong oxidation state for nitrogen in NO. |
| A6    | F: Iron (II) sulfate  
G: Barium sulfate  
H: Iron(II) hydroxide  
J: Iron(III) sulfate  
K: Iron (III) hydroxide  
Must be names and not chemical formula | $1 \times 5$ |
| A7    | Bitumen  
Calcium oxide/ calcium hydroxide  
Hydrogen | $1 \times 3$ | Could not identify hydrogen. |

### Section B

| B8a   | $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$  
In the blast furnace, Carbon in coke burns in air to form carbon dioxide.  
$\text{CO}_2 + \text{C} \rightarrow 2\text{CO}$  
Carbon dioxide further reacts with coke to form carbon monoxide.  
$\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$  
Carbon monoxide then reduces iron(III) oxide, haematite, to form molten iron and carbon dioxide. | leqf | Those who attempted managed to at least get the equations right. |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$</td>
<td>leqn</td>
</tr>
<tr>
<td></td>
<td>Carbon monoxide then reduces iron(III) oxide, haematite, to form molten iron and carbon dioxide.</td>
<td>leqn</td>
</tr>
<tr>
<td></td>
<td>1m for all the three proper descriptions</td>
<td></td>
</tr>
<tr>
<td>B8b</td>
<td>Steel is an alloy of iron. It is stronger and harder than iron.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
| B8c   | No of moles of 10000g of iron  
$= 10000/56 \text{ mol}$  
No of moles of carbon dioxide  
$= (10000/56) \times 3/2 \text{ mol}$  
Volume of $\text{CO}_2 = (10000/56) \times 3/2 \times 24$  
$= 6428.57 \text{ dm}^3$ | 1 |  |

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<p>| B9a | Crude oil is heated until it becomes vapor. The vapor cools and condenses in the fractionating tower and is collected into different fractions according to their different boiling points. The fraction with the lowest boiling point will condense and be collected at the <strong>top</strong> of the fractionating tower. The fraction with highest boiling point will condense and be collected at the <strong>bottom</strong> of the fractionating tower. | 1 | Many inappropriate keywords. Student's ans were highlighted for teachers to refer to. |
| B9bi | They have the same functional group; They have the same general formula; They differ by one –CH₂ group; They have the <strong>similar chemical properties</strong> | Any two (2m) | Same vs Similar Example similar functional group or similar general formula is different from same functional group and same general formula. |
| B9bii | CₙH₂n+2 | 1 |
| B9biii | Methane, CH₄ | 1 | Students did not recall formula for methane |
| B9ci | Draw C₂H₄ | 1 |
| B9cii | | 1 | Badly done. Either drew three units or ended the... |</p>
<table>
<thead>
<tr>
<th>Question</th>
<th>Task</th>
<th>Marks</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>B10ai</td>
<td>Paint acts as a <strong>protective layer</strong>, prevents contact with <strong>oxygen and water</strong></td>
<td>1</td>
<td>Many did not mention protective layer</td>
</tr>
<tr>
<td>B10aii</td>
<td>Measure the mass of each nail and record it as No and Mo. Place nail in a test tube labelled N filled with distilled water. Place the second nail in a test tube M filled with saltwater. Leave the test tubes in the lab for a week. Measure the dry mass of each nail and label it as N1 and M1. Calculate the mass gain as N1-N0 and M1-M0. The one with the higher mass gain has rusted more.</td>
<td>1</td>
<td>Badly done. Students want to time the rusting process. Students were highlighted for teachers to take note of.</td>
</tr>
<tr>
<td>B10bi</td>
<td>[3\text{Fe} + 4\text{H}_2\text{O} \rightarrow \text{Fe}_3\text{O}_4 + 4\text{H}_2]</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>B10bii</td>
<td>Insert a <strong>lighted splint</strong>. If the gas extinguishes the flame with a pop sound, it is hydrogen.</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

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READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, register number and class on the question booklet and Answer Sheet in the spaces provided unless this has been done for you.

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

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The total number of marks for this paper is 40.

A copy of the Data sheet is printed on page 9.
A copy of the Periodic Table is printed on page 10.
1. Which apparatus is most suitable for measuring 25.0 cm³ of hydrochloric acid?
   - A. beaker
   - B. burette
   - C. measuring cylinder
   - D. pipette

2. A substance X has the following properties.
   - fixed melting point
   - conducts electricity when molten
   - does not conduct electricity when in solid state

   Which row correctly describes substance X?

<table>
<thead>
<tr>
<th>Element, compound or mixture</th>
<th>Chemical bonding</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. compound</td>
<td>covalent</td>
</tr>
<tr>
<td>B. compound</td>
<td>ionic</td>
</tr>
<tr>
<td>C. element</td>
<td>covalent</td>
</tr>
<tr>
<td>D. mixture</td>
<td>ionic</td>
</tr>
</tbody>
</table>

3. An unknown oxide M reacts with both sulfuric acid and sodium hydroxide solution to produce salt and water only.

   Which oxide is M likely to be?
   
   - A. aluminium oxide
   - B. barium oxide
   - C. calcium oxide
   - D. magnesium oxide
4. Ammonia gas can be produced by reacting nitrogen and hydrogen as shown in the equation below.

\[ \text{N}_2 (g) + 3\text{H}_2 (g) \rightarrow 2\text{NH}_3 (g) \]

What volume of ammonia is produced when 50 cm\(^3\) of nitrogen is reacted with 90 cm\(^3\) of hydrogen?

A. 60 cm\(^3\)
B. 100 cm\(^3\)
C. 140 cm\(^3\)
D. 150 cm\(^3\)

5. Test tubes labelled 1, 2 and 3 respectively were filled with equal volumes of dilute hydrochloric acid. Three different metal strips of same size and mass were added separately to test tubes 1, 2 and 3. The diagram below shows the observations obtained.

What could be the identities of the metals in each test tube?

<table>
<thead>
<tr>
<th></th>
<th>test tube 1</th>
<th>test tube 2</th>
<th>test tube 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>calcium</td>
<td>copper</td>
<td>iron</td>
</tr>
<tr>
<td>B</td>
<td>calcium</td>
<td>zinc</td>
<td>copper</td>
</tr>
<tr>
<td>C</td>
<td>copper</td>
<td>iron</td>
<td>zinc</td>
</tr>
<tr>
<td>D</td>
<td>zinc</td>
<td>iron</td>
<td>copper</td>
</tr>
</tbody>
</table>
6  The ideal method of collecting gas X is shown below.

What can be deduced about the density and solubility of gas X in water?

<table>
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<tr>
<th></th>
<th>density of gas X</th>
<th>solubility of gas X in water</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>denser than air</td>
<td>insoluble</td>
</tr>
<tr>
<td>B</td>
<td>denser than air</td>
<td>soluble</td>
</tr>
<tr>
<td>C</td>
<td>less dense than air</td>
<td>insoluble</td>
</tr>
<tr>
<td>D</td>
<td>less dense than air</td>
<td>soluble</td>
</tr>
</tbody>
</table>

7  Iron can be extracted from its ore using a blast furnace as shown below.

At which position will molten iron be obtained?
8. Which substance is used to reduce acidity in soil?
   A. barium sulfate
   B. calcium hydroxide
   C. potassium chloride
   D. sodium hydroxide

9. Which is the major component of air?
   A. argon
   B. carbon dioxide
   C. nitrogen
   D. oxygen

10. Which is true about covalent bonds?
    A. Covalent bonds are formed between metals.
    B. Covalent bonds are formed by sharing electrons.
    C. Covalent bonds are formed by transferring electrons.
    D. Covalent bonds are weak.

11. Which row matches the fraction of crude oil to its use?

<table>
<thead>
<tr>
<th>fraction</th>
<th>use</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>bitumen to produce polishes</td>
</tr>
<tr>
<td>B</td>
<td>diesel to pave roads</td>
</tr>
<tr>
<td>C</td>
<td>kerosene to lubricate engines</td>
</tr>
<tr>
<td>D</td>
<td>naphtha to make plastics</td>
</tr>
</tbody>
</table>

12. Which equation represents a redox reaction?
    A. $\text{AgNO}_3 \text{(aq)} + \text{NaCl} \text{(aq)} \rightarrow \text{AgCl} \text{(s)} + \text{NaNO}_3 \text{(aq)}$
    B. $\text{Ca} \text{(s)} + 2\text{HCl} \text{(aq)} \rightarrow \text{CaCl}_2 \text{(aq)} + \text{H}_2 \text{(g)}$
    C. $\text{CuO} \text{(s)} + \text{H}_2\text{SO}_4 \text{(aq)} \rightarrow \text{CuSO}_4 \text{(aq)} + \text{H}_2\text{O} \text{(l)}$
    D. $\text{MgCO}_3 \text{(s)} + \text{H}_2\text{SO}_4 \text{(aq)} \rightarrow \text{MgSO}_4 \text{(aq)} + \text{H}_2\text{O} \text{(l)}$
13 When an unknown gas X was bubbled into bromine solution, the solution was decolourised rapidly.

Which could be gas X?

A ethane
B ethanoic acid
C ethanol
D ethene

14 The diagram below shows the structure of two atoms.

Which statement is true about the two atoms?

A Both atoms are isotopes.
B Both atoms are metals.
C Both atoms belong to the same group.
D Both atoms belong to the same period.

15 Moving from the left to the right side of the periodic table, elements

A become less metallic.
B become more metallic.
C decrease in mass.
D increase in reactivity.
Four set-ups containing iron nails are shown below.

In which order will the nail rust, from the fastest to the slowest?
A  W → X → Y → Z
B  X → Z → Y → W
C  Y → X → Z → W
D  Z → W → X → Y

As the number of carbon atoms in alkanes increases,
A  their melting and boiling points decrease.
B  they become more flammable.
C  they become more reactive.
D  they become more viscous.

Long chain alkanes can be cracked into smaller molecules to produce more useful products.

The equation below shows an example of such reactions.

\[ C_{38}H_{72} \rightarrow 2C_3H_6 + 2C_4H_8 + C_{19}H_{30} + X \]

What is a possible identity of X?
A  C₆H₁₂
B  C₆H₁₄
C  C₂₃H₄₆
D  C₂₃H₄₈
19 An equation is shown below.

\[ x\text{Fe} + y\text{Cl}_2 \rightarrow z\text{FeCl}_3 \]

Which numbers will correctly balance the equation?

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<tr>
<th></th>
<th>x</th>
<th>y</th>
<th>z</th>
</tr>
</thead>
<tbody>
<tr>
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<td>2</td>
<td>1</td>
</tr>
<tr>
<td>C</td>
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<tr>
<td>D</td>
<td>2</td>
<td>3</td>
<td>2</td>
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</tbody>
</table>

20 Which substance will be made up of particles packed closely together in an orderly arrangement at room temperature?

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<tr>
<th></th>
<th>melting point / °C</th>
<th>boiling point / °C</th>
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</tr>
<tr>
<td>D</td>
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</table>

END OF PAPER
Colours of Some Common Metal Hydroxides

<table>
<thead>
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<th>Metal Hydroxide</th>
<th>Colour</th>
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</thead>
<tbody>
<tr>
<td>Calcium hydroxide</td>
<td>white</td>
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<tr>
<td>Copper(II) hydroxide</td>
<td>light blue</td>
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<tr>
<td>Iron(II) hydroxide</td>
<td>green</td>
</tr>
<tr>
<td>Iron(III) hydroxide</td>
<td>red-brown</td>
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<tr>
<td>Lead(II) hydroxide</td>
<td>white</td>
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<tr>
<td>Zinc hydroxide</td>
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The Periodic Table of Elements

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<td>Tb</td>
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<tr>
<td>67</td>
<td>Ho</td>
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<td>165</td>
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<td>68</td>
<td>Er</td>
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<td>Tm</td>
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<td></td>
</tr>
</tbody>
</table>

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

Write your name, register number and class on this cover and all the work you hand in. Write in blue pen or black pen.
You may use a soft pencil for any diagrams, graphs or rough working. Do not use staples, paper clips, glue or correction fluid.
The use of an approved scientific calculator is expected, where appropriate.

Section A
Answer all questions in the spaces provided.

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

The total number of marks for this paper is 65.

A copy of the Data sheet is printed on page 14.
A copy of the Periodic Table is printed on page 15.
Section A [45 marks]
Answer all the questions in this section in the spaces provided.

A1 Some substances are listed below.

<table>
<thead>
<tr>
<th>air</th>
<th>carbon dioxide</th>
<th>iodine</th>
<th>lithium</th>
</tr>
</thead>
<tbody>
<tr>
<td>steel</td>
<td>sulfur dioxide</td>
<td>water</td>
<td>iron</td>
</tr>
</tbody>
</table>

Match the substance(s) to the descriptions given below.

(a) A gas that dissolves in water and turns Universal Indicator red.

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

(b) A mixture of elements and compounds.

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

(c) A transition metal.

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

(d) A substance which sublimes when heated.

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

A2 Chlorine and fluorine both belong to the same group in the Periodic Table.

(a) State the name given to this group of elements.

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

(b) Explain why chlorine and fluorine are placed in the same group in the Periodic Table.

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

(c) An element D was discovered by scientists and placed beneath astatine in the Periodic Table.

Predict the state of the element at room temperature and its reactivity compared to astatine.

state at room temperature: …………………………….

reactivity compared to astatine: ……………………………. [2]
A3

Fig. 3.1 shows the chromatogram of food products 1, 2 and 3 and permitted food dyes A, B and C.

(a) State and explain which food product(s) are safe for consumption.

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

(b) Explain why the sample of product 3 did not separate into different spots.

........................................................................................................................................ [1]
Aluminium is extracted from its ore by electrolysis.

The equation given below represents the process of extraction of aluminium from its ore.

\[ 2\text{Al}_2\text{O}_3 \rightarrow 4\text{Al} + 3\text{O}_2 \]

(a) Explain why aluminium cannot be extracted from its ore by heating with carbon.

(b) State and explain whether the process of extracting aluminium is a redox reaction.

(c) Suggest why aluminium is widely recycled in many countries rather than being extracted.
A5 Table 5.1 shows some information about the atoms of elements E, F, G and H.

Table 5.1

<table>
<thead>
<tr>
<th>element</th>
<th>proton</th>
<th>neutron</th>
<th>electron</th>
<th>mass</th>
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<tr>
<td>E</td>
<td>6</td>
<td>6</td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>F</td>
<td></td>
<td>20</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td></td>
<td></td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>H</td>
<td>18</td>
<td></td>
<td>18</td>
<td>40</td>
</tr>
</tbody>
</table>

(a) Complete Table 5.1. [3]

(b) State which element(s) is/are

(i) noble gas(es),

(ii) isotopes. [1]

A6 When stoves are operated in an enclosed area, carbon monoxide may be produced, which can harm human health.

(a) Explain how carbon monoxide is produced when stoves are operated in an enclosed area. [1]

(b) Describe the effects of carbon monoxide on human beings. [2]
A7 When yeast is added to hydrogen peroxide, it decomposes into water and oxygen as shown by the chemical equation below.

\[ 2\text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{O}_2 \]

Fig. 7.1 shows the graph of the volume of oxygen gas collected against time when 50 cm\(^3\) of hydrogen peroxide with concentration of 0.50 mol/dm\(^3\) is allowed to decompose in the presence of yeast.

(a) Explain why the volume of oxygen stops rising after some time.

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

(b) (i) On Fig. 7.1, sketch a curve of what would happen if the concentration of hydrogen peroxide was decreased to 0.25 mol/dm\(^3\).

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

(ii) Using your knowledge of collision theory, explain your answer in (b)(i).

........................................................................................................................................ [2]
Potassium hydroxide solution was slowly added to 40 cm$^3$ of nitric acid with a concentration of 1.00 mol/dm$^3$ and the temperature of the solution was measured and plotted on Fig. 8.1.

![Fig. 8.1](image)

The reaction between potassium hydroxide and nitric acid can be represented by the equation below.

$$KOH + HNO_3 \rightarrow KNO_3 + H_2O$$

(a) Name the type of reaction between potassium hydroxide and nitric acid. 

(b) State whether the reaction is exothermic or endothermic. Explain your answer using Fig. 8.1.

(c) Given that 30 cm$^3$ of potassium hydroxide was required to react with 40 cm$^3$ of nitric acid, find the concentration of the potassium hydroxide solution.
A9 (a) Fig. 9.1 shows part of the structure of an addition polymer.

![Polymer Structure](image)

(a) Draw the structural formula of the monomer that makes up the polymer in Fig. 9.1.

(b) Poly(ethene) is an example of an addition polymer that is widely used.

(i) State the condition(s) required for poly(ethene) to be formed from its monomer.

(ii) State one common use of poly(ethene).

(c) Disposal of polymers by burying them in landfills causes land pollution to occur.

Explain why polymers cause land pollution when buried.
Fig. 10.1 describes some properties and reactions of several substances.

(a) Name V, W, X, Y and Z.

V .................................................................
W .................................................................
X .................................................................
Y .................................................................
Z ................................................................. [5]

(b) Write a balanced chemical equation for any one of the reactions in Fig. 10.1.

........................................................................................................................................... [2]
B11 (a) Alkanes can react with halogens to produce other organic compounds.

(i) State the condition(s) required for halogens to react with alkanes.\\
\[\text{condition(s)}\] \[1]\n
(ii) When methane is reacted with chlorine, hydrogen chloride is produced. Name another product of the reaction and show its structural formula.

\[
\begin{array}{c}
\text{name:} \\
\text{structural formula:}
\end{array}
\] \[2]\n
(iii) Write a balanced chemical equation to describe the reaction of methane with oxygen.

\[\text{balanced equation}\] \[2]\n
(b) Another hydrocarbon, ethene, has the chemical formula $C_2H_4$.

(i) Draw the 'dot-and-cross' diagram of ethene.

(ii) Explain, using your knowledge of chemical bonding, why ethene is a gas at room temperature and pressure.

(iii) Explain why ethene is classified as an unsaturated hydrocarbon.
B12 (a) Describe, in terms of the arrangement and movement of particles, the process of ice melting.

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

(b) Water can be formed by the reaction between hydrogen and oxygen. The reaction can be described by the equation below.

\[ 2H_2 + O_2 \rightarrow 2H_2O \]

Find the mass of oxygen required to react with 32.0 cm\(^3\) of hydrogen.

mass of oxygen required: ...................... g [3]

(c) With the aid of a diagram, explain why alloys are harder and stronger than pure metals.

…………………………………………………………………………………………………….
…………………………………………………………………………………………………….
…………………………………………………………………………………………………….
……………………………………………………………………………………………………. [3]
B13  (a) Describe how you can prepare a pure dry sample of copper(II) chloride. You may use the following information to help you.

- copper(II) chloride is soluble in water
- copper metal does not react with dilute acids

(b) Ethanol can be used as a fuel for vehicle and other machines.

(i) Name the process by which ethanol is made from glucose.

(ii) State the chemical equation of the reaction named in (b)(i).

(iii) State the condition(s) required for the reaction in (b)(i) to occur.

(iv) Write a balanced chemical equation for the combustion of ethanol.
## Colours of Some Common Metal Hydroxides

<table>
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<th>Compound</th>
<th>Colour</th>
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<td>calcium hydroxide</td>
<td>white</td>
</tr>
<tr>
<td>copper(II) hydroxide</td>
<td>light blue</td>
</tr>
<tr>
<td>iron(III) hydroxide</td>
<td>green</td>
</tr>
<tr>
<td>iron(III) hydroxide</td>
<td>red-brown</td>
</tr>
<tr>
<td>lead(II) hydroxide</td>
<td>white</td>
</tr>
<tr>
<td>zinc hydroxide</td>
<td>white</td>
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### The Periodic Table of Elements

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<th>II</th>
<th>Key</th>
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<th>IV</th>
<th>V</th>
<th>VI</th>
<th>VII</th>
<th>O</th>
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<td></td>
<td>5</td>
<td>B</td>
<td>boron</td>
<td></td>
<td>8</td>
<td>O</td>
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<td>27</td>
<td>Si</td>
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<td>88</td>
<td>40</td>
<td>Ti</td>
</tr>
<tr>
<td>55</td>
<td>Cs</td>
<td>caesium</td>
<td>133</td>
<td>56</td>
<td>Ba</td>
<td>barium</td>
<td>137</td>
<td>72</td>
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<td>87</td>
<td>Fr</td>
<td>francium</td>
<td>–</td>
<td>–</td>
<td>Ra</td>
<td>radium</td>
<td>–</td>
<td>57</td>
<td>La</td>
</tr>
</tbody>
</table>

#### Lanthanoids

| 57 | La | lanthanum | 139 |
| 58 | Ce | cerium | 140 |
| 59 | Pr | praseodymium | 141 |
| 60 | Nd | neodymium | 144 |
| 61 | Pm | promethium | – |
| 62 | Sm | samarium | 150 |
| 63 | Eu | europium | 152 |
| 64 | Gd | gadolinium | 157 |
| 65 | Tb | terbium | 159 |
| 66 | Dy | dysprosium | 163 |
| 67 | Ho | holmium | 165 |
| 68 | Er | erbium | 167 |
| 69 | Tm | thulium | 169 |
| 70 | Yb | ytterbium | 173 |
| 71 | Lu | lutetium | 175 |

#### Actinoids

| 89 | Ac | actinium | 232 |
| 90 | Th | thorium | 231 |
| 91 | Pa | protactinium | 234 |
| 92 | U | uranium | 238 |
| 93 | Np | neptunium | – |
| 94 | Pu | plutonium | – |
| 95 | Am | americium | – |
| 96 | Cm | curium | – |
| 97 | Bk | berkelium | – |
| 98 | Cf | californium | – |
| 99 | Es | einsteinium | – |
| 100 | Fm | fermium | – |
| 101 | Md | mendelevium | – |
| 102 | No | nobelium | – |
| 103 | Lr | lawrencium | – |

The volume of one mole of any gas is 24 dm$^3$ at room temperature and pressure (r.t.p.)
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GREENRIDGE SECONDARY SCHOOL
O LEVEL PRELIMINARY EXAMINATION 2019
Secondary 4 Express / 5 Normal Academic

SCIENCE (CHEMISTRY, BIOLOGY)  5078/01
Paper 1

4 September 2019  1 hour
Wednesday

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, register number and class on the question booklet and Answer Sheet in the spaces provided unless this has been done for you.

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

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The total number of marks for this paper is 40.

A copy of the Data sheet is printed on page 9.
A copy of the Periodic Table is printed on page 10.
1 Which apparatus is most suitable for measuring 25.0 cm$^3$ of hydrochloric acid?
   A beaker
   B burette
   C measuring cylinder
   D pipette

2 A substance X has the following properties.
   - fixed melting point
   - conducts electricity when molten
   - does not conduct electricity when in solid state

Which row correctly describes substance X?

<table>
<thead>
<tr>
<th></th>
<th>element, compound or mixture</th>
<th>chemical bonding</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>compound</td>
<td>covalent</td>
</tr>
<tr>
<td>B</td>
<td>compound</td>
<td>ionic</td>
</tr>
<tr>
<td>C</td>
<td>element</td>
<td>covalent</td>
</tr>
<tr>
<td>D</td>
<td>mixture</td>
<td>ionic</td>
</tr>
</tbody>
</table>

3 An unknown oxide M reacts with both sulfuric acid and sodium hydroxide solution to produce salt and water only.

Which oxide is M likely to be?

A aluminium oxide
B barium oxide
C calcium oxide
D magnesium oxide
4 Ammonia gas can be produced by reacting nitrogen and hydrogen as shown in the equation below.

\[ \text{N}_2 (g) + 3\text{H}_2 (g) \rightarrow 2\text{NH}_3 (g) \]

What volume of ammonia is produced when 50 cm\(^3\) of nitrogen is reacted with 90 cm\(^3\) of hydrogen?

- **A** 60 cm\(^3\)
- **B** 100 cm\(^3\)
- **C** 140 cm\(^3\)
- **D** 150 cm\(^3\)

5 Test tubes labelled 1, 2 and 3 respectively were filled with equal volume of dilute hydrochloric acid. Three different metal strips of same size and mass were added separately to test tubes 1, 2 and 3. The diagram below shows the observations obtained.

What could be the identities of the metals in each test tube?

<table>
<thead>
<tr>
<th></th>
<th>test tube 1</th>
<th>test tube 2</th>
<th>test tube 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
<td>calcium</td>
<td>copper</td>
<td>iron</td>
</tr>
<tr>
<td><strong>B</strong></td>
<td><strong>calcium</strong></td>
<td><strong>zinc</strong></td>
<td><strong>copper</strong></td>
</tr>
<tr>
<td><strong>C</strong></td>
<td>copper</td>
<td>iron</td>
<td>zinc</td>
</tr>
<tr>
<td><strong>D</strong></td>
<td>zinc</td>
<td>iron</td>
<td><strong>copper</strong></td>
</tr>
</tbody>
</table>
6 The ideal method of collecting gas X is shown below.

[Diagram of a J-shaped tube with gas X flowing from the left to the right]

What can be deduced about the density and solubility of gas X in water?

<table>
<thead>
<tr>
<th>Density of gas X</th>
<th>Solubility of gas X in water</th>
</tr>
</thead>
<tbody>
<tr>
<td>A denser than air</td>
<td>insoluble</td>
</tr>
<tr>
<td>B denser than air</td>
<td>soluble</td>
</tr>
<tr>
<td>C less dense than air</td>
<td>insoluble</td>
</tr>
<tr>
<td>D less dense than air</td>
<td>soluble</td>
</tr>
</tbody>
</table>

7 Iron can be extracted from its ore using a blast furnace as shown below.

At which position will molten iron be obtained?

[Diagram of a blast furnace with arrows indicating the flow of materials]
8. Which substance is used to reduce acidity in soil?
   A. barium sulfate
   B. calcium hydroxide
   C. potassium chloride
   D. sodium hydroxide

9. Which is the major component of air?
   A. argon
   B. carbon dioxide
   C. nitrogen
   D. oxygen

10. Which is true about covalent bonds?
    A. Covalent bonds are formed between metals.
    B. Covalent bonds are formed by sharing electrons.
    C. Covalent bonds are formed by transferring electrons.
    D. Covalent bonds are weak.

11. Which matches the fraction of crude oil to its use?

<table>
<thead>
<tr>
<th>fraction</th>
<th>use</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>bitumen</td>
</tr>
<tr>
<td>B</td>
<td>diesel</td>
</tr>
<tr>
<td>C</td>
<td>kerosene</td>
</tr>
<tr>
<td>D</td>
<td>naphtha</td>
</tr>
<tr>
<td></td>
<td>to produce polishes</td>
</tr>
<tr>
<td></td>
<td>to pave roads</td>
</tr>
<tr>
<td></td>
<td>to lubricate engines</td>
</tr>
<tr>
<td></td>
<td>to make plastics</td>
</tr>
</tbody>
</table>

12. Which equation represents a redox reaction?
   A. AgNO₃ (aq) + NaCl (aq) → AgCl (s) + NaNO₃ (aq)
   B. Ca (s) + 2HCl (aq) → CaCl₂ (aq) + H₂ (g)
   C. CuO (s) + H₂SO₄ (aq) → CuSO₄ (aq) + H₂O (l)
   D. MgCO₃ (s) + H₂SO₄ (aq) → MgSO₄ (aq) + H₂O (l)
13 When an unknown gas X was bubbled into bromine solution, the solution was decolourised rapidly.
Which could be gas X?
A ethane
B ethanoic acid
C ethanol
D *ethene*

14 The diagram below shows the structure of two atoms.

![Diagram of two atoms](image.jpg)

Which is **true about the two atoms**?
A Both atoms are isotopes.
B Both atoms are metals.
C Both atoms belong to the same group.
D Both atoms belong to the same period.

15 Moving from the left to the right side of the periodic table, elements
A become less metallic.
B become more metallic.
C decrease in mass.
D increase in reactivity.
16 Four set ups containing iron nails are shown below.

In which order will the nail rust from the fastest to the slowest?

A  W → X → Y → Z
B  X → Z → Y → W
C  Y → X → Z → W
D  Z → W → X → Y

17 As the number of carbon atoms in alkanes increase,
A  their melting and boiling points decrease.
B  they become more flammable.
C  they become more reactive.
D  they become more viscous.

18 Long chain alkanes can be cracked into smaller molecules to produce more useful products.

The equation below shows an example of such reactions.

\[ C_{35}H_{72} \rightarrow 2C_3H_6 + 2C_4H_8 + C_{15}H_{30} + X \]

What is a possible identity of X?

A  C_6H_{12}
B  C_8H_{14}
C  C_{23}H_{46}
D  C_{23}H_{48}
19  An equation is shown below.

\[ xFe + yCl_2 \rightarrow zFeCl_3 \]

Which numbers will correctly balance the equation?

<table>
<thead>
<tr>
<th></th>
<th>x</th>
<th>y</th>
<th>z</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>C</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>D</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

20  Which substance will be made up of particles packed closely together in an orderly arrangement at room temperature?

<table>
<thead>
<tr>
<th></th>
<th>melting point / °C</th>
<th>boiling point / °C</th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>-20</td>
<td>17</td>
</tr>
<tr>
<td>B</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>C</td>
<td>15</td>
<td>131</td>
</tr>
<tr>
<td>D</td>
<td>40</td>
<td>150</td>
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</table>

~ End of Paper ~
Colours of Some Common Metal Hydroxides

<table>
<thead>
<tr>
<th>Compound</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium hydroxide</td>
<td>white</td>
</tr>
<tr>
<td>Copper(II) hydroxide</td>
<td>light blue</td>
</tr>
<tr>
<td>Iron(II) hydroxide</td>
<td>green</td>
</tr>
<tr>
<td>Iron(III) hydroxide</td>
<td>red-brown</td>
</tr>
<tr>
<td>Lead(II) hydroxide</td>
<td>white</td>
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<tr>
<td>Zinc hydroxide</td>
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The Periodic Table of Elements

<table>
<thead>
<tr>
<th>Group</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
<th>VII</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>He</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Li</td>
<td>Be</td>
<td>B</td>
<td>C</td>
<td>N</td>
<td>O</td>
<td>F</td>
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<tr>
<td>7</td>
<td>3</td>
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<td>7</td>
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<td>9</td>
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<td>P</td>
<td>S</td>
<td>Cl</td>
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<td>23</td>
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<td>Ca</td>
<td>Sc</td>
<td>Ti</td>
<td>V</td>
<td>Cr</td>
<td>Mn</td>
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<td>85</td>
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<td>42</td>
<td>43</td>
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<td>45</td>
</tr>
<tr>
<td>55</td>
<td>Cs</td>
<td>Ba</td>
<td>Hf</td>
<td>Ta</td>
<td>W</td>
<td>Re</td>
<td>Os</td>
</tr>
<tr>
<td>133</td>
<td>37</td>
<td>88</td>
<td>91</td>
<td>93</td>
<td>96</td>
<td>100</td>
<td>103</td>
</tr>
<tr>
<td>87</td>
<td>Fr</td>
<td>Ra</td>
<td>Rf</td>
<td>Db</td>
<td>Sg</td>
<td>Bh</td>
<td>Hs</td>
</tr>
</tbody>
</table>

Key:
- proton (atomic) number
- atomic symbol
- name
- relative atomic mass

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The volume of one mole of any gas is 24 dm$^3$ at room temperature and pressure (r.t.p.).
GREENRIDGE SECONDARY SCHOOL
O LEVEL PRELIMINARY EXAMINATION 2019
Secondary 4 Express / 5 Normal Academic

SCIENCE
Paper 3 Chemistry

30 August 2019

Additional Materials: Nil

READ THESE INSTRUCTIONS FIRST

Write your name, register number and class on this cover and all the work you hand in.
Write in blue pen or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, glue or correction fluid.
The use of an approved scientific calculator is expected, where appropriate.

Section A
Answer all questions in the spaces provided.

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

The total number of marks for this paper is 65.

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 Only

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Section A</td>
<td>/ 45</td>
</tr>
<tr>
<td>Section B</td>
<td>/ 20</td>
</tr>
<tr>
<td>Total</td>
<td>/ 65</td>
</tr>
</tbody>
</table>

This document consists of 15 printed pages, including this cover page.

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Section A [45 marks]

Answer all the questions in this section in the spaces provided.

A1 Some substances are listed below.

- air
- steel
- carbon dioxide
- sulfur dioxide
- iodine
- water
- lithium
- iron

Match the substance(s) to the descriptions given below.

(a) A gas that dissolves in water and turns Universal Indicator red.

Sulfur dioxide [1]

(b) A mixture of elements and compounds.

air [1]

(c) A transition metal.

iron [1]

(d) A substance which sublimes when heated.

iodine [1]

A2 Chlorine and fluorine both belong to the same group in the Periodic Table.

(a) State the name given to this group of elements.

halogens [1]

(b) Explain why chlorine and fluorine are placed in the same group in the Periodic Table.

Both have 7 valence electrons/they have same number of valence electrons [1]

(c) An element D was discovered by scientists and placed beneath astatine in the Periodic Table.

Predict the state of the element at room temperature and its reactivity compared to astatine.

state at room temperature: solid

reactivity compared to astatine: less reactive [2]
Fig. 3.1 shows the chromatogram of food products 1, 2 and 3 and permitted food dyes A, B and C.

(a) State and explain which food product(s) are safe for consumption.

Product 1. Contains only permitted food dyes.  
........................................................................................................................................................................... [2]

(b) Explain why the sample of product 3 did not separate into different spots.

The dye is insoluble. [1]
Aluminium is extracted from its ore by electrolysis.

The equation given below represents the process of extraction of aluminium from its ore.

\[ 2\text{Al}_2\text{O}_3 \rightarrow 4\text{Al} + 3\text{O}_2 \]

(a) Explain why aluminium cannot be extracted from its ore by heating with carbon.

Aluminium is above carbon in the reactivity series. Carbon cannot reduce aluminium oxide as it is less reactive than aluminium.

(b) State and explain if the process of extracting aluminium is a redox reaction.

Extraction of aluminium is a redox reaction as aluminium is reduced from +3 in \( \text{Al}_2\text{O}_3 \) to 0 in Al and oxygen is oxidized from -2 in \( \text{Al}_2\text{O}_3 \) to 0 in \( \text{O}_2 \). Oxidation and reduction occurs simultaneously hence the process is a redox reaction.

(c) Suggest why aluminium is widely recycled in many countries rather than being extracted.

Extraction of aluminium requires large amounts of energy which can be expensive, recycling reduces the cost of production.
A5  Table 5.1 shows some information about the atoms of elements E, F, G and H.

<table>
<thead>
<tr>
<th>element</th>
<th>proton</th>
<th>neutron</th>
<th>electron</th>
<th>mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>F</td>
<td>19</td>
<td>20</td>
<td>19</td>
<td>39</td>
</tr>
<tr>
<td>G</td>
<td>6</td>
<td>8</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>H</td>
<td>18</td>
<td>22</td>
<td>18</td>
<td>40</td>
</tr>
</tbody>
</table>

(a) Complete Table 5.1.  
[b) State which element(s) is/are

(i) noble gas(es),

H  

(ii) isotopes.

E and G  

A6  When stoves are operated in an enclosed area, carbon monoxide may be produced which can harm human health.

(a) Explain how carbon monoxide is produced when stoves are operated in an enclosed area.

Incomplete combustion of fuels due to lack of oxygen.  

(b) Describe the effects of carbon monoxide on human beings.

Carbon monoxide binds irreversibly to haemoglobin, reducing ability of blood to carry oxygen throughout body.  

Causes fatigue, headache and death.  

.................................................................
A7 When yeast is added to hydrogen peroxide, it decomposes into water and oxygen as shown by the chemical equation below.

\[ 2H_2O_2 \rightarrow 2H_2O + O_2 \]

Fig. 7.1 shows the graph of the volume of oxygen gas collected against time when 50 cm\(^3\) of hydrogen peroxide with concentration of 0.50 mol/dm\(^3\) is allowed to decompose in the presence of yeast.

(a) Explain why the volume of oxygen stops rising after some time.

All the hydrogen peroxide is used up/decomposed.

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

(b) (i) On Fig. 7.1, sketch a curve of what would happen if the concentration of hydrogen peroxide was decreased to 0.25 mol/dm\(^3\).

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

(ii) Using your knowledge of collision theory, explain your answer in (b)(i).

Number of particles decreased in the same volume.

Lower rate of effective collisions, hence lower rate of reaction.

.................................................................................................................................................. [2]
A8 Potassium hydroxide solution was slowly added to 40 cm³ of nitric acid with a concentration of 1.00 mol/dm³ and the temperature of the solution was measured and plotted on Fig. 8.1.

![Graph showing temperature of solution vs volume of potassium hydroxide added]

**Fig. 8.1**

The reaction between potassium hydroxide and nitric acid can be represented by the equation below.

\[
\text{KOH} + \text{HNO}_3 \rightarrow \text{KNO}_3 + \text{H}_2\text{O}
\]

(a) Name the type of reaction between potassium hydroxide and nitric acid.

**Neutralisation** [1]

(b) State if the reaction is exothermic or endothermic. Explain your answer using Fig. 8.1.

**Exothermic. Temperature of solution increased when potassium hydroxide was added to nitric acid.** [2]

(c) Given that 30 cm³ of potassium hydroxide was required to react with 40 cm³ of nitric acid, find the concentration of the potassium hydroxide solution.

\[
\begin{align*}
\text{No. of moles of HNO}_3 &= 1.00 \times 0.04 = 0.04 \text{ mol} \ [1] \\
\text{HNO}_3 : \text{KOH} &= 1:1 \\
\text{No. of moles of KOH} &= 0.04 \text{ mol} \ [1] \\
\text{Concentration of KOH} &= \frac{0.04}{0.03} = 1.33 \text{ mol/dm}^3 \ [1] \text{ (must be in 3s.f. NOT fraction)}
\end{align*}
\]

[3]
A9  (a)  Fig. 9.1 shows part of the structure of an addition polymer.

 ![Structure of an addition polymer](image)

**Fig. 9.1**

(a) Draw the structural formula of the monomer that makes up the polymer in Fig. 9.1.

![Monomer structure](image)

(b) Poly(ethene) is an example of an addition polymer that is widely used.

(i) State the condition(s) required for poly(ethene) to be formed from its monomer.

High temperature and pressure, presence of catalyst.  

(ii) State one common use of poly(ethene).

Plastic bags (accept reasonable answers)

(c) Disposal of polymers by burying them in landfills causes land pollution to occur.

Explain why polymers cause land pollution when buried.

Polymers are usually non-biodegradable.
Fig. 10.1 below describes some properties and reactions of several substances.

(a) Name V, W, X, Y and Z.

V zinc  
W copper  
X zinc nitrate  
Y zinc hydroxide  
Z ammonia

(b) Write a balanced chemical equation for any one of the reactions in Fig. 10.1.

\[ \text{Zn} + \text{Cu(NO}_3\text{)}_2 \rightarrow \text{Zn(NO}_3\text{)}_2 + \text{Cu} \]  
\[ \text{Zn(NO}_3\text{)}_2 + 2\text{NaOH} \rightarrow \text{Zn(OH)}_2 + 2\text{NaNO}_3 \]

~End of Section A~
Section B [20 marks]
Answer any two questions.

B11 (a) Alkanes can react with halogens to produce other organic compounds.

(i) State the condition(s) required for halogens to react with alkanes.

Presence of UV light. [1]

(ii) When methane is reacted with chlorine, hydrogen chloride is produced. Name another product of the reaction and show its structural formula.

name: chloromethane
structural formula:

[2]

(iii) Write a balanced chemical equation, to describe the reaction of methane with oxygen.

\[ \text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O} \] [2]
(b) Another hydrocarbon, ethene, has the chemical formula \( \text{C}_2\text{H}_4 \).

(i) Draw the 'dot-and-cross' diagram of ethene.

(ii) Explain, using your knowledge of chemical bonding, why ethene is a gas at room temperature and pressure.

Ethene exists as a simple covalent molecule which is held together by weak intermolecular forces of attraction. Little energy is required to overcome it. Hence, it has low melting and boiling point, therefore it is a gas at room temperature.

(iii) Explain why ethene is classified as an unsaturated hydrocarbon.

Ethene contains carbon-carbon double bond.
Describe in terms of the arrangement and movement of particles, the process of ice melting.

Particles in ice are held together closely in an orderly manner and they vibrate and rotate about a fixed position. [1]
As they absorb energy from the surroundings, the particles begin vibrating faster and start moving apart. [1]
When it reaches the melting point, energy absorbed is sufficient to overcome the intermolecular forces of attraction holding the particles together and the particles break apart from their fixed positions. [1]
The particles can now move around freely by sliding across each other. [1]

(b) Water can be formed by the reaction between hydrogen and oxygen. The reaction can be described by the equation below.

$$2H_2 + O_2 \rightarrow 2H_2O$$

Find the mass of oxygen required to react with 32.0 cm$^3$ of hydrogen.

No. of moles of $H_2 = 32.0 / 24000 = 0.00133$ mol [1]

$H_2 : O_2$  
2 : 1  
0.00133 : 0.000666  
No. of moles of $O_2 = 0.000666$ mol [1]  
Mass of $O_2 = 0.000666 \times 32 = 0.0213$ g [1]

mass of oxygen required: ...................... g [3]

(c) With the aid of a diagram, explain why alloys are harder and stronger than pure metals.

Different sized atoms disrupt the orderly arrangement of metals. [1]  
This makes it difficult for the layers atoms to slide across each other when a force is applied. [1]  
Therefore, alloys are stronger and harder than pure metals.  

[1] for diagram
B13 (a) Describe how you can prepare a pure dry sample of copper(II) chloride. You may use the following information to help you.

- copper(II) chloride is soluble in water
- copper metal does not react with dilute acids

To 50 cm³ of hydrochloric acid, add excess copper(II) oxide/copper(II) carbonate and stir. [1] Continue adding copper(II) oxide/copper(II) carbonate while stirring until no more dissolves. [1] Filter the mixture to obtain copper(II) chloride as the filtrate. [1] Heat the filtrate until it is saturated. [1] Let the filtrate cool and crystallise. Filter the mixture to obtain the crystals and wash with cold distilled water. Dry the crystals between sheets of filter paper. [1]

(b) Ethanol can be used as a fuel for vehicle and other machines.

(i) Name the process by which ethanol is made from glucose.
   Fermentation [1]

(ii) State the chemical equation of the reaction named in (b)(i).
    \[ C_6H_{12}O_6 \text{(aq)} \rightarrow 2C_2H_5OH \text{(aq)} + 2CO_2 \text{(g)} \] [1]

(iii) State the condition(s) required for the reaction in (b)(i) to occur.
    Temperature maintained at 37 °C [1]
    Absence of air/oxygen [1]
    Presence of yeast [2]

(iv) Write a balanced chemical equation for the combustion of ethanol.
    \[ C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O \] [1]
# Colours of Some Common Metal Hydroxides

<table>
<thead>
<tr>
<th>Compound</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>calcium hydroxide</td>
<td>white</td>
</tr>
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<td>copper(II) hydroxide</td>
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<td>lead(II) hydroxide</td>
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<td>zinc hydroxide</td>
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### The Periodic Table of Elements

<table>
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<th>Group</th>
<th>Symbol</th>
<th>Name</th>
<th>Proton Number</th>
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<tbody>
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<td>Lithium, Beryllium, Boron, Carbon, Nitrogen, Oxygen, Fluorine, Neon</td>
<td>3-10</td>
<td>6.941 - 15.999</td>
<td>3-10</td>
<td>3-10</td>
<td></td>
</tr>
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<td>Sodium, Magnesium, Aluminium, Silicon, Phosphorus, Sulfur, Chlorine, Argon</td>
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<td>Actinium, Thorium, Protactinium, Uranium, Plutonium, Americium, Curium, Berkelium, Californium, Einsteinium, Fermium, Mendelevium, Nobelium, Lawrencium</td>
<td>47-57</td>
<td>229.02 - 257.49</td>
<td>47-57</td>
<td>47-57</td>
<td></td>
</tr>
</tbody>
</table>

**Key:**
- Proton (atomic) number
- Relative atomic mass
- Atomic symbol

---

The volume of one mole of any gas is 24 dm$^3$ at room temperature and pressure (r.t.p.)
Need a home tutor? Visit smiletutor.sg
21 The diagram below shows four pieces of laboratory equipment.

Which equipment is essential to find out if dissolving a salt in water is an exothermic process?

<table>
<thead>
<tr>
<th></th>
<th>balance</th>
<th>pipette</th>
<th>stop-clock</th>
<th>thermometer</th>
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<tr>
<td>A</td>
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<td>X</td>
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<tr>
<td>B</td>
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<td>X</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>C</td>
<td>X</td>
<td>✓</td>
<td>X</td>
<td>✓</td>
</tr>
<tr>
<td>D</td>
<td>✓</td>
<td>X</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

22 A beaker containing solid carbon dioxide is placed in a fume cupboard at room temperature. The carbon dioxide becomes gaseous.

Which process describes this change of state?

A boiling  
B condensation  
C evaporation  
D sublimation

23 Which statement about paper chromatography is correct?

A The solvent should cover the start line.  
B The start line should be drawn in pencil.  
C A solvent is needed to dissolve the paper.  
D Paper chromatography separates mixtures of solvents.
24 Which statement about diagrams P, Q and R is correct?

A Diagram P contains two elements and diagram Q contains a mixture.
B Diagram Q contains two compounds and diagram R contains a mixture.
C Diagram P contains two elements and diagram Q contains one compound.
D Diagram P contains two compounds and diagram R contains two elements.

25 Atom M has an electronic structure 2,5. Atom N has an electronic structure 2,8,5.

Which statement about element N is correct?

A N has more electron shells than M.
B N has more electrons in its outer shell than M.
C N is in the same period of the Periodic Table as M.
D N is in a different group of the Periodic Table from M.

26 X, Y and Z are three elements found in the third period of the Periodic Table. The nature of their oxides is shown in the following table.

<table>
<thead>
<tr>
<th>element</th>
<th>type of oxide formed</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>acidic</td>
</tr>
<tr>
<td>Y</td>
<td>basic</td>
</tr>
<tr>
<td>Z</td>
<td>amphoteric</td>
</tr>
</tbody>
</table>

Which of the following shows the order of increasing proton number for the three elements?

A X, Y, Z
B Y, Z, X
C Z, X, Y
D Z, Y, X

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27 The apparatus shown is used to prepare aqueous copper(II) sulfate. Solid X is added into solution Y before the mixture is filtered to remove solid X as the residue.

What are X and Y?

<table>
<thead>
<tr>
<th></th>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>copper</td>
<td>sulfuric acid</td>
</tr>
<tr>
<td>B</td>
<td>copper(II) carbonate</td>
<td>sulfuric acid</td>
</tr>
<tr>
<td>C</td>
<td>copper</td>
<td>aqueous iron(II) sulfate</td>
</tr>
<tr>
<td>D</td>
<td>sulfur</td>
<td>aqueous copper(II) chloride</td>
</tr>
</tbody>
</table>

28 The diagram shows the arrangement of electrons in a molecule of compound \( \text{ST}_2 \).

Which of the following pairs could be S and T?

<table>
<thead>
<tr>
<th></th>
<th>S</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>calcium</td>
<td>chlorine</td>
</tr>
<tr>
<td>B</td>
<td>carbon</td>
<td>oxygen</td>
</tr>
<tr>
<td>C</td>
<td>oxygen</td>
<td>hydrogen</td>
</tr>
<tr>
<td>D</td>
<td>sulfur</td>
<td>chlorine</td>
</tr>
</tbody>
</table>
29 The table below shows some information about four substances, A to D.

Which substance is most likely to be potassium chloride?

<table>
<thead>
<tr>
<th></th>
<th>melting point / °C</th>
<th>boiling point / °C</th>
<th>conductor of electricity in solid state</th>
<th>conductor of electricity in molten state</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>–95</td>
<td>69</td>
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<td>770</td>
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<td>no</td>
<td>yes</td>
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<tr>
<td>C</td>
<td>1240</td>
<td>2100</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>D</td>
<td>1650</td>
<td>2230</td>
<td>no</td>
<td>no</td>
</tr>
</tbody>
</table>

30 A student passes air forward and backward over heated copper using the apparatus as shown until the volume of air remains constant. Some unreacted copper remains. The original volume of air in the apparatus is 50.0 cm³.

What is the final volume of gas in the apparatus?
[All volumes are measured at room temperature and pressure.]

A 10 cm³  B 20 cm³  C 40 cm³  D 60 cm³

31 Which volume of 0.1 mol/dm³ hydrochloric acid is required to react completely with 25 cm³ of 0.2 mol/dm³ aqueous lithium hydroxide?

\[ \text{HC}_1 + \text{LiOH} \rightarrow \text{LiCl} + \text{H}_2\text{O} \]

A 6.25 cm³  B 25 cm³  C 50 cm³  D 100 cm³

32 Which of the following is not a property of Group I metals?

A They are soft and can be cut with a knife.
B They react readily when exposed to oxygen in the air.
C They react rapidly with water producing hydrogen gas.
D They produce an acidic solution when they react with water.
33 Small portions of aqueous potassium iodide and of acidified, aqueous potassium manganate(VII) were separately added to a colourless solution \( W \). The colour changes are shown in the table.

<table>
<thead>
<tr>
<th>aqueous potassium iodide</th>
<th>acidified aqueous potassium manganate(VII)</th>
</tr>
</thead>
<tbody>
<tr>
<td>colourless to brown</td>
<td>purple to colourless</td>
</tr>
</tbody>
</table>

Which statement about \( W \) is correct?
A \( W \) is both an oxidising and a reducing agent.
B \( W \) is neither an oxidising nor a reducing agent.
C \( W \) is an oxidising agent but not a reducing agent.
D \( W \) is a reducing agent but not an oxidising agent.

34 Which material is not involved in the large-scale extraction of iron from iron ore?
A coke
B haematite
C limestone
D slag

35 Instant cooling packs are used to treat sports injuries. When the pack is squeezed, a chemical reaction takes place and the pack becomes very cold.

Which row shows the temperature change and the type of reaction taking place?

<table>
<thead>
<tr>
<th>temperature change</th>
<th>type of reaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>A decrease</td>
<td>endothermic</td>
</tr>
<tr>
<td>B decrease</td>
<td>exothermic</td>
</tr>
<tr>
<td>C increase</td>
<td>endothermic</td>
</tr>
<tr>
<td>D increase</td>
<td>exothermic</td>
</tr>
</tbody>
</table>

36 Which reaction is endothermic?
A \( 2\text{Ca} + \text{O}_2 \rightarrow 2\text{CaO} \)
B \( \text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2 \)
C \( \text{Ca} + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2 \)
D \( \text{CaO} + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O} \)
37 The mass of a beaker and its contents is plotted against time.

Which graph represents what happens when sodium carbonate reacts with an excess of dilute hydrochloric acid in an open beaker?

A  

B  

C  

D  

38 Ethanol is made by fermentation.

How is ethanol obtained from the fermentation mixture?

A  chromatography
B  crystallisation
C  filtration
D  fractional distillation

39 When crude oil is distilled, a number of fractions are collected. Which of these statements about the fractions is true?

A  Each fraction is a single pure substance.
B  Each fraction boils at the same temperature.
C  The fraction with the highest range of boiling points burns least well.
D  The fraction with the lowest range of boiling points burns with very sooty flame.

40 Which statement about the compound shown below is correct?

\[
\begin{align*}
\text{H}_2\text{O} & \quad \text{C} \quad \text{CH}_2 \quad \text{CH}_3 \\
\end{align*}
\]

A  It is ethanoic acid.
B  It does not react with ammonia.
C  It is formed by oxidation of propanol.
D  It does not react with sodium carbonate.
Data Sheet

Colours of Some Common Metal Hydroxides

<table>
<thead>
<tr>
<th>Compound</th>
<th>Colour</th>
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<tr>
<td>calcium hydroxide</td>
<td>white</td>
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<tr>
<td>copper(II) hydroxide</td>
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<tr>
<td>iron(II) hydroxide</td>
<td>green</td>
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<tr>
<td>iron(III) hydroxide</td>
<td>red-brown</td>
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<tr>
<td>lead(II) hydroxide</td>
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</table>
The Periodic Table of Elements

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</tbody>
</table>

The volume of one mole of any gas is 24 dm$^3$ at room temperature and pressure (r.t.p.).
SECONDARY 4 EXPRESS / 5 NORMAL ACADEMIC PRELIM EXAMINATION 2019

SCIENCE (CHEMISTRY) 5076/03, 5078/03
Paper 3 Chemistry
Thursday 1040 – 1155
29 August 2019
1 hour 15 minutes

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

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on all the work you hand in.
You may use a soft pencil for any diagrams, graphs, tables or rough working.
Write in dark blue or black pen.
Do not use staples, paper clips, 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 working 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.

This document consists of 15 printed pages, including the cover page.
Section A

Answer all questions in the spaces provided.

1 Fig. 1.1 shows the formulae of some gases found in a sample of polluted air.

Fig. 1.1

(a) Choose formulae from Fig. 1.1 to answer the following questions.

(i) Give the formulae of a gas that is produced by incomplete combustion of fuels.

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

(ii) Give the formulae of a gas that contributes to global warming when present in excess.

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

(iii) Give the formulae of two gases that each contain an element with an oxidation state of +2.

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

(b) It was found that two of the gases are acidic and may cause acid rain.

(i) Name the two gases.

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

(ii) Explain why acid rain is harmful to the environment.

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

(c) Which gas can be used to fill lightbulbs? Give a reason for your answer.

..................................................................................................................................................
.................................................................................................................................................. [1]
2. **$^{44}\text{Ca}$** is an isotope of calcium.

(a) Explain what is meant by the term *isotope*.

(b) Complete Table 2.1 to show the numbers of each type of particle in an atom of $^{44}\text{Ca}$.

<table>
<thead>
<tr>
<th>particle</th>
<th>number</th>
</tr>
</thead>
<tbody>
<tr>
<td>proton</td>
<td></td>
</tr>
<tr>
<td>neutron</td>
<td></td>
</tr>
<tr>
<td>electron</td>
<td></td>
</tr>
</tbody>
</table>

(c) Table 2.2 shows an ion of $^{44}\text{Ca}$ containing the following particles.

<table>
<thead>
<tr>
<th>particle</th>
<th>number</th>
</tr>
</thead>
<tbody>
<tr>
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<td>20</td>
</tr>
<tr>
<td>neutron</td>
<td>24</td>
</tr>
<tr>
<td>electron</td>
<td>18</td>
</tr>
</tbody>
</table>

Would you expect the number of electrons in an atom of calcium to be the same as that of its ion? Give a reason to justify your answer.

Need a home tutor? Visit smiletutor.sg
Table 3.1 shows the soil pH ranges required by different crops for growth.

<table>
<thead>
<tr>
<th>crop</th>
<th>pH range</th>
</tr>
</thead>
<tbody>
<tr>
<td>peanut</td>
<td>5.0 – 6.5</td>
</tr>
<tr>
<td>millet</td>
<td>6.0 – 6.5</td>
</tr>
<tr>
<td>sunflower</td>
<td>6.0 – 7.5</td>
</tr>
<tr>
<td>paprika</td>
<td>7.0 – 8.5</td>
</tr>
<tr>
<td>mango</td>
<td>5.5 – 6.0</td>
</tr>
</tbody>
</table>

(a) A farmer plants peanuts and millet crops. Only the peanut crop grows well.

(i) Predict the pH of the soil the farmer used.

(ii) Which other crop is most likely to grow well in the same soil?

(b) The farmer adds calcium hydroxide to the soil before adding fertiliser containing ammonium sulfate to the soil. Suggest one purpose of using calcium hydroxide.

(c) A reaction occurs between calcium hydroxide, \( \text{Ca(OH)}_2 \) and ammonium sulfate, \( (\text{NH}_4)_2\text{SO}_4 \). Explain why the farmer should not have added these two substances to the soil.

Include one chemical equation to support your answer.

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Fig. 4.1 describes a series of reaction for four substances A, B, C and D.

![Diagram of reactions]

Give the names of the following substances.

(a) (i) A, ........................................
(ii) B, ........................................
(iii) C, ........................................
(iv) D. ........................................ [4]

(b) Suggest the name of the metal ore from which grey metal A can be extracted from.

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

(c) Write an ionic equation to show the reaction between colourless solution B and aqueous sodium hydroxide.

.................................................................................................................. [1]
A student carried out some experiments to determine the relative reactivity of four metals, P, Q, R and S. Table 5.1 shows the results.

<table>
<thead>
<tr>
<th></th>
<th>metal P</th>
<th>metal Q</th>
<th>metal R</th>
<th>metal S</th>
</tr>
</thead>
<tbody>
<tr>
<td>solution of P nitrate</td>
<td>–</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>solution of Q nitrate</td>
<td>✔</td>
<td>–</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>solution of R nitrate</td>
<td>✔</td>
<td>X</td>
<td>–</td>
<td>✔</td>
</tr>
<tr>
<td>solution of S nitrate</td>
<td>✔</td>
<td>X</td>
<td>X</td>
<td>–</td>
</tr>
</tbody>
</table>

Key
- ✔ shows a reaction happened
- X show no reaction happened
- – show the experiment was not performed

(a) Arrange the metals in order of reactivity, starting with the most reactive metal.


(b) Metal S reacts with hydrochloric acid. What would you observe when metal S reacts with hydrochloric acid? Explain your reasoning.


(c) Metal P melts at 650 °C and boils at 1091 °C.

Describe the arrangement and movement of the particles in metal P at 666 °C. Draw a diagram in Fig. 5.2 to illustrate your answer.

Fig. 5.2

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Fig. 6.1 shows some characteristics and chemical reactions of two organic compounds, ethane and ethene.

(a) Fill in the missing boxes in Fig. 6.1. [3]

(b) Identify the following:

(i) name of reaction J ....................................................... [2]

(ii) condition K .......................................................... [2]

(c) Define what is meant by the term homologous series.

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

............................................................................................................ [1]
(d) Both ethane and ethene exist as colourless gases at room temperature and pressure. Describe a test which can be used to distinguish between these two gases.

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

7 Photochromic glass is used in sunglasses. In bright light, the glass darkens reducing the amount of light reaching the eye. When the light is less bright, the glass becomes colourless increasing the amount of light reaching the eye.

Photochromic glass contains very small amounts of the halides silver chloride and copper(I) chloride. The reaction between these two chlorides is considered to be a redox reaction.

\[ \text{AgCl} + \text{CuCl} \rightarrow \text{Ag} + \text{CuCl}_2 \]
colourless colourless grey colourless

(a) Explain why the reaction is redox.

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

(b) A student attempted to make a sample of pure silver chloride by reacting silver oxide with dilute hydrochloric acid. He did not succeed.

(i) Explain why the student was not successful in obtaining pure silver chloride.

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

(ii) Suggest and name two reagents that can be used to make silver chloride.

Outline the steps the student should take in order to make a pure and dry sample of silver chloride.

…………………………………………………………………………………………………………
…………………………………………………………………………………………………………
…………………………………………………………………………………………………………
…………………………………………………………………………………………………………
………………………………………………………………………………………………………… [3]
Ammonia, NH₃, has many uses. It is used predominantly in the manufacture of fertilisers to support agriculture. It is also used extensively in the chemical and textile industries. A very soluble gas, ammonia dissolves in water to form aqueous ammonia, an alkali.

Ammonia is made via a reaction between nitrogen and hydrogen known as the Haber process. This reaction can be represented by the following chemical equation:

\[ \text{N}_2(g) + 3\text{H}_2(g) \rightarrow 2\text{NH}_3(g) \]

Fig. 8.1 shows the percentage yield of ammonia when different temperatures and pressures are used during the manufacture of ammonia.

(a) State a source of hydrogen gas.

(b) A student made the following claim:

"Ammonia does not conduct electricity in gaseous state but it can conduct electricity in aqueous state."

Do you agree with the student’s claim? Explain your answer.
(c) (i) With reference to Fig. 8.1, do you think that it is better to use a higher temperature to manufacture ammonia? Explain your answer.

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

(ii) Use your knowledge of reacting particles to explain how the rate of reaction may be affected when the pressure used to manufacture ammonia increases.

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

(d) Calculate the maximum volume of ammonia gas that can be produced if 60 dm³ of hydrogen was made to react with excess nitrogen in the Haber process. [All volumes are measured at room temperature and pressure.]

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

(e) Draw a ‘dot and cross’ diagram to show the arrangement of electrons in one molecule of ammonia. Only the outer shell electrons need to be shown.

.............................................................................................................................................. [2]
Potassium is a Group I metal and it is typically stored in kerosene. When potassium is reacted with oxygen, potassium oxide is formed.

(a) (i) Explain why potassium is stored in kerosene.

(ii) Describe what you will observe when a piece of potassium metal reacts with cold water. Include a balanced chemical equation, with state symbols, to support your answer.

(iii) Suggest another use for kerosene.

(b) Draw a ‘dot and cross’ diagram to show the arrangement of electrons in potassium oxide. Only the outer shell electrons need to be shown.

(c) Potassium oxide exists as a solid at room temperature and pressure.

Use your knowledge of the bonding and structure in potassium oxide to justify this observation.
10 Group VII elements, also known as halogens, exist as diatomic molecules.

(a) (i) Define the term diatomic.

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

(ii) Explain why halogens exist as diatomic molecules.

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

(b) Describe two trends, in terms of physical properties, that can be observed in the Group VII elements.

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

(c) A student wanted to investigate the relative reactivity of two Group VII elements.

Chemicals provided include:
- aqueous sodium bromide
- aqueous sodium iodide
- bromine solution
- iodine solution

No other chemicals are available.

Describe two tests which the student can carry out to determine the relative reactivity of bromine and iodine. Include observations that may occur during the tests.

………………………………………………………………………………………………………………………… [3]
(d) Iodine can react with hydrogen to form hydrogen iodide, HI.

\[ \text{I}_2(\text{s}) + \text{H}_2(\text{g}) \rightarrow 2\text{HI}(\text{g}) \]

(i) Calculate the mass of solid that is required to form 256 g of hydrogen iodide.

(ii) Sketch a graph to show how the volume of hydrogen iodide produced changes with time during the experiment.
# Data Sheet

**Colours of Some Common Metal Hydroxides**

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<tr>
<td>iron(II) hydroxide</td>
<td>green</td>
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<tr>
<td>iron(III) hydroxide</td>
<td>red-brown</td>
</tr>
<tr>
<td>lead(II) hydroxide</td>
<td>white</td>
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<tr>
<td>zinc hydroxide</td>
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The Periodic Table of Elements

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<th>III</th>
<th>IV</th>
<th>V</th>
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<td>indium</td>
<td>thallium</td>
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<td>thallium</td>
</tr>
</tbody>
</table>

Key:
- proton (atomic number)
- atom name
- relative atomic mass

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).
<table>
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<tr>
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<td>D</td>
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<td>D</td>
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SEC 4E5N – SCIENCE (CHEMISTRY) 5076/5078 – PRELIM 2019 – SUGGESTED ANSWERS

PAPER 3 – Section A (45 marks)

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<tr>
<th>Qn</th>
<th>Answers</th>
<th>Mark</th>
</tr>
</thead>
</table>
| 1  | (a) (i) CO [1]  
     (ii) CO₂ [1]  
     (iii) CO [1] and NO [1]  
   (b) (i) nitrogen dioxide [1] and sulfur dioxide [1]  
         (ii) acidic gas that irritates the eyes and attacks the lungs, causing breathing difficulties / can lead to bronchitis or reacts with rainwater and causes acid rain, corrodes metal buildings / destroy stone structures / leaches important nutrients from the soil thereby destroy forest / lowers pH of water thereby killing aquatic lives [1]  
   (c) Argon / Ar as it is an inert / unreactive gas [1] | [8] |
| 2  | (a) Isotopes are atoms of the same element / with same number of protons but different number of neutrons / nucleon number. [1]  
   (b) proton: 20  
           neutron: 24  
           electron: 20  
           3 answers correct – [2]  
           1 – 2 answers correct – [1]  
           0 answer correct – [0]  
   (c) the no. of electrons in an atom is expected to be different from that of an ion. [must answer but no mark awarded]  
     Atom is electrically neutral / no. of electrons is the same as no. of protons in an atom [1]  
     whereas the no. of electrons is 2 fewer in a calcium ion as a calcium atom has lost 2 valence electrons [0.5] to achieve the stable noble gas configuration [0.5] | [5] |
| 3  | (a) (i) any pH greater than or equals to 5.0 but less than 6.0 [1]  
         (ii) mango [1]  
   (b) calcium hydroxide: to neutralise / remove excess H⁺ ion / soil acidity [1]  
         reject: to increase pH of the soil  
   (c) Ammonium sulfate will react with calcium calcium hydroxide to form ammonia [1] which is liberated and leads to a loss of nitrogen that is essential for plant growth [1].  
     \[ \text{Ca(OH)}_2 + (\text{NH}_4)_2\text{SO}_4 \rightarrow \text{CaSO}_4 + 2\text{NH}_3 + 2\text{H}_2\text{O} \] [1] | [6] |
4 (a) (i) iron \([1]\)
   (ii) sulfuric acid \([1]\)
   (iii) iron(II) sulfate \([1]\)
   (iv) iron(II) hydroxide \([1]\)
(b) haematite \([1]\)
(c) \(\text{H}^+\text{(aq)} + \text{OH}^-(\text{aq}) \rightarrow \text{H}_2\text{O}()\) \([1]\)

5 (a) P, S, R, Q \([1]\)
(b) effervescence can be observed \([1]\)
   metal S reacts with hydrochloric acid to form salt and hydrogen gas \([1]\)
(c) the particles are close together in a disorderly arrangement \([1]\)
   the particles are able to move freely throughout the entire volume \([1]\)
   
   \[\text{students must draw at least 9 particles} - [0.5]\]
   \[\text{particles are close together and of the same size} - [0.5]\]
   \[\text{zero mark if student identified wrong physical state}\]

6 (a) structural formula of ethene \([1]\)

\[
\text{polymerisation of ethene} \ [1]
\]

\[
\text{general formula of alkanes: } \text{C}_n\text{H}_{2n+2} \ [0.5]
\]

\[
\text{general formula of alkenes: } \text{C}_n\text{H}_{2n} \ [0.5]
\]
(b) (i) hydrogenation \([1]\)
   (ii) UV light \([1]\)
(c) A homologous series is a family of organic compounds which has the same functional group, \([0.5]\) + one of the following
   \[\text{same general formula} \ [0.5]\]
   \[\text{each successive member differing in composition by a } \text{-CH}_2- \text{group} \ [0.5]\]
   \[\text{similar chemical properties} \ [0.5]\]
(d) **Bubble the gases** separately into **aqueous bromine / bromine solution**. [1] 
Gas is **alkene** if reddish-brown solution decolourises. Gas is **alkane** if the reddish-brown solution remains.

**7**

(a) O.S. of copper increased from +1 in CuCl to +2 in CuCl₂ or Cu⁺ loses an electron and is oxidised to form Cu²⁺ [1]

O.S. of silver decreased from +1 in AgCl to 0 in Ag or Ag⁺ gains an electron and is reduced to form Ag [1]

Since reduction and oxidation occurred simultaneously, the reaction is redox. (−0.5 if concluding statement is missing)

(b) (i) the silver chloride produced forms an **insoluble layer** around the insoluble **silver oxide**, preventing further reaction with the acid. [1]

(ii) **any 2 aqueous reagents** that can be used to make **silver chloride** [1]

Mix the two aqueous reagents together [0.5]
Filter the mixture to obtain **silver chloride as residue** [0.5]
Wash the silver chloride residue with distilled water [0.5]
Dry by pressing between sheets of filter paper [0.5]

**PAPER 3 – Section B (20 marks)**

<table>
<thead>
<tr>
<th>Qn</th>
<th>Answers</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>(a) <strong>cracking of petroleum / crude oil</strong> [1]</td>
<td>[10]</td>
</tr>
</tbody>
</table>
|    | (b) **Agree with student [no mark awarded]**  
Ammonia does not conduct electricity in gaseous state as there are **no free moving ions and electrons** to act as charge carriers. [1]  
The presence of free moving ions in aqueous ammonia act as charge carriers to conduct electricity. [1] | |
|    | (c) (i) **No, it is better to use lower temperature**  
The percentage of ammonia produced decreases when a higher temperature is used [1] | |
|    | (ii) **as pressure increases, there are more particles per unit volume** [0.5] **no. of effective collisions increase**, [0.5] therefore **rate of reaction increases** [1] | |
|    | (d) Based on the given equation, no. of moles of H₂:NH₃ is 3:2. [1]  
max. volume of NH₃ produced  
= (2 + 3) × 60  
= **40.0 dm³** [1] | |
|    | **alternative answer**  
max. volume of NH₃ produced  
= (60 ÷ 24) × (2 ÷ 3) × 24 | |
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Potassium oxide has a giant ionic structure. [0.5] A large amount of energy required [0.5] to overcome the strong electrostatic forces of attraction between the oppositely charged ions, [0.5] hence it has a relatively high melting point [0.5] and exists as a solid at r.t.p.
(a) (i) two atoms covalently bonded / chemically combined together [1]

(ii) as the atoms have 7 valence electrons, [0.5] they share electrons to achieve the stable noble gas configuration [0.5]

(b) Down the group,
- colour intensity increases
- melting and/or boiling points increase
- physical state at r.t.p. goes from gas to liquid to solid
- any two of the above physical properties [2]

(c) add bromine solution to aqueous sodium iodide [0.5]
if reddish-brown brome solution turns colourless / decolourises, [0.5] a displacement reaction has taken place and bromine is more reactive than iodine [0.5]

add iodine solution to sodium bromide solution. [0.5]
the solution turns yellow / black solids formed in the solution [0.5]
which shows that displacement reaction did not take place and iodine is less reactive than bromine [0.5]

R: solution turns black

(d) no. of moles of hydrogen iodide
= 256 \div (127 + 1)
= 256 \div 128
= 2.00 \text{ mol} [1]

no. of moles of iodine
= 0.5 \times \text{ no. of moles of hydrogen iodide}
= 0.5 \times 2.00
= 1.00 \text{ mol}

mass of solid (iodine) required
= 1.00 \times (127 \times 2)
= 1.00 \times 254
= 254 \text{ g} [1]

(e) volume of hydrogen iodide / cm³

![Correct shape of graph – 1]([1])
INSTRUCTIONS TO CANDIDATES

Write your name, class and register number on the Answer Sheet in the spaces provided unless this has been done for you.

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 Answer Sheet.

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 19.
A copy of the Periodic Table is printed on page 20.
1 One of the instructions for an experiment reads as follows:

‘Add about 30 cm³ of hydrochloric acid into a conical flask.’

Which of the following apparatus should be used to measure the stated volume of acid?

A burette
B beaker
C pipette
D measuring cylinder

2 The following diagram shows the result of a chromatogram obtained from two mixtures, X and Y.

Which of the substance(s) is/are present in mixture Y but not mixture X?

A S only
B T only
C Q and S only
D R and T only
3 A chemist discovered four unknown solids $W, X, Y$ and $Z$ during a research trip. He conducted a few experiments to identify these solids. Below are the results of these experiments.

<table>
<thead>
<tr>
<th>Solid $W$</th>
<th>Solid $X$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid $W$ has a constant composition and decomposes into two elements when heated.</td>
<td>Solid $X$ is coloured grey and is attracted to a magnet. It cannot be decomposed into anything simpler.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Solid $Y$</th>
<th>Solid $Z$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid $Y$ is coloured white. Only some parts dissolve in an excess of water.</td>
<td>Solid $Z$ is black. It can be formed by strongly heating copper in oxygen.</td>
</tr>
</tbody>
</table>

Which of the above solid can be classified as a compound?

A Solid $W$ only
B Solid $Y$ only
C Solid $X$ and $Y$
D Solid $W$ and $Z$

4 The table gives data about four substances.

In which substance are the particles far apart and moving randomly at high speeds at room temperature?

<table>
<thead>
<tr>
<th>melting point / °C</th>
<th>boiling point / °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 62</td>
<td>149</td>
</tr>
<tr>
<td>B -18</td>
<td>82</td>
</tr>
<tr>
<td>C -128</td>
<td>-25</td>
</tr>
<tr>
<td>D 1050</td>
<td>1648</td>
</tr>
</tbody>
</table>
The graph below shows the trend of a property of the elements in period 3.

What is the property?

A charge of ions  
B ease of gaining electrons  
C number of electron shells  
D number of valence electrons

The nucleon number and proton number of an atom of \( U \) and an atom of \( V \) are shown.

<table>
<thead>
<tr>
<th></th>
<th>( U )</th>
<th>( V )</th>
</tr>
</thead>
<tbody>
<tr>
<td>nucleon number</td>
<td>23</td>
<td>24</td>
</tr>
<tr>
<td>proton number</td>
<td>11</td>
<td>10</td>
</tr>
</tbody>
</table>

A An atom of \( U \) has fewer electrons than an atom of \( V \).  
B An atom of \( U \) has fewer neutrons than an atom of \( V \).  
C \( U \) is above \( V \) in the same group of the Periodic Table.  
D \( U \) is in the same period in the Periodic Table as \( V \).
7 Which of the following could be magnesium oxide?

<table>
<thead>
<tr>
<th></th>
<th>melting point / °C</th>
<th>boiling point / °C</th>
<th>electrical conductivity of solid</th>
<th>liquid</th>
<th>solution in water</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>-112</td>
<td>-83.7</td>
<td>poor</td>
<td>poor</td>
<td>good</td>
</tr>
<tr>
<td>B</td>
<td>660</td>
<td>2470</td>
<td>good</td>
<td>good</td>
<td>insoluble</td>
</tr>
<tr>
<td>C</td>
<td>801</td>
<td>1413</td>
<td>poor</td>
<td>good</td>
<td>good</td>
</tr>
<tr>
<td>D</td>
<td>1610</td>
<td>2230</td>
<td>poor</td>
<td>poor</td>
<td>insoluble</td>
</tr>
</tbody>
</table>

8 The bonding in sulfuric acid can be represented by the structure shown.

What is the total number of electrons in the covalent bonds surrounding the sulfur atom?

A 6  
B 8  
C 10  
D 12

9 Solution X turns aqueous potassium iodide from colourless to brown.
What must solution X contain?

A an alkali  
B a reducing agent  
C an oxidising agent  
D an ammonium salt
A thermometer is placed in water and the temperature is measured as shown. An endothermic change takes place as a solid is dissolved in the water. The temperature changes by 5.0 °C.

What is the final temperature shown by the thermometer?

A 37.5 °C  
B 38.0 °C  
C 47.5 °C  
D 48.0 °C

Hydrated magnesium sulfate has the molecular formula MgSO₄·5H₂O. What is the relative molecular mass, \( M_r \), of hydrated magnesium sulfate?

A 110  
B 206  
C 210  
D 220

What is the mass of sodium hydroxide present in 0.5 dm³ of 2.5 mol/dm³ sodium hydroxide solution?

A 1.25 g  
B 5 g  
C 50 g  
D 200 g
13. Which of the following compounds has the most number of atoms?

A. 1 mol of NH₄NO₃
B. 1 mol of CO(NH₂)₂
C. 1 mol of (NH₄)₂CO₃
D. 1 mol of NH₄Cl

14. Which of the following is not a reason for recycling metals?

A. The supply of metal ores on the earth is limited.
B. Extraction of metal from metal ores requires fossil fuels which are finite.
C. Recycling of metals causes less pollution than extracting metals from metal ores.
D. Recycling metals is more expensive than extracting metals from metal ores.

15. Which pair of substances act as reducing agents in the blast furnace?

A. carbon and oxygen
B. carbon and carbon monoxide
C. carbon dioxide and oxygen
D. carbon dioxide and carbon monoxide

16. A salt is prepared by titration by reacting a carbonate and an acid. Which of the following shows the correct solubilities of carbonate, acid and salt?

<table>
<thead>
<tr>
<th></th>
<th>carbonate</th>
<th>acid</th>
<th>salt</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>soluble</td>
<td>soluble</td>
<td>soluble</td>
</tr>
<tr>
<td>B</td>
<td>insoluble</td>
<td>soluble</td>
<td>soluble</td>
</tr>
<tr>
<td>C</td>
<td>soluble</td>
<td>soluble</td>
<td>insoluble</td>
</tr>
<tr>
<td>D</td>
<td>insoluble</td>
<td>soluble</td>
<td>insoluble</td>
</tr>
</tbody>
</table>

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17 Carbon monoxide is a pollutant emitted from car exhausts.

Which of its properties makes it harmful to humans?

A It has no colour, taste or smell.
B It has a corrosive action on lung tissue.
C It forms a stable compound with haemoglobin causing lack of oxygen.
D It combines with oxygen in the lungs resulting in breathing difficulty.

18 Which gas is the main cause of damage to stonework on buildings?

A methane
B nitrogen
C carbon monoxide
D sulfur dioxide

19 Which property of the alkanes does not increase as the relative molecular mass increases?

A boiling point
B flammability
C density
D viscosity
20 The following formula represents a monomer.

\[
\text{CH}_3\text{CF}_3 \\
\text{C} = \text{C} \\
\text{H} \cdot \text{H}
\]

Which formula shows a part of the polymer chain formed from 3 molecules of the monomer?

A

\[
\begin{array}{c}
\text{CH}_3 \text{F} \quad \text{CH}_3 \text{F} \quad \text{CH}_3 \text{F} \\
\text{H} \quad \text{F} \quad \text{H} \quad \text{F} \quad \text{H} \\
\end{array}
\]

B

\[
\begin{array}{c}
\text{CH}_3 \text{CF}_3 \quad \text{CH}_3 \text{CF}_3 \quad \text{CH}_3 \text{CF}_3 \\
\text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \\
\end{array}
\]

C

\[
\begin{array}{c}
\text{H} \quad \text{H} \quad \text{H} \quad \text{F} \quad \text{H} \\
\text{C} = \text{C} \quad \text{H} \quad \text{H} \quad \text{F} \quad \text{H} \\
\end{array}
\]

D

\[
\begin{array}{c}
\text{CH}_3 \quad \text{CH}_3 \quad \text{CF}_3 \quad \text{CF}_3 \quad \text{CH}_3 \\
\text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \\
\end{array}
\]
Colours of some common metal hydroxides

<table>
<thead>
<tr>
<th>Metal Hydroxide</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>aluminium hydroxide</td>
<td>white</td>
</tr>
<tr>
<td>calcium hydroxide</td>
<td>white</td>
</tr>
<tr>
<td>copper(II) hydroxide</td>
<td>light blue</td>
</tr>
<tr>
<td>iron(II) hydroxide</td>
<td>green</td>
</tr>
<tr>
<td>iron(III) hydroxide</td>
<td>red-brown</td>
</tr>
<tr>
<td>lead(II) hydroxide</td>
<td>white</td>
</tr>
<tr>
<td>zinc hydroxide</td>
<td>white</td>
</tr>
</tbody>
</table>
The Periodic Table of Elements

<table>
<thead>
<tr>
<th>Group</th>
<th>Periodic Table Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Na, Mg, Al</td>
</tr>
<tr>
<td>II</td>
<td>K, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, Ge, As, Se, Br, Kr</td>
</tr>
<tr>
<td>III</td>
<td>Rb, Sr, Y, Zr, Nb, Mo, Tc, Ru, Rh, Pd, Ag, Cd, In, Sn, Sb, Te, I, Xe</td>
</tr>
<tr>
<td>IV</td>
<td>Cs, Ba, Lanthanoids, Actinoids</td>
</tr>
<tr>
<td>V</td>
<td>Fr, Ra, Actinoids, Lanthanoids</td>
</tr>
</tbody>
</table>

Key:
- Proton (atomic) number
- Atomic symbol
- Relative atomic mass

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).
INSTRUCTIONS TO CANDIDATES
Write your name, class and register number in the spaces provided at the top of this page. Write in dark blue or black pen. You may use a soft pencil for any diagrams, graphs or rough working.

Section A [45 marks]
Answer all questions. Write your answers in the spaces provided on the Question Paper.

Section B [20 marks]
Answer any two questions. Write your answers in the spaces provided on the Question Paper.

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 15. A copy of the Periodic Table is printed on page 16.

For Examiner's Use

Parent's Signature

<table>
<thead>
<tr>
<th>Section A</th>
<th>Section B</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This paper consists of 16 printed pages and no blank page. Setter: Ms Lim Si Ting Need a home tutor? Visit smiletutor.sg
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Section A

Answer all the questions in this section in the spaces provided.

A1 Details of the oxides of elements in Period 3 of the Periodic Table are shown in Table 1.1.

<table>
<thead>
<tr>
<th>group number of elements</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
<th>VII</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>formula of oxide</td>
<td>Na₂O</td>
<td>MgO</td>
<td>Al₂O₃</td>
<td>SiO₂</td>
<td>P₂O₅</td>
<td>SO₃</td>
<td>Cl₂O</td>
<td>None</td>
</tr>
<tr>
<td>approximate melting point of oxide °C</td>
<td>900</td>
<td>3000</td>
<td>2000</td>
<td>1500</td>
<td>600</td>
<td>20</td>
<td>-20</td>
<td></td>
</tr>
</tbody>
</table>

Table 1.1

(a) Name the oxide that will react with both acids and alkalis. [1]

(b) Explain why Group 0 elements do not form oxides. [1]

(c) (i) Draw the ‘dot and cross’ diagram of Na₂O and Cl₂O. [4]
Show only valence electrons.

Na₂O:
(ii) Na₂O and Cl₂O has boiling points 1950 °C and -123 °C respectively. Using structure and bonding, explain the difference between the melting point of Na₂O and Cl₂O.

[Total: 9 marks]
Linoleic acid is an unsaturated carboxylic acid used to make fats. It has the structural formula shown below.

![Diagram 2.1](image)

A2

(a) Explain the term *unsaturated*. 

(b) Name the two functional groups present in Linoleic acid.

*Functional group 1:* ………………………………………………………………. 

*Functional group 2:* ………………………………………………………………. 

(c) State the observations if the following reagents were added to Linoleic acid.

(i) aqueous bromine 

(ii) universal indicator 

[Total: 5 marks]
A3 An experimental set-up to determine the speed of reaction between marble chips, CaCO₃, and 0.1 mol/dm³ of excess dilute hydrochloric acid is shown in Figure 3.1. The reaction starts when the thread is released and marble chips in the small test-tube is mixed with dilute hydrochloric acid.

![Figure 3.1](image)

A graph of mass against time was plotted to measure the speed of reaction.

(a) Explain why the mass of the reaction mixture decreases as the reaction proceeds. [1]

(b) Using the graph, state what happens to the speed of reaction as time increases. Explain your answer using collision theory. [2]
(c) Sketch on the graph above, the results obtained if

(i) 0.05 mol/dm³ of hydrochloric acid is used, [1]

(ii) powdered marble is used. [1]

(d) Using collision theory, explain your answer in (c)(i). [2]

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

(e) Calculate the number of moles of carbon dioxide produced in the reaction. [1]

[Total: 8 marks]
A4. The flow chart below describes some of the properties and reactions of several substances.

(a) Suggest the identity of the following substances:

A ........................................................

B ........................................................

C ........................................................

D ........................................................

E ........................................................

(b) Write an ionic equation for the formation of white precipitate B.

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

(c) State the name of reaction F. Explain your answer using the gain or loss of electrons.

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

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

[Total: 8 marks]

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A5 To separate the components of clean air industrially, the air must be cooled to -200 °C before entering a cryogenic (low temperature) air separation unit as shown in Figure 5.1.

(a) Deduce the separation method used in Figure 5.1. [1]

(b) Describe what happens to the movement and arrangement of air particles as it is cooled to -200 °C. [2]

(c) After separation of the components of air, the gases are stored in gas tanks. The technician accidently mixed up the gas tank labels between oxygen gas and nitrogen gas.

Suggest a chemical test that can be used to distinguish between the gas tank with oxygen gas and the gas tank with nitrogen gas. [2]

[Total: 5 marks]
A6 Solid Rocket Boosters (SRBs) are the main source of thrust for the Space Shuttle during the first two minutes of flight. The main components in SRBs are aluminium and ammonium perchlorate that reacts to produce a lot of heat and energy for the space shuttle to take off.

The chemical equation for the reaction can be represented as:

\[ 10 \text{Al} + 6 \text{NH}_4\text{ClO}_4 \rightarrow 4 \text{Al}_2\text{O}_3 + 2 \text{AlCl}_3 + 12 \text{H}_2\text{O} + 3 \text{N}_2 \]

(a) Suggest whether the reaction between aluminium and ammonium perchlorate is an exothermic or endothermic reaction. Explain your answer.

(b) (i) Calculate the oxidation state of chlorine in ammonium perchlorate, \( \text{NH}_4\text{ClO}_4 \).

(ii) In terms of change in oxidation state, explain whether chlorine is oxidised or reduced in the reaction.

[Total: 5 marks]
Table 7.1 shows the proportions of some of the exhaust gases released by a car.

<table>
<thead>
<tr>
<th>gas</th>
<th>% in exhaust gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>carbon dioxide</td>
<td>6.0</td>
</tr>
<tr>
<td>carbon monoxide</td>
<td>4.0</td>
</tr>
<tr>
<td>oxygen</td>
<td>8.0</td>
</tr>
<tr>
<td>unburnt hydrocarbon</td>
<td>1.5</td>
</tr>
<tr>
<td>nitrogen oxides</td>
<td>0.2</td>
</tr>
<tr>
<td>sulfur dioxide</td>
<td>trace</td>
</tr>
</tbody>
</table>

Table 7.1

(a) Explain how this data shows that complete combustion is not taking place in the car exhaust. [1]

(b) (i) Explain how nitrogen oxides are formed in the car exhaust. [2]

(ii) State and explain the environmental effects of nitrogen oxides. [2]

[Total: 5 marks]
Section B

Answer any **two** questions.
Write your answers in the spaces provided.

**B8** Table 8.1 shows the properties of some compounds.

<table>
<thead>
<tr>
<th>substance</th>
<th>chemical formula</th>
<th>solubility in water</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>potassium sulfate</td>
<td></td>
<td>soluble</td>
<td></td>
</tr>
<tr>
<td>HNO₃</td>
<td></td>
<td>soluble</td>
<td>1.0</td>
</tr>
<tr>
<td>silver chloride</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>barium hydroxide</td>
<td></td>
<td>soluble</td>
<td></td>
</tr>
<tr>
<td>CaCO₃</td>
<td></td>
<td>insoluble</td>
<td></td>
</tr>
</tbody>
</table>

**Table 8.1**

(a) Fill in the blanks in Table 8.1. [4]

(b) (i) State the method used to prepare potassium sulfate. [1]

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(ii) Describe, with named reagents, the method used to prepare potassium sulfate solution. [3]

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Four different metals, A, B, C and D are tested in a laboratory. Their results are shown in Table 9.1.

<table>
<thead>
<tr>
<th>metal</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Has to be hot before it reacts with steam.</td>
</tr>
<tr>
<td>B</td>
<td>Does not react with steam. Reacts slowly with hydrochloric acid.</td>
</tr>
<tr>
<td>C</td>
<td>Only metal to react with cold water. The reaction with water is steady but not explosive.</td>
</tr>
<tr>
<td>D</td>
<td>Does not react with dilute sulfuric acid.</td>
</tr>
</tbody>
</table>

Table 9.1

(a) Place the metals, A, B, C and D in increasing order of reactivity. [1]

(b) One of the metals in Table 9.1 is magnesium.

(i) Which metal, A, B, C or D could be magnesium? [1]

(ii) Write a balanced equation for the reaction of magnesium described in Table 9.1. [1]

(iii) Calculate the volume of gas evolved from reacting 2.4 g of magnesium. [2]
(c) One of the metals in Table 9.1 is an alkali metal.

(i) Which metal, A, B, C or D could be an alkali metal? [1]

(ii) State two physical properties of alkali metals that differs from other metals. [2]

(iii) State and explain the chemical reactivity of alkali metals down the Group. [2]

[Total: 10 marks]

B10 Petroleum is a complex mixture of hydrocarbons. Table 10.1 shows the fractions obtained and the amounts produced by fractional distillation compared with the amount required.

<table>
<thead>
<tr>
<th>fraction</th>
<th>percentage produced (supply)</th>
<th>percentage required (demand)</th>
</tr>
</thead>
<tbody>
<tr>
<td>petroleum gas</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>petrol</td>
<td>14</td>
<td>45</td>
</tr>
<tr>
<td>naphtha</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>kerosene</td>
<td>15</td>
<td>7</td>
</tr>
<tr>
<td>diesel</td>
<td>10</td>
<td>22</td>
</tr>
<tr>
<td>heavy oil and bitumen</td>
<td>49</td>
<td>19</td>
</tr>
</tbody>
</table>

Table 10.1

(a) State one industrial use for naphtha. [1]

(b) (i) From Table 10.1, state the fraction which has demand exceeding the supply by the greatest amount. [1]
(ii) Name a chemical process that is used to meet the demands of the fraction stated in (b)(i). [1]

(c) Hydrogen is produced as one of the products from the chemical process in (b)(ii). Hydrogen undergoes addition reaction with alkenes.

(i) State the conditions for addition of hydrogen to alkenes. [1]

(ii) Draw the chemical equation, with full structural formula, for addition of hydrogen to propene. [2]

(d) Ethanol can be produced by fermentation of glucose. Describe, with the use of a chemical equation, how fermentation is carried out to produce pure ethanol. [4]

[Total: 10 marks]

End of Paper
DATA SHEET

Colours of some common metal hydroxides

<table>
<thead>
<tr>
<th>Metal Hydroxide</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>aluminium hydroxide</td>
<td>white</td>
</tr>
<tr>
<td>calcium hydroxide</td>
<td>white</td>
</tr>
<tr>
<td>copper(II) hydroxide</td>
<td>light blue</td>
</tr>
<tr>
<td>iron(II) hydroxide</td>
<td>green</td>
</tr>
<tr>
<td>iron(III) hydroxide</td>
<td>red-brown</td>
</tr>
<tr>
<td>lead(II) hydroxide</td>
<td>white</td>
</tr>
<tr>
<td>zinc hydroxide</td>
<td>white</td>
</tr>
</tbody>
</table>
The Periodic Table of Elements

<table>
<thead>
<tr>
<th>Group</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
<th>VII</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Li</td>
<td>4 Be</td>
<td>5 B</td>
<td>6 C</td>
<td>7 N</td>
<td>8 O</td>
<td>9 F</td>
<td>10 Ne</td>
<td>2 He</td>
</tr>
<tr>
<td>11 Na</td>
<td>12 Mg</td>
<td>13 Al</td>
<td>14 Si</td>
<td>15 P</td>
<td>16 S</td>
<td>17 Cl</td>
<td>18 Ar</td>
<td>4 Ar</td>
</tr>
<tr>
<td>19 K</td>
<td>20 Ca</td>
<td>21 Sc</td>
<td>22 Ti</td>
<td>23 V</td>
<td>24 Cr</td>
<td>25 Mn</td>
<td>26 Fe</td>
<td>27 Co</td>
</tr>
<tr>
<td>37 Rb</td>
<td>38 Sr</td>
<td>39 Y</td>
<td>40 Zr</td>
<td>41 Nb</td>
<td>42 Mo</td>
<td>43 Tc</td>
<td>44 Ru</td>
<td>45 Rh</td>
</tr>
<tr>
<td>55 Cs</td>
<td>56 Ba</td>
<td>57 La</td>
<td>58 Ce</td>
<td>59 Pr</td>
<td>60 Nd</td>
<td>61 Pm</td>
<td>62 Sm</td>
<td>63 Eu</td>
</tr>
<tr>
<td>72 Hf</td>
<td>73 Ta</td>
<td>74 W</td>
<td>75 Re</td>
<td>76 Os</td>
<td>77 Ir</td>
<td>78 Pt</td>
<td>79 Au</td>
<td>80 Hg</td>
</tr>
</tbody>
</table>

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).
Peirce Sec 4E and 5NA Science Chemistry SA2/prelim

Paper 1: MCQ

<p>| | | | | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
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<th></th>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>B</td>
<td>D</td>
<td>C</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>C</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td>16</td>
<td>17</td>
<td>18</td>
<td>19</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>C</td>
<td>C</td>
<td>D</td>
<td>B</td>
<td>A</td>
<td>C</td>
<td>D</td>
<td>B</td>
<td>B</td>
<td></td>
</tr>
</tbody>
</table>

Paper 3

Section A : 45 marks

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Marks</th>
<th>Marker’s comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>(a)</td>
<td>Aluminium oxide</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(b)</td>
<td>Group 0 elements have fully filled valence shell that makes them stable and will not form compounds.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(c)</td>
<td>(i)</td>
<td>Na₂O:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1m for correct dot and cross for ions</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1m for balancing charges</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cl₂O:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1m for correct sharing</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1m for correct valence electrons</td>
<td>2</td>
</tr>
</tbody>
</table>
(ii) Sodium oxide is an ionic compound with **strong electrostatic forces of attraction holding sodium ions and oxide ions** together.

While \( \text{Cl}_2\text{O} \) is a covalent molecule with **weak intermolecular forces of attraction holding molecules** together.

Thus, **more energy** is needed to overcome the strong electrostatic forces of attraction in sodium oxide as compared to weak intermolecular forces of attraction in \( \text{Cl}_2\text{O} \).  

<table>
<thead>
<tr>
<th>A2</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Total: 9 marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td></td>
<td>Any molecule that <strong>contains carbon-carbon double bonds</strong> is unsaturated.</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b)</td>
<td></td>
<td><strong>Functional group 1:</strong> carbon-carbon double bond</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(c)</td>
<td>(i)</td>
<td><strong>Reddish brown bromine water decolourises</strong> quickly.</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(ii)</td>
<td>Colour of universal indicator turns from <strong>green to orange/pink</strong></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>A3</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Total: 5 marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td></td>
<td><strong>Carbon dioxide is given off</strong> during the reaction.</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b)</td>
<td></td>
<td><strong>Rate of reaction decreases</strong> (^1) as time increases, because reactants are being used up, resulting in less reacting particles in the reaction mixture.(^1) <strong>When marble</strong> chips have fully reacted, the reaction stops.</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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*Note: The table includes a detailed explanation of the components and reactions, focusing on the electrostatic and intermolecular forces, the properties of sodium oxide and \( \text{Cl}_2\text{O} \), and observations during the reaction.*
(c) [Graph showing data points and lines]

(d) When the concentration of hydrochloric acid decreases, the amount of particles per unit volume decreases. This results in decrease in the frequency of effective collisions between reacting particles, thus rate of reaction decreases.

(e) Mass of CO₂ = 256.56 – 255.76 = 0.8 g
No. of mol = 0.8/44 = 0.0182 mol (3s.f.)

Total: 8 marks

A4 (a) A iron(II) sulfate
B barium sulfate
C iron(II) chloride
D iron(II) hydroxide
E iron (III) hydroxide

5 Chemical formulae are accepted.
<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(b)</td>
<td>Ba^{2+} (aq) + SO_{4}^{2-} (aq) → BaSO_{4} (s)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>(c)</td>
<td>Oxidation. Fe^{2+} loses one electron to produce Fe^{3+}.</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>A5</strong></td>
<td>Fractional distillation</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>(b)</td>
<td>From particles spaced far apart and moving at high speeds in all directions,[1] particles loses kinetic energy and are quite closely packed, sliding pass each other at 200 °C [1]</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>(c)</td>
<td>Take a sample of the gas and do a glowing splint test. If glowing split relights, the tank contains oxygen. If the glowing splint is extinguished, the gas is nitrogen.</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>8 marks</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>A6</strong></td>
<td>Reaction is exothermic [1] as the a lot of heat is produced.[1]</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>(b)</td>
<td>(i) +7</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>(ii)</td>
<td>Chlorine is reduced as its oxidation state decreases from +7 in NH_{4}ClO_{4} to -1 in AICI_{3}</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>5 marks</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>A7</strong></td>
<td>4% of carbon monoxide was produced in the the car exhaust.</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
(b) (i) **Temperature is very high** in the car exhaust.
Nitrogen combines with oxygen in the air to form nitrogen oxides.  

(ii) Reacts with water in the air to form acid rain,  
Which corrodes buildings and harm aquatic life and plants.  

Total: 5 marks

Section B: 20 marks

<table>
<thead>
<tr>
<th>B8</th>
<th>(a)</th>
<th>substance</th>
<th>chemical formula</th>
<th>solubility in water</th>
<th>pH</th>
<th>4</th>
<th>No half mark. Every 2 answers 1 mark</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Potassium sulfate</td>
<td>$K_2SO_4$</td>
<td>soluble</td>
<td>7.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nitric acid</td>
<td>HNO$_3$</td>
<td>soluble</td>
<td>1.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>silver chloride</td>
<td>AgCl</td>
<td>Insoluble</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Barium hydroxide</td>
<td>$Ba(OH)_2$</td>
<td>soluble</td>
<td>13.0 or 14.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Calcium carbonate</td>
<td>CaCO$_3$</td>
<td>insoluble</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(b) (i) Titration  

(ii) Add 25.0 cm$^3$ of sulfuric acid using a pipette into a conical flask.  
Fill a burette with potassium hydroxide. Add methyl orange indicator.
<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slowly add potassium hydroxide into sulfuric acid until sulfuric acid is completely neutralised.</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repeat the titration without the methyl orange indicator to produce potassium sulfate solution.</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(c)</td>
<td>2HNO₃ (aq) + CaCO₃ (s) → Ca(NO₃)₂ (aq) + H₂O(l) + CO₂ (g)</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 mark for state symbols</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total: 10 marks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**B9**

(a) D, B, A, C | 1 |

(b) (i) A | 1 |

(ii) Mg + H₂O → MgO + H₂ | 1 |

(iii) No. Of mol of Mg = 2.4/24 = 0.1 mol [1]
No of mol of H₂ = 0.1 mol
Volume of H₂ = 0.1 × 24 = 2.4 dm³[1] | 2 |

(c) (i) C | 1 |

(ii) Low density,
Low melting and boiling point,
Soft, can be cut with a knife | 2 Any 2 |

(iii) Down the group, reactivity increases [1] as the atomic size of atoms increases, thus valence electrons are further away from positively | 2 |
<table>
<thead>
<tr>
<th>B10</th>
<th>charged nucleus, making it <strong>easier for atoms to lose the valence electron</strong>. [1]</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>Chemical feedstock for industries.</td>
</tr>
<tr>
<td>(b)</td>
<td>Petrol</td>
</tr>
<tr>
<td>(i)</td>
<td>Catalytic cracking.</td>
</tr>
<tr>
<td>(ii)</td>
<td>Note: cracking also accepted</td>
</tr>
<tr>
<td>(c)</td>
<td>200°C, Nickel catalyst</td>
</tr>
<tr>
<td>(i)</td>
<td></td>
</tr>
<tr>
<td>(ii)</td>
<td></td>
</tr>
<tr>
<td>(d)</td>
<td>C₆H₁₂O₆ → 2C₂H₅OH + 2CO₂</td>
</tr>
<tr>
<td></td>
<td>Glucose solution is mixed with yeast and mixture is kept at about 37°C.</td>
</tr>
<tr>
<td></td>
<td>The apparatus is kept <strong>air tight with a rubber</strong> bung and delivery tube that</td>
</tr>
<tr>
<td></td>
<td>connects to limewater.</td>
</tr>
<tr>
<td></td>
<td>A dilute solution of <strong>ethanol</strong> is produced. Ethanol is obtained by fractional</td>
</tr>
<tr>
<td></td>
<td>distillation.</td>
</tr>
</tbody>
</table>
READ THESE INSTRUCTIONS FIRST
Write your class, index number and name on the Answer Sheet and this Question Paper
You may use a soft pencil for any diagrams, graphs, tables or rough working.
Write in soft pencil.
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.

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 11.
A copy of the Periodic Table is printed on page 12.
The use of an approved scientific calculator is expected, where appropriate.
1. A student mixes 25 cm³ samples of dilute hydrochloric acid with different volumes of aqueous sodium hydroxide.

In each case, the change in temperature is measured to test if the reaction is exothermic.

Which apparatus is **not** needed?

![Images of burette, stopwatch, pipette, thermometer]

2. The table shows the colours and solubilities in water of four solids.

<table>
<thead>
<tr>
<th>solid</th>
<th>colour</th>
<th>solubility in water</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>blue</td>
<td>insoluble</td>
</tr>
<tr>
<td>X</td>
<td>blue</td>
<td>soluble</td>
</tr>
<tr>
<td>Y</td>
<td>white</td>
<td>insoluble</td>
</tr>
<tr>
<td>Z</td>
<td>white</td>
<td>soluble</td>
</tr>
</tbody>
</table>

A mixture containing two of the solids is added to excess water, stirred and filtered. A blue filtrate and a white residue are obtained.

Which two solids are present in the mixture?

A. W and Y  
B. X and Y  
C. W and Z  
D. X and Z
Three substances have the following properties:

- substance 1 is brittle and conducts electricity;
- substance 2 melts at 5°C and boils at 150°C;
- substance 3 has a high melting point of 800°C.

What is the state of each substance at 65°C?

<table>
<thead>
<tr>
<th></th>
<th>substance 1</th>
<th>substance 2</th>
<th>substance 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>solid</td>
<td>solid</td>
<td>liquid</td>
</tr>
<tr>
<td>B</td>
<td>liquid</td>
<td>solid</td>
<td>solid</td>
</tr>
<tr>
<td>C</td>
<td>solid</td>
<td>liquid</td>
<td>solid</td>
</tr>
<tr>
<td>D</td>
<td>liquid</td>
<td>liquid</td>
<td>solid</td>
</tr>
</tbody>
</table>

An excess of sodium hydroxide is added to an aqueous solution of salt V and boiled. Ammonia gas is only given off after aluminium foil is added to the hot solution.

What could salt V be?

A. ammonium sulfate  
B. ammonium nitrate  
C. sodium sulfate  
D. sodium nitrate

The following diagram shows the symbol and some information about two particles T and U.

Which of the following is correct?

A. T and U are different elements with the same number of neutrons.  
B. T and U are different elements with the different number of neutrons.  
C. T and U will form negative ions of different charges.  
D. T and U are isotopes since they have the same number of neutrons.
6 The diagram shows the paper chromatograms of four substances, P, Q, R and S. They are made up of either elements or mixtures.

Which of the following conclusions can be made, based on the results?

A P is a pure substance.
B Q and S are the same elements.
C R is a mixture of elements Q and S.
D S is less soluble in the solvent used to run the chromatogram than Q.

7 The electronic structures of atoms M and N are shown.

M and N react to form an ionic compound.

What is the formula of this compound?

A \( \text{MN}_2 \)
B \( \text{M}_2\text{N} \)
C \( \text{MN}_6 \)
D \( \text{M}_2\text{N}_5 \)
8. The circles of different sizes represent atoms of different elements.

Which diagram can represent a gaseous mixture of oxygen and argon?

A  
B  
C  
D  


\[ \text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3 \]

What volume of nitrogen is needed to produce 48 dm\(^3\) of ammonia?

A  7 dm\(^3\)  
B  12 dm\(^3\)  
C  17 dm\(^3\)  
D  24 dm\(^3\)  

10. The diagram shows a match.

By striking the match, a chemical reaction takes place.

Which of the following sets about the chemical reaction is correct?

A  It is an endothermic reaction since energy is taken in as the match burns  
B  It is an endothermic reaction since energy is released as the match burns  
C  It is an exothermic reaction since energy is taken in as the match burns  
D  It is an exothermic reaction since energy is released as the match burns
11 When excess calcium carbonate chips are added to dilute hydrochloric acid, the reaction gradually becomes slower and finally comes to a stop.

Which statement best explains why this happens?

A The bubbles of carbon dioxide cover the surface of calcium carbonate.
B The concentration of acid gradually reduces to zero.
C The pieces of calcium carbonate gradually become smaller.
D An insoluble layer of oxide is formed on the calcium carbonate.

12 Copper metal reacts with silver bromide, according to the equation:

\[ \text{Cu} + 2\text{AgBr} \rightarrow \text{CuBr}_2 + 2\text{Ag} \]

Which of the following correctly describes this change?

A Copper is the reducing agent in this reaction.
B Copper is reduced.
C Silver ions are oxidised in this reaction.
D Silver ions are neither oxidised nor reduced in this reaction.

13 Two indicators, bromophenol blue and Congo red, show the following colours in acidic and alkaline solutions.

<table>
<thead>
<tr>
<th>indicator</th>
<th>acid</th>
<th>alkali</th>
</tr>
</thead>
<tbody>
<tr>
<td>bromophenol blue</td>
<td>yellow</td>
<td>blue</td>
</tr>
<tr>
<td>Congo red</td>
<td>violet</td>
<td>red</td>
</tr>
</tbody>
</table>

A few drops of each indicator are added to separate samples of a solution of pH 2.

What are the colours of the indicators in this solution?

<table>
<thead>
<tr>
<th></th>
<th>in a solution of pH 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>bromophenol blue is</td>
</tr>
<tr>
<td>A</td>
<td>blue</td>
</tr>
<tr>
<td>B</td>
<td>violet</td>
</tr>
<tr>
<td>C</td>
<td>yellow</td>
</tr>
<tr>
<td>D</td>
<td>yellow</td>
</tr>
</tbody>
</table>
14 In which experiment is there **no** reaction with limewater?

![Experiment A](image1)

![Experiment B](image2)

![Experiment C](image3)

![Experiment D](image4)

15 The table shows the densities of four Group I metals.

<table>
<thead>
<tr>
<th>metal</th>
<th>density, g/cm³</th>
</tr>
</thead>
<tbody>
<tr>
<td>lithium</td>
<td>0.53</td>
</tr>
<tr>
<td>sodium</td>
<td>0.97</td>
</tr>
<tr>
<td>potassium</td>
<td>0.86</td>
</tr>
<tr>
<td>rubidium</td>
<td>1.53</td>
</tr>
</tbody>
</table>

Which of these metals sinks in benzene (density = 0.88 g/cm³) but floats in nitrobenzene (density = 1.2 g/cm³)?

A lithium  
B sodium   
C potassium 
D rubidium
16 The diagrams show the reactions of three different metals with dilute hydrochloric acid.

Identify metals W, X and Y.

<table>
<thead>
<tr>
<th></th>
<th>W</th>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>copper</td>
<td>magnesium</td>
<td>zinc</td>
</tr>
<tr>
<td>B</td>
<td>copper</td>
<td>zinc</td>
<td>magnesium</td>
</tr>
<tr>
<td>C</td>
<td>magnesium</td>
<td>zinc</td>
<td>copper</td>
</tr>
<tr>
<td>D</td>
<td>zinc</td>
<td>magnesium</td>
<td>lead</td>
</tr>
</tbody>
</table>

17 An experiment to investigate the effect of treating iron with grease is shown.

The experiment is left for seven days.

After seven days, what would happen to the water levels in tubes X and Y?

<table>
<thead>
<tr>
<th></th>
<th>tube X</th>
<th>tube Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>falls</td>
<td>no change</td>
</tr>
<tr>
<td>B</td>
<td>rises</td>
<td>no change</td>
</tr>
<tr>
<td>C</td>
<td>rises</td>
<td>falls</td>
</tr>
<tr>
<td>D</td>
<td>no change</td>
<td>rises</td>
</tr>
</tbody>
</table>
Compounds $S$ and $T$ occur naturally.

$S$ is $\text{C}_6\text{H}_{14}$ and $T$ is $\text{C}_6\text{H}_{12}\text{O}_6$.

Which of the statements is correct?

A $T$ is not a hydrocarbon but it is present in crude oil.
B $S$ is not a hydrocarbon and it is not present in crude oil.
C $T$ is a hydrocarbon and it is present in crude oil.
D $S$ is a hydrocarbon and it is present in crude oil.

$X$, $Y$ and $Z$ are three hydrocarbons.

$X$ $\text{CH}_2\text{=CH}_2$ $Y$ $\text{CH}_3\text{=CH}=\text{CH}_2$ $Z$ $\text{CH}_3\text{=CH}_2\text{=CH}=\text{CH}_2$

What do they have in common?

1. They are all alkenes.
2. They have the same general molecular formula.
3. They all have the same boiling point.

A Statements 1 and 2 are correct.
B Statements 1 and 3 are correct.
C Statements 2 and 3 are correct.
D Statements 1, 2 and 3 are correct.
20 The structural formula of methyl propene is shown below.

\[ \text{\begin{tikzpicture}
    \begin{scope}[scale=0.5]
    \begin{scope}[shift={(0,0)}]
    \draw[thick] (0,0) -- (1,0) -- (2,1) -- (1,2) -- (0,2) -- cycle;
    \end{scope}
    \begin{scope}[shift={(0,0.5)}]
    \draw[thick] (0,0) -- (1,0) -- (2,1) -- (1,2) -- (0,2) -- cycle;
    \draw[thick] (0,0) -- (1,0);
    \draw[thick] (1,0) -- (2,1);
    \draw[thick] (2,1) -- (1,2);
    \draw[thick] (1,2) -- (0,2);
    \draw[thick] (0,2) -- (0,0);
    \end{scope}
    \end{scope}
\end{tikzpicture}} \]

It can undergo polymerisation to form a polymer.

Which diagram shows the correct structure of the polymer?

A
\[ \text{\begin{tikzpicture}
    \begin{scope}[scale=0.5]
    \begin{scope}[shift={(0,0)}]
    \draw[thick] (0,0) -- (1,0) -- (2,1) -- (1,2) -- (0,2) -- cycle;
    \end{scope}
    \begin{scope}[shift={(0,0.5)}]
    \draw[thick] (0,0) -- (1,0) -- (2,1) -- (1,2) -- (0,2) -- cycle;
    \draw[thick] (0,0) -- (1,0);
    \draw[thick] (1,0) -- (2,1);
    \draw[thick] (2,1) -- (1,2);
    \draw[thick] (1,2) -- (0,2);
    \draw[thick] (0,2) -- (0,0);
    \end{scope}
    \end{scope}
\end{tikzpicture}} \]

B
\[ \text{\begin{tikzpicture}
    \begin{scope}[scale=0.5]
    \begin{scope}[shift={(0,0)}]
    \draw[thick] (0,0) -- (1,0) -- (2,1) -- (1,2) -- (0,2) -- cycle;
    \end{scope}
    \begin{scope}[shift={(0,0.5)}]
    \draw[thick] (0,0) -- (1,0) -- (2,1) -- (1,2) -- (0,2) -- cycle;
    \draw[thick] (0,0) -- (1,0);
    \draw[thick] (1,0) -- (2,1);
    \draw[thick] (2,1) -- (1,2);
    \draw[thick] (1,2) -- (0,2);
    \draw[thick] (0,2) -- (0,0);
    \end{scope}
    \end{scope}
\end{tikzpicture}} \]

C
\[ \text{\begin{tikzpicture}
    \begin{scope}[scale=0.5]
    \begin{scope}[shift={(0,0)}]
    \draw[thick] (0,0) -- (1,0) -- (2,1) -- (1,2) -- (0,2) -- cycle;
    \end{scope}
    \begin{scope}[shift={(0,0.5)}]
    \draw[thick] (0,0) -- (1,0) -- (2,1) -- (1,2) -- (0,2) -- cycle;
    \draw[thick] (0,0) -- (1,0);
    \draw[thick] (1,0) -- (2,1);
    \draw[thick] (2,1) -- (1,2);
    \draw[thick] (1,2) -- (0,2);
    \draw[thick] (0,2) -- (0,0);
    \end{scope}
    \end{scope}
\end{tikzpicture}} \]

D
\[ \text{\begin{tikzpicture}
    \begin{scope}[scale=0.5]
    \begin{scope}[shift={(0,0)}]
    \draw[thick] (0,0) -- (1,0) -- (2,1) -- (1,2) -- (0,2) -- cycle;
    \end{scope}
    \begin{scope}[shift={(0,0.5)}]
    \draw[thick] (0,0) -- (1,0) -- (2,1) -- (1,2) -- (0,2) -- cycle;
    \draw[thick] (0,0) -- (1,0);
    \draw[thick] (1,0) -- (2,1);
    \draw[thick] (2,1) -- (1,2);
    \draw[thick] (1,2) -- (0,2);
    \draw[thick] (0,2) -- (0,0);
    \end{scope}
    \end{scope}
\end{tikzpicture}} \]

------ End of Paper ------
## Colours of Some Common Metal Hydroxides

<table>
<thead>
<tr>
<th>Compound</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>calcium hydroxide</td>
<td>white</td>
</tr>
<tr>
<td>copper(II) hydroxide</td>
<td>light blue</td>
</tr>
<tr>
<td>iron(II) hydroxide</td>
<td>green</td>
</tr>
<tr>
<td>iron(III) hydroxide</td>
<td>red-brown</td>
</tr>
<tr>
<td>lead(II) hydroxide</td>
<td>white</td>
</tr>
<tr>
<td>zinc hydroxide</td>
<td>white</td>
</tr>
</tbody>
</table>
The Periodic Table of Elements

<table>
<thead>
<tr>
<th>Group</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
<th>VII</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key</td>
<td>proton (atomic number)</td>
<td>atomic symbol</td>
<td>name</td>
<td>relative atomic mass</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>H</td>
<td>hydrogen</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>He</td>
<td>helium</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Li</td>
<td>lithium</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Be</td>
<td>beryllium</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>B</td>
<td>boron</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>C</td>
<td>carbon</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>N</td>
<td>nitrogen</td>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>O</td>
<td>oxygen</td>
<td>16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>F</td>
<td>fluorine</td>
<td>19</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).
CANDIDATE NAME

CLASS INDEX NUMBER

SCIENCE (CHEMISTRY, BIOLOGY) 5078/03
Paper 3 Chemistry 6 AUGUST 2019
1 hour 15 minutes

READ THESE INSTRUCTIONS FIRST
Write your class, index number and name on all the work you hand in.
You may use a soft pencil for any diagrams, graphs, tables or rough working.
Write in a dark blue or black pen.
Do not use staples, paper clips, 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 working 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 15.
A copy of the Periodic Table is printed on page 16.

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.

This document consists of 15 printed pages and 1 blank page.

Need a home tutor? Visit smiletutor.sg
Section A
Answer all questions in the spaces provided.

1 (a) Define the terms *molecule* and *element*.
   molecule
   ...................................................................................................................
   element
   ...................................................................................................................
   [2]

(b) Table 1.1 shows the composition of four particles E, F, G and H. The letters are not the chemical symbols.

<table>
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<tr>
<th>Particle</th>
<th>number of protons</th>
<th>number of neutrons</th>
<th>number of electrons</th>
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</thead>
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<td>12</td>
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</tr>
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<td>F</td>
<td>12</td>
<td>10</td>
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<tr>
<td>G</td>
<td>16</td>
<td>16</td>
<td>18</td>
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<tr>
<td>H</td>
<td>10</td>
<td>12</td>
<td>10</td>
</tr>
</tbody>
</table>

(i) What is the nucleon number of E?  
...................................................................................................................

(ii) Which particles are ions?  
...................................................................................................................

(iii) Which particles have the same chemical symbol?  
...................................................................................................................

(iv) Which particle is inert?  
...................................................................................................................

(v) Which particle is non-metal?  
................................................................................................................... [5]

[Total: 7]
This question is about carbon compounds. Look at the displayed formulae of some compounds in Fig. 2.1.

(a) Which of the compounds is a hydrocarbon that forms a single product with bromine?  

(b) Which two compounds have the same molecular formula?  

(c) When cracked, a molecule of dodecane, C_{10}H_{22}, gives compound E and one other hydrocarbon, X. Deduce the molecular formula of X.  

(d) Which of the compounds is formed when compound B is reacted with acidified potassium manganate (VII)?  

[Total: 4]
Fig. 3.1 below shows properties and reactions of several chemical substances.

(a) Identify substances A, B, C, D, E, F and G.

A
B
C
D
E
F
G

[7]

(b) Give the ionic equation for any one of the reactions included in Fig. 3.1.

[2]

[Total: 9]
4 Table 4.1 shows the atmospheric compositions for Earth and Venus.

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<thead>
<tr>
<th></th>
<th>Earth</th>
<th>Venus</th>
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<tr>
<td><strong>Distance from Sun / millions of km</strong></td>
<td>150</td>
<td>108</td>
</tr>
<tr>
<td><strong>Surface temperature / °C</strong></td>
<td>15</td>
<td>462</td>
</tr>
<tr>
<td><strong>Composition of atmosphere</strong></td>
<td>78% N₂ 21% O₂ 0.03% CO₂ (plus other gases)</td>
<td>97% CO₂ (plus other gases)</td>
</tr>
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</table>

(a) On both Earth and Venus, there are evidence of sulfur dioxide in their atmospheres. Suggest a possible source of sulfur dioxide in the atmosphere of Venus.

(b) There is more sulfur dioxide in the atmosphere of Venus than in that of Earth. Sulfur dioxide dissolves in water droplets present in the atmosphere of Venus. Predict, with a reason, the pH of water found on Venus.

(c) Rainwater never reaches the surface of Venus. Use the information in the table to suggest the reason.

(d)(i) On Earth, besides sulfur dioxide, nitrogen oxides are also found in its atmosphere. Explain in brief details, how nitrogen oxides come about on Earth.
What impact would the presence of sulfur dioxide and nitrogen oxides have on humans and buildings?

5. 12.16 g of anhydrous iron (II) sulfate was heated. It decomposed, according to the equation shown.

\[ 2\text{FeSO}_4 (s) \rightarrow \text{Fe}_2\text{O}_3 (s) + \text{SO}_2 (g) + \text{SO}_3 (g) \]

(a) Calculate the mass of iron (III) oxide formed.

(b) What is the total volume of gases produced (at r.t.p.) at the end of this decomposition reaction?

(c) Sulfur dioxide decolourises acidified potassium manganate (VII) solution. What can be said of its nature? Explain your answer.
6 (a) Complete the Table 6.1.

Table 6.1

<table>
<thead>
<tr>
<th>solution</th>
<th>approximate pH</th>
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<tr>
<td>(i) 0.2 mol/dm³ hydrochloric acid</td>
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</tr>
<tr>
<td>(ii) 0.1 mol/dm³ sodium hydroxide</td>
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<tr>
<td>(iii) a mixture of 20 cm³ of (i) and 40 cm³ of (ii)</td>
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</tbody>
</table>

(b) Table 6.2 lists the solubility of some substances in cold water.

Table 6.2

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<thead>
<tr>
<th>substance</th>
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<td>ammonium chloride</td>
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<td>calcium sulfate</td>
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<tr>
<td>lead (II) carbonate</td>
<td>insoluble</td>
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<tr>
<td>lead (II) chloride</td>
<td>insoluble</td>
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<td>lead (II) nitrate</td>
<td>soluble</td>
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<tr>
<td>sodium carbonate</td>
<td>soluble</td>
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<tr>
<td>sodium sulfate</td>
<td>soluble</td>
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</table>

(i) Which two substances from Table 6.2, when dissolved in water, can be mixed to form each of the following precipitates?

- calcium sulfate: 1. ____________________________________________ 2. ____________________________________________
- lead (II) carbonate: 1. ____________________________________________ 2. ____________________________________________ [2]

(ii) How could you prepare a pure sample of powdered lead (II) chloride from using two substances from Table 6.2?

- ____________________________________________  ____________________________________________  ____________________________________________  ____________________________________________  ____________________________________________  ____________________________________________  ____________________________________________ [3]

[Total: 8]
Section B
Answer any two questions in this section.
Write your answers in the spaces provided.

7. Iron is extracted from its ore using coke in a blast furnace in Fig. 7.1.

(a) Name the ore of iron that is mainly iron (III) oxide. [1]

(b) Describe the reactions occurring in the blast furnace. In your answer, include
   - two reasons for using coke in the blast furnace;
   - a chemical equation for the reduction of iron (III) oxide;
   - an explanation for using limestone in the blast furnace.

.................................................................................................................................................... [5]
Crude iron, also called pig iron, is first obtained from the blast furnace. This form of iron has high carbon content, making it very brittle. From your knowledge of iron and its alloys, explain its brittleness.

Iron reacts with dilute sulfuric acid, producing iron (II) sulfate solution as one of the products. When aqueous hydrogen peroxide is added to this solution of iron (II) sulfate, a yellow solution was formed. Explain this change.
8 Zinc reacts with hydrochloric acid to produce zinc chloride and hydrogen gas.

(a) Write the balanced chemical equation for this reaction.

\[ \text{Zinc reacts with hydrochloric acid to produce zinc chloride and hydrogen gas.} \]

An investigation was carried out to find out how fast different metals reacted with an acid. Zinc powder and iron powder were reacted separately with excess dilute hydrochloric acid, using the setup shown in Fig. 8.1 below.

![Fig. 8.1](image)

The volume of gas produced was measured and recorded every 10 seconds.

Three different experiments were conducted, according to the following:
- 50 cm³ hydrochloric acid and 0.15 g of zinc powder
- 50 cm³ hydrochloric acid and 0.15 g of iron powder
- 50 cm³ hydrochloric acid and 0.075 g of zinc powder mixed with 0.075 g of iron powder

The first two sets of results were plotted in the graph in Fig. 8.2 below.

![Fig. 8.2](image)
(b)(i) What was the rate of reaction of iron during the first 30 seconds of reaction?

\[
\text{rate of reaction} = \ldots \ldots \text{cm}^3/\text{s} \quad [1]
\]

(ii) Predict the total volume of hydrogen formed for the third experiment.

\[
\text{Total volume of hydrogen} = \ldots \ldots \text{cm}^3 \quad [1]
\]

(c) Using the mass of zinc, calculate the minimum concentration of hydrochloric acid used in the investigation.

\[ [3] \]

(d)(i) How would the experiment differ, if the concentration of acid be doubled?

\[ [2] \]

(ii) Explain your answer for (d)(i).

\[ [2] \]

[Total: 10]
9  (a)(i)  In the space below, draw the “dot and cross” diagram for potassium chloride, showing only the outershell electrons.  

(ii) How does the structure of a molecule of chlorine differ from this?  

(b) An experiment was carried out to determine the trend in reactivity of halogens. Table 9.1 shows the results obtained when solutions of halogens were added to different halide solutions.

<table>
<thead>
<tr>
<th>Halogen added</th>
<th>Halide solution</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>potassium</td>
<td>potassium</td>
</tr>
<tr>
<td></td>
<td>chloride</td>
<td>bromide</td>
</tr>
<tr>
<td>bromine</td>
<td>no reaction</td>
<td>no reaction</td>
</tr>
<tr>
<td>chlorine</td>
<td>no reaction</td>
<td>turns yellow</td>
</tr>
<tr>
<td></td>
<td></td>
<td>orange</td>
</tr>
<tr>
<td>iodine</td>
<td>no reaction</td>
<td>no reaction</td>
</tr>
</tbody>
</table>

(i) Use the results in the table to give the order of reactivity of the halogens. Explain your answer.  

(ii) Write a balanced chemical equation for any of the reactions.
(c) When silver nitrate solution is added to a solution of potassium bromide, a cream precipitate of silver bromide is formed. The following reaction takes place.

$$\text{AgNO}_3 (aq) + \text{KBr (aq)} \rightarrow \text{KNO}_3 (aq) + \text{AgBr (s)}$$

Calculate the mass of silver nitrate needed to form 47 g of silver bromide.
### Colours of Some Common Metal Hydroxides

<table>
<thead>
<tr>
<th>Compound</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>calcium hydroxide</td>
<td>white</td>
</tr>
<tr>
<td>copper(II) hydroxide</td>
<td>light blue</td>
</tr>
<tr>
<td>iron(II) hydroxide</td>
<td>green</td>
</tr>
<tr>
<td>iron(III) hydroxide</td>
<td>red-brown</td>
</tr>
<tr>
<td>lead(II) hydroxide</td>
<td>white</td>
</tr>
<tr>
<td>zinc hydroxide</td>
<td>white</td>
</tr>
</tbody>
</table>
The Periodic Table of Elements

<table>
<thead>
<tr>
<th>Group</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
<th>VII</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>Key</td>
<td></td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>proton (atomic number)</td>
<td>H</td>
<td></td>
<td>50</td>
<td>C</td>
<td></td>
<td>N</td>
<td>O</td>
<td>F</td>
</tr>
<tr>
<td>atomic symbol</td>
<td></td>
<td></td>
<td>118</td>
<td></td>
<td>B</td>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>relative atomic mass</td>
<td>1</td>
<td></td>
<td>120</td>
<td></td>
<td>Al</td>
<td></td>
<td></td>
<td>Ne</td>
</tr>
</tbody>
</table>

| 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100| 101 | 102| 103| 104| 105| 106| 107| 108| 109| 110| 111| 112| 113| 114| 115| 116| 117| 118| 119| 120| 121| 122| 123| 124| 125| 126| 127| 128| 129| 130| 131| 132| 133| 134| 135| 136| 137| 138| 139| 140| 141| 142| 143| 144| 145| 146| 147| 148| 149| 150| 151| 152| 153| 154| 155| 156| 157| 158| 159| 160| 161| 162| 163| 164| 165| 166| 167| 168| 169| 170| 171| 172| 173| 174| 175|

Lanthanoids:

| lanthanoids | 57 | La | lanthanum | 58 | Ce | cerium | 59 | Pr | praseodymium | 60 | Nd | neodymium | 61 | Pm | promethium | 62 | Sm | samarium | 63 | Eu | europium | 64 | Gd | gadolinium | 65 | Tb | terbium | 66 | Dy | dysprosium | 67 | Ho | holmium | 68 | Er | erbia | 69 | Tm | thulium | 70 | Yb | ytterbium | 71 | Lu | lutetium |

Actinoids:

| actinoids | 89 | Ac | actinium | 90 | Th | thorium | 91 | Pa | protactinium | 92 | U | uranium | 93 | Np | neptunium | 94 | Pu | plutonium | 95 | Am | americium | 96 | Cm | curium | 97 | Bk | berkellium | 98 | Cf | californium | 99 | Es | einsteinium | 100 | Fm | fermium | 101 | Md | mendelium | 102 | No | nobelium | 103 |

The volume of one mole of any gas is 24 dm$^3$ at room temperature and pressure (r.t.p.).
Section A
Answer all questions in the spaces provided.

1 (a)\textsuperscript{k} molecule \textit{Made up of two or more atoms chemically combined}

\begin{itemize}
  \item element \textit{Substance made up of atoms of same number of protons/}
  \begin{itemize}
    \item A pure substance that cannot be broken down into simpler
    \item substances by chemical processes
  \end{itemize}
\end{itemize} \hspace{1cm} [2]

(b)\textsuperscript{a}
\begin{enumerate}
  \item 24 \hspace{1cm} [1]
  \item F, G \hspace{1cm} [1]
  \item E and F \hspace{1cm} [1]
  \item H \hspace{1cm} [1]
  \item H \hspace{1cm} [1]
\end{enumerate}

\textbf{[Total: 7]}

2 (a)\textsuperscript{a} E \hspace{1cm} [1]

(b)\textsuperscript{u} C and F \hspace{1cm} [1]

(c)\textsuperscript{a} \textit{C}_8\textit{H}_{18} \hspace{1cm} [1]

(d)\textsuperscript{a} A \hspace{1cm} [1]

\textbf{[Total: 4]}

Need a home tutor? Visit smiletutor.sg
3 (a) A copper (II) hydroxide / Cu(OH)$_2$
B copper (II) sulfate / CuSO$_4$
C copper (II) oxide / CuO
D calcium sulfate / CaSO$_4$  
E calcium oxide / CaO  
F calcium hydroxide / Ca(OH)$_2$  
G water / H$_2$O

[b] A Correction balanced eqn [1]; correct state symbols [1]

[Total: 9]

4 (a) A Volcanic eruption / volcanoes;

(b) A pH 1 – 2 [1]:

sulfur dioxide is an acidic gas; OR SO$_2$ dissolves in water to form an acid [1]

(c) A Surface temperature of Venus is 462°C; [½]

water’s boiling point is 100°C; [½]

Before water has a chance to reach the surface, it would have turned into a gas / evaporated [1];

(d) (i) A In internal combustion engines of cars [1]:

High temperature of car engines cause nitrogen and oxygen to react; [1]

Producing nitrogen oxides; lightning activity / forest fires; high T causes N$_2$ and O$_2$ from air to react [2]

(ii) A These acidic gases [½] dissolve in rain water to form acid rain [½];

Cause respiratory problems for humans; [1]

Damage buildings / dissolve limestone / concrete structures; [1]

[Total: 10]

5 (a) A No. of mole of FeSO$_4$ used = 12.16 g / 152 = 0.08 mol [1]
Mole ratio of FeSO$_4$: Fe$_2$O$_3$ = 2:1
No. of mole of Fe$_2$O$_3$ formed = 0.04 mol [1]
Mass of Fe$_2$O$_3$ formed = 0.04 mol x 160 = 6.4 g [1]

[3]
Total no. of mole of gases produced = no. of mol of FeSO₄
= 0.08 mol; [1]
Total volume of gases produced = 0.08 mol x 24 dm³
= 1.92 dm³ OR 1,920 cm³ [1] [2]

Sulfur dioxide is a reducing agent [1]

Acidified potassium manganate (VII) is a strong oxidising agent; / 
O.S. of Mn changed from +7 in KMnO₄ to +2 in Mn²⁺;[1] 

[b] 6  (a) [1]  

<table>
<thead>
<tr>
<th>solution</th>
<th>approximate pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) 0.2 mol/dm³ hydrochloric acid</td>
<td>1</td>
</tr>
<tr>
<td>(ii) 0.1 mol/dm³ sodium hydroxide</td>
<td>14</td>
</tr>
<tr>
<td>(iii) a mixture of 20 cm³ of (i) and 40 cm³ of (ii)</td>
<td>7</td>
</tr>
</tbody>
</table>

(b) (i) [1]  

**calcium sulfate:**  
1. calcium chloride  
2. sodium sulfate  

**lead (II) carbonate:**  
1. lead (II) nitrate  
2. sodium carbonate  

(ii) [1]  

Mix Pb(NO₃)₂ with CaCl₂ or NH₄Cl; [1]  
Filter to obtain residue of calcium sulfate; [1]  
Rinse with distilled water and dry; [1]  

[Total: 8]
Section B
Answer two questions in the spaces provided.

7  (a) K  haematite  [1]

(b) U  Two reasons:

burning of coke exothermic, helps to heat furnace to high T [1];

To produce carbon monoxide, reducing agent for the reaction [1];

Fe₂O₃ + 3CO → 2Fe + 3CO₂; [1]

Limestone; decomposes to calcium oxide; reacts with acidic impurities or SiO₂; [1]

Combines to form calcium silicate / slag; [1]  [5]

(c) A  Carbon atom different size from iron;

Disrupts regular arrangement of iron atoms;

Cannot slide over each other;  [2]

(d) A  Hydrogen peroxide is an oxidising agent; [1]

Iron (II) ions oxidised by hydrogen peroxide into iron (III) ions. [1]  [2]

[Total: 10]

8  (a) A  Zn + 2HCl → ZnCl₂ + H₂  [1]

(b)(i) A  44 cm³ / 30 s = 1.47 cm³/s  [1]

rate of reaction = 1.47 cm³/s

(ii) A  (32 + 28) cm³ = 60 cm³  [1]

Total volume of hydrogen = 60 cm³

(c) A  Number of mole of zinc used = 0.15g / 65 = 0.0023 mol [1]

Mole ratio of Zn:HCl = 1:2; [½]

No. of mol of HCl used = 0.00468 mol [½]

Concentration of HCl = 0.00468 mol / 0.050 dm³

= 0.0936 mol/dm³ [1]  [3]
(d) (i) Smoother gradient/faster initial rate \([1]\),
same height where the curve levels off; \([1]\) \([2]\)

(ii) Zinc limiting reactant, final volume of gas produced depends on Zn; \([1]\)
Higher acid conc, more reactants for greater effective collisions \([1]\)
Faster initial rate; \([2]\)

[Total: 10]

9 (a)(i) Correct ion + correct charge – 1m each

\[
\begin{align*}
\text{K}^+ & \quad \text{Cl}^- \\
\end{align*}
\]

(ii) Covalent bonding from sharing electrons / 2 chlorine atoms covalently bonded; \([1]\)

(b) (i) Chlorine > Bromine > Iodine; ORA \([1]\)
Chlorine can displace both bromide and iodide, most reactive; /
Iodine cannot displace any halide; least reactive; /
Bromine can only displace iodide but not chloride; more reactive than iodine but less reactive than chlorine; [any 2 points for 2m] \([3]\)

(ii) Write a balanced chemical equation for any of the reactions.
\[
\text{Cl}_2 + 2\text{KI} \rightarrow 2\text{KCl} + \text{I}_2
\]

(c) \(Mr(\text{AgBr}) = 188, Mr(\text{AgNO}_3) = 170 \([1]\)\)
No. of mol of AgBr to produce = 47/188 = 0.25 \([1]\)
Mole ratio of AgBr:AgNO\(_3\) = 1:1 \([1/2]\)
No. of mol of AgNO\(_3\) needed = 0.25mol \([1/2]\)
Mass of AgNO\(_3\) needed = 0.25 \times 170 = 42.5 \text{ g} \([1]\)

Max 3m \([3]\)

[Total: 10]
READ THESE INSTRUCTIONS FIRST

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

Use soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your Class, Name and Class Index Number in the spaces at the top of this page and on the
Multiple Choice Answer Sheet.

Read the instructions on the Multiple Choice Answer Sheet carefully

There are forty questions in 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
Multiple Choice Answer Sheet.

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 13.
A copy of the Periodic Table is included on page 14.

The use of an approved scientific calculator is expected, where appropriate.
1. The conical flask contains compound X which is present in solid, liquid and gaseous states.

Which of the following is not correct?

A. A gaseous X molecule has a lower mass than a liquid X molecule.
B. Energy is released when X changes from gas to liquid.
C. Gas X molecules occupy a larger space than same number of liquid X molecules.
D. Solid X molecules vibrate about fixed positions.

2. The following diagrams show two methods of gas collection.

Which row gives the properties of a gas which could be collected by both methods?

<table>
<thead>
<tr>
<th>property 1</th>
<th>property 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>denser than air</td>
</tr>
<tr>
<td>B</td>
<td>less dense than air</td>
</tr>
<tr>
<td>C</td>
<td>denser than air</td>
</tr>
<tr>
<td>D</td>
<td>less dense than air</td>
</tr>
</tbody>
</table>

3. Substance E melts at -114 °C and boils at 78 °C. It is soluble in water.

Which method can be used to obtain a significant amount of a pure sample of E from a mixture of E and water?

A. crystallisation
B. filtration
C. fractional distillation
D. paper chromatography
4 Which of the following diagrams shows the arrangement of the atoms in stainless steel?

![Diagram A]

![Diagram B]

![Diagram C]

![Diagram D]

**Key**
- = iron atom
- = chromium atom
= carbon atom

5 The following apparatus can be used in the measurement of volumes of liquids:

- I 25 ml beaker
- II 50 ml burette
- III 25 ml graduated measuring cylinder
- IV 25 ml pipette

Which of the following shows the correct order of increasing accuracy of these apparatus?

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

6 The following graph shows the temperature changes when a 1:1 mixture of methanol (melting point: $-97 \degree C$, boiling point 65 $\degree C$) and propanol (melting point: $-89 \degree C$, boiling point: 82 $\degree C$) was distilled.

![Graph]

If a 3 cm$^3$ fraction of the distillate was collected at each of the points A, B, C and D indicated on the graph, which fraction would contain the highest proportion of propanol?
7 Nitric acid can be decomposed into nitrogen dioxide, water and oxygen as shown in the equation given below.

\[ 4 \text{HNO}_3(aq) \rightarrow 4\text{NO}_2(g) + 2\text{H}_2\text{O}(l) + \text{O}_2(g) \]

What volume of gas would be produced if 12.6 g of nitric acid was used?

A 1.2 dm³  
B 4.8 dm³  
C 6.0 dm³  
D 8.4 dm³

8 An element \(X\) has two isotopes, \(^{238}X\) and \(^{235}X\).

How does \(^{238}X\) differ from \(^{235}X\)?

A It has 3 more neutrons.  
B It has 3 more neutrons and 3 more electrons.  
C It has 3 more protons.  
D It has 3 more protons and 3 more electrons.

9 Which of the following pairs of ions cannot be distinguished using aqueous sodium hydroxide?

A \(\text{Ca}^{2+}\) and \(\text{Fe}^{2+}\)  
B \(\text{Cu}^{2+}\) and \(\text{Fe}^{3+}\)  
C \(\text{NH}_4^+\) and \(\text{H}^+\)  
D \(\text{Pb}^{2+}\) and \(\text{Zn}^{2+}\)

10 What are the two reagents that cannot be used to prepare a soluble salt of magnesium ethanoate?

A magnesium and ethanoic acid  
B magnesium carbonate and ethanoic acid  
C magnesium hydroxide and ethanoic acid  
D magnesium nitrate solution and potassium ethanoate solution
11. The electrical properties of four substances W, X, Y and Z are shown below:

<table>
<thead>
<tr>
<th>substance</th>
<th>electrical property</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>conducts electricity only in aqueous solution</td>
</tr>
<tr>
<td>X</td>
<td>conducts electricity when molten and in solid state</td>
</tr>
<tr>
<td>Y</td>
<td>conducts electricity when molten and in aqueous state</td>
</tr>
<tr>
<td>Z</td>
<td>does not conduct electricity under any conditions</td>
</tr>
</tbody>
</table>

What could these four substances be?

<table>
<thead>
<tr>
<th></th>
<th>W</th>
<th>X</th>
<th>Y</th>
<th>Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>CaCl₂</td>
<td>HC₁</td>
<td>P</td>
<td>Pb</td>
</tr>
<tr>
<td>B</td>
<td>HC₁</td>
<td>Pb</td>
<td>CaCl₂</td>
<td>P</td>
</tr>
<tr>
<td>C</td>
<td>P</td>
<td>CaCl₂</td>
<td>P</td>
<td>Pb</td>
</tr>
<tr>
<td>D</td>
<td>Pb</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

12. Metals W, X, Y and Z are placed in salt solutions as shown in the table

<table>
<thead>
<tr>
<th>result of placing metal in solution of</th>
<th>salt of W</th>
<th>salt of X</th>
<th>salt of Y</th>
<th>salt of Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>no reaction</td>
<td>X displaced</td>
<td>Y displaced</td>
<td>no reaction</td>
</tr>
<tr>
<td>X</td>
<td>no reaction</td>
<td>no reaction</td>
<td>no reaction</td>
<td>no reaction</td>
</tr>
<tr>
<td>Y</td>
<td>no reaction</td>
<td>X displaced</td>
<td>no reaction</td>
<td>no reaction</td>
</tr>
<tr>
<td>Z</td>
<td>W displaced</td>
<td>X displaced</td>
<td>Y displaced</td>
<td>no reaction</td>
</tr>
</tbody>
</table>

What is the order of reactivity of the metals from most reactive to least reactive?

A: Y → X → W → Z
B: Y → W → Z → X
C: Z → W → Y → X
D: Z → Y → X → W
13 The figures below show the particles in a substance at two different temperatures but at the same pressure.

Which of the following most likely indicates the melting point and boiling point of the substance?

<table>
<thead>
<tr>
<th></th>
<th>melting point / °C</th>
<th>boiling point / °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>180</td>
<td>200</td>
</tr>
<tr>
<td>B</td>
<td>23</td>
<td>80</td>
</tr>
<tr>
<td>C</td>
<td>-78</td>
<td>13</td>
</tr>
<tr>
<td>D</td>
<td>-123</td>
<td>-10</td>
</tr>
</tbody>
</table>

14 Which of the following shows the correct trends down the group for the melting point, density and atomic radius of alkali metals?

<table>
<thead>
<tr>
<th></th>
<th>melting point</th>
<th>density</th>
<th>atomic radius</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>increasing</td>
<td>decreasing</td>
<td>increasing</td>
</tr>
<tr>
<td>B</td>
<td>decreasing</td>
<td>increasing</td>
<td>increasing</td>
</tr>
<tr>
<td>C</td>
<td>increasing</td>
<td>increasing</td>
<td>decreasing</td>
</tr>
<tr>
<td>D</td>
<td>decreasing</td>
<td>decreasing</td>
<td>decreasing</td>
</tr>
</tbody>
</table>

15 In which of the reaction is the underlined substance acting as an oxidising agent?

A \( \text{Cl}_2 + 2\text{FeCl}_2 \rightarrow 2\text{FeCl}_3 \)
B \( 2\text{HCl} + \text{MgO} \rightarrow \text{MgCl}_2 + \text{H}_2\text{O} \)
C \( \text{CuO} + \text{H}_2 \rightarrow \text{Cu} + \text{H}_2\text{O} \)
D \( \text{ZnO} + \text{CO} \rightarrow \text{Zn} + \text{CO}_2 \)
Some crystals of magnesium carbonate were added to an excess of sulfuric acid at room temperature.

The volume of carbon dioxide produced was measured over a period of time. The results are shown in graph $S$.

The experiment was repeated and graph $T$ was obtained.

Which change was used to obtain the results shown in graph $T$?

A. Acid of the same volume and half the original concentration was used.
B. Half the mass of magnesium carbonate was used.
C. Larger crystals of magnesium carbonate were used.
D. Using a lower temperature.

Rice mills face a greater threat of explosion from production of rice flour compared to rice silos which store rice grains.

Below are four statements which can explain why rice mills have a higher possibility of explosion occurring.

I. The combustion of rice flour is exothermic.
II. Rice flour is less combustible than rice grains.
III. Rice flour dust has a larger surface area than rice grains.
IV. Rice flour catalyses the combustion of gaseous fuel in the mills.

Which of the above are true?

A. I and III only
B. II and IV only
C. I and IV only
D. I, III and IV only
A student investigated the reaction of vegetable oils with hydrogen. 100 cm³ of hydrogen was bubbled through 1 g samples of four vegetable oils containing a suitable catalyst. The volume of hydrogen gas remaining after each experiment was recorded in the table below.

<table>
<thead>
<tr>
<th>vegetable oil</th>
<th>volume of hydrogen gas remaining/ cm³</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>100</td>
</tr>
<tr>
<td>Q</td>
<td>87</td>
</tr>
<tr>
<td>R</td>
<td>63</td>
</tr>
<tr>
<td>S</td>
<td>0</td>
</tr>
</tbody>
</table>

Which vegetable oils are unsaturated?

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

When ethanol is left standing in the air for some time, it becomes acidic.

Which chemical equation represents this change?

A \( \text{CH}_3\text{CH}_2\text{OH} + \text{CO} \rightarrow \text{CH}_3\text{CH}_2\text{CO}_2\text{H} \)  
B \( \text{CH}_3\text{CH}_2\text{OH} + \text{O}_2 \rightarrow \text{CH}_3\text{CO}_2\text{H} + \text{H}_2\text{O} \)  
C \( \text{CH}_3\text{CH}_2\text{OH} + 3\text{O}_2 \rightarrow 2\text{CO}_2 + 3\text{H}_2\text{O} \)  
D \( 2\text{CH}_3\text{CH}_2\text{OH} + \text{O}_2 \rightarrow 2\text{CH}_3\text{CO}_2\text{H} + 2\text{H}_2 \)

The table shows the observations made when an organic compound \( \text{X} \) reacts with aqueous bromine and acidified potassium manganate(VII)

<table>
<thead>
<tr>
<th>reagent</th>
<th>observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>aqueous bromine</td>
<td>no visible reaction</td>
</tr>
<tr>
<td>acidified potassium manganate(VII)</td>
<td>purple solution turns colourless</td>
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What is compound \( \text{X} \)?

A ethane  
B ethanoic acid  
C methanol  
D propene
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END OF PAPER
### DATA SHEET

**Colours of Some Common Metal Hydroxides**

<table>
<thead>
<tr>
<th>Metal Hydroxide</th>
<th>Colour</th>
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<tbody>
<tr>
<td>calcium hydroxide</td>
<td>white</td>
</tr>
<tr>
<td>copper(II) hydroxide</td>
<td>light blue</td>
</tr>
<tr>
<td>iron(II) hydroxide</td>
<td>green</td>
</tr>
<tr>
<td>iron(III) hydroxide</td>
<td>red-brown</td>
</tr>
<tr>
<td>lead(II) hydroxide</td>
<td>white</td>
</tr>
<tr>
<td>zinc hydroxide</td>
<td>white</td>
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The Periodic Table of Elements

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<tr>
<td>65</td>
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<td>lawrencium</td>
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</table>

The volume of one mole of any gas is 24 dm$^3$ at room temperature and pressure (r.t.p.).
YUHUA SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2019
SECONDARY 4 EXPRESS / 5 NORMAL ACADEMIC

4E/5N

CANDIDATE NAME

CLASS

INDEX NUMBER

SCIENCE (CHEMISTRY) 5076/03, 5078/03

Paper 3 29 Aug 2019
1 hour 15 minutes

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

Setter: Ms Cheong Ai Hwa

READ THESE INSTRUCTIONS FIRST
Write your name, class and index number on all the work you hand in.
Write in dark blue and black pen.
You may use a soft pencil for any diagrams or graphs.
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 working 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.

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 12.
A copy of the Periodic Table is printed on page 13.

For Examiner's Use

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<thead>
<tr>
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This document consists of 13 printed pages, inclusive of this page.

[Turn over

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Section A

Answer all questions in the spaces provided.

1 (a) Copper(II) sulfate is an ionic compound. Its crystals can be prepared by using dilute sulfuric acid and a suitable solid compound.

(i) Name a suitable solid compound that can be used to prepare copper(II) sulfate.

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

(ii) Describe in four steps how a pure, dry sample of copper(II) sulfate crystals can be prepared using the reactants in (a)(i).

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

(b) When iron is extracted from haematite, Fe₂O₃, in the blast furnace, waste gases and solid waste products are formed.

(i) Name the two main waste products of this process.

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

(ii) Write chemical equations to show how each of them are produced.

equation 1: ....................................................................................................................................

equation 2: .................................................................................................................................... [2]
2. Carbon disulfide, CS₂, is a simple covalent compound used in manufacturing polymers and fibres.

(a) Draw a ‘dot-and-cross’ diagram to show the bonding in carbon disulfide. Show valence electrons only.

(b) Using your understanding of chemical bonding and structure, suggest why carbon disulfide has a low melting point of 46.3 °C.

(c) Sulfur reacts with magnesium to form an ionic compound called magnesium sulfide. Write the chemical formula for magnesium sulfide.

3. Table 3 shows the average concentration of carbon monoxide in the air in Orchid Road in country X for two years.

<table>
<thead>
<tr>
<th>time interval (h)</th>
<th>6 am – 8 am</th>
<th>8 am – 10 am</th>
<th>10 am – 12 pm</th>
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</thead>
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<tr>
<td>concentration of carbon monoxide (volume of carbon monoxide per 1000 000 cm³ of air)</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 3

(a) Suggest the main source of carbon monoxide at Orchid Road.

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(b) (i) In which time period is the concentration of the carbon monoxide the highest?

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

(ii) Suggest an explanation for this phenomenon

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

(c) State a reason why carbon monoxide is harmful to our health.

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

4 Fig. 4 shows the series of reactions involving a blue solid W.

![Diagram of chemical reactions]

(a) Identify substances W, X, Y and Z.

W: .............................................. X: ..............................................


(b) Write a balanced chemical equation for the formation of blue precipitate Z.

.............................................................................................................................. [1]
(c) Green precipitate Y was heated strongly in the boiling tube for 10 minutes.

(i) State what you would observe.

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

(ii) Explain your observation.

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

5 Urea, \( \text{CON}_2\text{H}_4 \) is commonly used as a fertiliser in agriculture. Ammonia gas and carbon dioxide gas can react to form urea in a chemical reaction as follows.

\[
2\text{NH}_3 + \text{CO}_2 \rightarrow \text{CON}_2\text{H}_4 + \text{H}_2\text{O}
\]

A fertiliser plant produces 120 kg of urea on a daily basis.

(a) Calculate the relative molecular mass of urea.

relative molecular mass = ........................................ [1]

(b) What is the mass of ammonia required to produce 120 kg of urea?

mass of ammonia = ........................................ g [3]

(c) Find the volume of carbon dioxide gas needed in the reaction.

volume of carbon dioxide = ...................... dm\(^3\) [2]
Hydrogen peroxide is a colourless liquid at room temperature and pressure. An aqueous solution of hydrogen peroxide reacts with the iodide ions in acidified potassium iodide to form water and iodine as shown in the following ionic equation.

$$\text{H}_2\text{O}_2(\text{aq}) + 2\text{H}^+(\text{aq}) + 2\text{I}^-\text{(aq)} \rightarrow 2\text{H}_2\text{O}(l) + \text{I}_2(\text{aq})$$

Table 6 shows the speed of this reaction when different concentrations of potassium iodide and sulfuric acid are used. The concentration of the products was measured once at the same time interval. The hydrogen peroxide is always in excess and the temperature remains constant.

<table>
<thead>
<tr>
<th>experiment</th>
<th>concentration of potassium iodide (mol/dm³)</th>
<th>concentration of sulfuric acid (mol/dm³)</th>
<th>speed of reaction (mol/dm³)</th>
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<tbody>
<tr>
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<td>0.1</td>
<td>0.00017</td>
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<tr>
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<td>0.1</td>
<td>0.00034</td>
</tr>
<tr>
<td>3</td>
<td>0.1</td>
<td>0.2</td>
<td>0.00017</td>
</tr>
<tr>
<td>4</td>
<td>0.3</td>
<td>0.1</td>
<td>0.00051</td>
</tr>
<tr>
<td>5</td>
<td>0.1</td>
<td>0.3</td>
<td>0.00017</td>
</tr>
</tbody>
</table>

(a) (i) Explain why iodide ions act as the reducing agent in this reaction.

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

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

(ii) Describe the colour change that will be observed.

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

(b) Use the information in Table 6 to describe how the concentration of potassium iodide affects the time a colour change is first observed in the reaction.

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

(c) Does the concentration of H⁺ ions affect the rate of reaction? Explain your reasoning.

................................................................................................................................................ [2]
(d) Apart from changing the concentration of the reagents, suggest a method of prolonging the time for a colour change to be first observed. Use your knowledge of reacting particles to explain your answer.

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7 Fatty acids play a role in managing inflammation in the body. Fig. 7 shows the structures of two fatty acids P and Q.

(a) Circle the functional groups found in fatty acid P.

(b) (i) State a chemical test that can be carried out to differentiate between fatty acid P and fatty acid Q.

………………………………………………………………………………………………

(ii) Briefly describe the observations you would see for the test described in (b)(i).

………………………………………………………………………………………………
Section B
Answer any two questions in the spaces provided.

8 (a) Fig. 8.1 and Fig. 8.2 show the arrangement of apparatus used to try to dissolve hydrogen chloride in methylbenzene and in water respectively.

(a) (i) State the observations made when magnesium ribbon is placed in beaker A and B respectively?

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

(ii) Explain your answers in (a)(i).

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(iii) Write the chemical equation for the reaction in beaker B.

........................................................................................................................................... [1]
(b) Fig. 8.3 shows the apparatus used to separate a mixture of octane, \( \text{C}_8\text{H}_{18} \) and decane, \( \text{C}_{10}\text{H}_{22} \).

![Diagram of separation apparatus with thermometer, condenser, water in and out, beaker, and mixture containing octane and decane.]

**Fig. 8.3**

(i) State the general name for this method of separation.

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

(ii) What property must the two liquids have to be separated by this method?

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

(iii) State the purpose of the water in the condenser.

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

(iv) Which one of these alkanes will give a smokier flame when burnt? Explain your answer.

.............................................................................................................................................. [2]
9 (a) Experiments can be conducted to determine the chemical reactivity of metals.

(i) Briefly describe an experiment using water that shows the order of chemical reactivity of the three metals lithium, sodium and potassium.

(ii) List the metals from (a)(i) in decreasing order of reactivity.

(ii) What would be observed if a piece of francium was used instead of sodium? Explain your answer.

(b) Fluorine, bromine and iodine are in Group VII.

(i) Why are the halogens above placed in the same group?

(ii) What would be observed if bromine is introduced into a solution of sodium iodide? Explain your answer.
10 (a) (i) Petroleum can be separated into several useful substances in a fractionating tower. Describe the separation process.

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(ii) Name one of the substance produced and give a use for this named substance.

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(b) The alkenes form a homologous series.

(i) State the general formula of alkenes.

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(ii) One alkene contains 3 carbon atoms in its molecule. Draw the full structural formula for this molecule.

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(iii) The alkene in (b)(ii) undergoes addition polymerisation. Draw the polymer showing two repeat units.

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.................................................................................................................................................................................... [1]
### Colours of Some Common Metal Hydroxides

<table>
<thead>
<tr>
<th>Compound</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>calcium hydroxide</td>
<td>white</td>
</tr>
<tr>
<td>copper(II) hydroxide</td>
<td>light blue</td>
</tr>
<tr>
<td>iron(II) hydroxide</td>
<td>green</td>
</tr>
<tr>
<td>iron(III) hydroxide</td>
<td>red-brown</td>
</tr>
<tr>
<td>lead(II) hydroxide</td>
<td>white</td>
</tr>
<tr>
<td>zinc hydroxide</td>
<td>white</td>
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</table>
### The Periodic Table of Elements

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<tr>
<th>Group</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
<th>VII</th>
<th>O</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>H</td>
<td>hydrogen</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>He</td>
<td>helium</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
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<td>3</td>
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<td>4</td>
<td>Be</td>
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<td>5</td>
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</tr>
<tr>
<td>7</td>
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<td>barium</td>
<td>137</td>
<td>La</td>
<td>lanthanum</td>
</tr>
</tbody>
</table>

#### Lanthanoids

| 57 | La | lanthanum | 139 | 58 | Ce | cerium | 140 | 59 | Pr | praseodymium | 141 | 60 | Nd | neodymium | 142 | 61 | Pm | promethium | 143 | 62 | Sm | samarium | 144 | 63 | Eu | europium | 145 | 64 | Gd | gadolinium | 146 | 65 | Tb | dysprosium | 147 | 66 | Dy | holmium | 148 | 67 | Ho | holmium | 149 | 68 | Er | erbium | 150 | 69 | Tm | thulium | 151 | 70 | Yb | ytterbium | 152 | 71 | Lu | lutetium | 153 | Ac | actinium | 154 | 90 | Th | thorium | 232 | 91 | Pa | protactinium | 233 | 92 | U | uranium | 238 | 93 | Np | neptunium | 237 | 94 | Pu | plutonium | 243 | 95 | Am | americium | 243a | 96 | Cm | curium | 244 | 97 | Bk | berkelium | 247 | 98 | Cf | californium | 251 | 99 | Es | einsteinium | 252 | 100 | Fm | fermium | 257 | 101 | Md | mendeleevium | 258 | 102 | No | nobelium | 259 | 103 | Lr | lawrencium | 262 |

#### Actinoids

The volume of one mole of any gas is 24 dm$^3$ at room temperature and pressure (r.t.p.).
Section A: Multiple-Choice Questions (20 marks)
Answer all the questions by writing your answers in the table provided.

<table>
<thead>
<tr>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>Q5</th>
<th>Q6</th>
<th>Q7</th>
<th>Q8</th>
<th>Q9</th>
<th>Q10</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>A</td>
<td>D</td>
<td>C</td>
<td>A</td>
<td>D</td>
<td>D</td>
</tr>
<tr>
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<td>Q12</td>
<td>Q13</td>
<td>Q14</td>
<td>Q15</td>
<td>Q16</td>
<td>Q17</td>
<td>Q18</td>
<td>Q19</td>
<td>Q20</td>
</tr>
<tr>
<td>B</td>
<td>C</td>
<td>C</td>
<td>B</td>
<td>C</td>
<td>B</td>
<td>A</td>
<td>C</td>
<td>B</td>
<td>C</td>
</tr>
</tbody>
</table>

Section B: Structured Questions (30 marks)
Answer all the questions by writing your answers in the space provided.

1. (a) (i) Copper(II) carbonate or copper(II) oxide or copper(II) hydroxide can be used. [1]
(ii) The four steps:
1. Add excess solid (CuCO₃, CuO or Cu(OH)₂) to a fixed volume of dilute sulfuric acid and stir. [1]
2. Filter the mixture and collect the filtrate. [1]
3. Heat the filtrate till saturated/ to remove excess water. [1]
4. Cool the solution/filtrate to allow crystals to form. [1]

0 marks awarded if steps 1 and 2 are missing. No mark for step 4 if step 3 is missing.

(b) (i) Any Two correct: carbon dioxide; carbon monoxide; calcium silicate/slag [2]

(ii) Any Two correct:
\[ \text{C} + \text{O}_2 \rightarrow \text{CO}_2 \]
\[ \text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2 \]
\[ \text{C} + \text{CO}_2 \rightarrow 2\text{CO} \]
\[ \text{CaO} + \text{SiO}_2 \rightarrow \text{CaSiO}_3 \]
double covalent bond between C and S[1]
correct no of valence electrons[1]

(b) There are weak intermolecular forces of attraction between molecules [1]
Thus need a little amount of energy to overcome these forces [1]

(c) MgS [1]

3 (a) Incomplete combustion of fuels in car engine.[1]

(b) (i) The concentration is highest during 8am to 10am.[1]
(ii) Many people are travelling to work using motor vehicles:[1]

(c) Carbon monoxide is binded to the haemoglobin, preventing oxygen
from being transported around the body.[1]
This causes breathing difficulties or even death[1]

4 (a) W: copper(II) nitrate / Cu(NO₃)₂ [1]
X: ammonia/NH₃ [1]
Y: copper(II) carbonate/CuCO₃ [1]
Z: copper(II) hydroxide / Cu(OH)₂ [1]

(b) Cu(NO₃)₂ + 2 NaOH → Cu(OH)₂ + 2NaNO₃
(correct formulae-1m; correct balancing-1m)

(c) (i) Green precipitate turned black.[1]
(ii) It has been decomposed by the heat[1]

5 (a) Calculate the relative molecular mass of urea. [1]
\[ M_r[\text{CON}_2\text{H}_4] = 60[1] \]

(b) What is the mass of ammonia required to produce 120 kg of urea? [3]
No of mole of \(\text{CON}_2\text{H}_4\) produced = 120 000/60
\[ = 2000[1] \]
Mole ratio of \(\text{CON}_2\text{H}_4 : \text{NH}_3 = 1: 2\)
Hence no of mole of \(\text{NH}_3\) used = 2 X 2000 = 4000 [1]
Mass of ammonia required = 4000 X 17 g = 68 000 g[1]
(c) What is the volume of carbon dioxide gas needed in (b)?

Mole ratio of $\text{CON}_2\text{H}_4 : \text{CO}_2 = 1:1$

No of mole of $\text{CO}_2$ needed $= 2000$ [1]

Volume of $\text{CO}_2$ $= 24 \text{ dm}^3 \times 2000 = 48 000 \text{ dm}^3$ [1]

6 (a) (i) It is because iodide ions are oxidised to iodine, the oxidation state of iodine has increased from $-1$ in iodide ion to $0$ in iodine OR electrons lost when $\text{I}^-$ is converted to $\text{I}_2$ [1]

(ii) The solution turned from colourless to brown / yellow [1]

(b) The higher the concentration of potassium iodide used, the shorter the time taken OR the faster the reaction[1]

(c) the concentration of $\text{H}^+$ ions does not affect the rate of reaction[1]. It is because the amount of products produced remained constant at 0.00017 mol/dm$^3$ when its concentration changes from 0.1 mol/dm$^3$ to 0.3 mol/dm$^3$[1]

(d) It can be done by reducing the temperature of the solution [1]. When the kinetic energy of the reactant molecules is lowered[1], they will move slower[1] and will reduce the frequency of effective collision to result in reaction[1]

7 (a) Functional groups present:

- C=C (carbon carbon double bond)[1]
- COOH (carboxyl group)[1]

(b) (i) Test with aqueous bromine or bromine solution[1]

(ii) Observation with fatty acid P: reddish brown bromine solution decolourised / turns colourless.[1]

Observation with fatty acid Q: bromine solution remains reddish-brown[1]

8 (a) (i) Beaker A – No visible reaction[1]

Beaker B -- Effervescence is seen OR Mg dissolved in acid to form a colourless solution. [1]

(ii) In beaker A, HCl in methylbenzene does not dissociate into $\text{H}^+$ ions and is not acidic. [1]

In beaker B, the presence of water causes HCl to dissociate to form $\text{H}^+$ ions which react with magnesium to form hydrogen gas. [1]

(iii) $\text{Mg} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2$  [1]

(b) (i) fractional distillation [1]

(ii) The 2 liquids must have different boiling points which are close together. [1]

(iii) the water will cool down the hot vapour and changes/ condenses it into liquid[1]

(iv) Decane will give a smokier flame. [1]

It has a higher percentage by mass of carbon[1], hence will be less likely to be completely burnt in oxygen [1]

9 (a) Add a small piece of lithium into a beaker of water. [1]

(i) Need a home tutor? Visit smiletutor.sg
• Effervescence was observed and metal darts and float on the water.[1]
• The experiment was repeated using different metals and the observation was recorded.[1]
• The reaction which produces most gas / reaction being the most vigorously will be the most reactive metal[1]

(ii) Potassium > sodium>lithium[1]
(ii) The reaction will be more vigorous when a piece of francium is used as compared to sodium[1].
Francium is more reactive than sodium[1]

(b) (i) All of them have seven valence electrons [1]

(ii) Observations: the colourless solution turned into a yellow/ brown solution [1]
Explanation: Bromine is more reactive than iodine and displaces it from its aqueous solution[1]

10 (a) • In the furnace, petroleum is heated and turned into vapour (vapourised)[1]
• The hot vapour rises up the column, it begins to cool and condense.[1]
• Lighter fractions have lower boiling points will be condensed and collected at the top of the fractionating column as gases.[1]
• Heavier fractions have higher boiling point will be condensed and collected at the lower sections of the column.[1]

One of the useful substance is bitumen[1]. It is used to surface road[1]
(Accept any of the correct fraction and its use from the column.)

(b) (i) \( C_nH_{2n} \) [1]

(ii) [1]

(iii) [2] Need a home tutor? Visit smiletutor.sg
All bonds correct [1] no of C and H atoms correct[1]