Fill in these boxes and read what is printed below.

<table>
<thead>
<tr>
<th>Full name of centre</th>
<th>Town</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Forename</th>
<th>Surname</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date of birth</th>
<th>Scottish candidate number</th>
<th>Number of seat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day</td>
<td>Month</td>
<td>Year</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. All questions should be attempted.
2. Necessary data will be found in the Data Booklet provided for Chemistry at Standard Grade and Intermediate 2.
3. The questions may be answered in any order but all answers are to be written in this answer book, and must be written clearly and legibly in ink.
4. Rough work, if any should be necessary, as well as the fair copy, is to be written in this book.
   Rough work should be scored through when the fair copy has been written.
5. Additional space for answers and rough work will be found at the end of the book.
6. The size of the space provided for an answer should not be taken as an indication of how much to write. It is not necessary to use all the space.
7. Before leaving the examination room you must give this book to the Invigilator. If you do not, you may lose all the marks for this paper.
PART 1

In Questions 1 to 9 of this part of the paper, an answer is given by circling the appropriate letter (or letters) in the answer grid provided. In some questions, two letters are required for full marks. If more than the correct number of answers is given, marks will be deducted. A total of 20 marks is available in this part of the paper.

SAMPLE QUESTION

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH$_4$</td>
<td>H$_2$</td>
<td>CO$_2$</td>
</tr>
<tr>
<td>D</td>
<td>E</td>
<td>F</td>
</tr>
<tr>
<td>CO</td>
<td>C$_2$H$_5$OH</td>
<td>C</td>
</tr>
</tbody>
</table>

(a) Identify the hydrocarbon.

The one correct answer to part (a) is A. This should be circled.

(b) Identify the two elements.

As indicated in this question, there are two correct answers to part (b). These are B and F. Both answers are circled.

If, after you have recorded your answer, you decide that you have made an error and wish to make a change, you should cancel the original answer and circle the answer you now consider to be correct. Thus, in part (a), if you want to change an answer A to an answer D, your answer sheet would look like this:

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>E</td>
<td>F</td>
</tr>
</tbody>
</table>

If you want to change back to an answer which has already been scored out, you should enter a tick (✓) in the box of the answer of your choice, thus:

<table>
<thead>
<tr>
<th>✓A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>E</td>
<td>F</td>
</tr>
</tbody>
</table>
1. Crude oil can be separated into fractions.

<table>
<thead>
<tr>
<th>Fraction</th>
<th>Number of carbon atoms per molecule</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1–4</td>
</tr>
<tr>
<td>B</td>
<td>4–10</td>
</tr>
<tr>
<td>C</td>
<td>10–16</td>
</tr>
<tr>
<td>D</td>
<td>16–20</td>
</tr>
<tr>
<td>E</td>
<td>20+</td>
</tr>
</tbody>
</table>

(a) Identify the fraction which is the most viscous.

A
B
C
D
E

(b) Identify the fraction used as camping gas.

A
B
C
D
E

1

1 (2)
2. The grid contains the symbols for some common elements.

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>H</td>
<td>N</td>
<td>Si</td>
</tr>
<tr>
<td>D</td>
<td>Al</td>
<td>Mg</td>
<td>O</td>
</tr>
</tbody>
</table>

(a) Identify the element which has a density of 1.74 g/cm³.
You may wish to use the data booklet to help you.

(b) Identify the two elements which react together to form a molecule with the same shape as a methane molecule.

(c) Identify the two elements which form an ionic compound with a formula of type $X_2Y_3$, where $X$ is a metal.
3. The grid shows information about some particles.

\[
\begin{array}{ccc}
\text{A} & \text{B} & \text{C} \\
\text{D} & \text{E} & \text{F} \\
\end{array}
\]

\begin{itemize}
\item[(a)] Identify the \textbf{two} particles with the same number of neutrons.
\item[(b)] Identify the particle which has the same electron arrangement as neon.
\end{itemize}
4. The grid shows the names of some carbohydrates.

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>fructose</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td></td>
<td>glucose</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td>maltose</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td>sucrose</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>starch</td>
</tr>
</tbody>
</table>

(a) Identify the condensation polymer.

(b) Identify the two monosaccharides.
5. Iron can be coated with different materials which provide a physical barrier against corrosion.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>oil</td>
</tr>
<tr>
<td>B</td>
<td>zinc</td>
</tr>
<tr>
<td>C</td>
<td>plastic</td>
</tr>
<tr>
<td>D</td>
<td>tin</td>
</tr>
<tr>
<td>E</td>
<td>paint</td>
</tr>
</tbody>
</table>

(a) Identify the coating which is used to galvanise iron.

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
</tr>
<tr>
<td>B</td>
</tr>
<tr>
<td>C</td>
</tr>
<tr>
<td>D</td>
</tr>
<tr>
<td>E</td>
</tr>
</tbody>
</table>

1

(b) Identify the coating which, if scratched, would cause the iron to rust faster than normal.

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
</tr>
<tr>
<td>B</td>
</tr>
<tr>
<td>C</td>
</tr>
<tr>
<td>D</td>
</tr>
<tr>
<td>E</td>
</tr>
</tbody>
</table>

1 (2)
6. The structures of some hydrocarbons are shown in the grid.

(a) Identify the two hydrocarbons with the general formula $C_nH_{2n}$, which do not react quickly with bromine solution.

(b) Identify the hydrocarbon which is the first member of a homologous series.

(c) Identify the two isomers of

\[ \text{H} \quad \text{H} \quad \text{H} \]
\[ \text{H} \quad \text{C} \quad \text{C} = \text{C} \quad \text{C} \quad \text{H} \]
\[ \text{H} \quad \text{H} \quad \text{H} \]

---

[0500/402] Page eight
7. Elements can be used in different ways.

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>chlorine</td>
<td>potassium</td>
<td>platinum</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>hydrogen</td>
<td>neon</td>
<td>iron</td>
</tr>
</tbody>
</table>

(a) Identify the element which is a reactant in the Haber Process.

(b) Identify the element used as the catalyst in the manufacture of nitric acid (Ostwald Process).
8. The grid shows some statements which can be applied to different solutions.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>It has a pH less than 7.</td>
</tr>
<tr>
<td>B</td>
<td>It conducts electricity.</td>
</tr>
<tr>
<td>C</td>
<td>It contains less OH(^-)(aq) ions than pure water.</td>
</tr>
<tr>
<td>D</td>
<td>It does not neutralise dilute hydrochloric acid.</td>
</tr>
<tr>
<td>E</td>
<td>When diluted the concentration of OH(^-)(aq) ions decreases.</td>
</tr>
</tbody>
</table>

Identify the **two** statements which are correct for an alkaline solution.

A  
B  
C  
D  
E  

(2)
9. The grid shows pairs of chemicals.

Which two boxes contain a pair of chemicals that react together to form a gas?

Which **two** boxes contain a pair of chemicals that react together to form a gas?

![Chemical Reactions Grid]

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>copper carbonate + dilute sulphuric acid</td>
<td>lead nitrate solution + potassium iodide solution</td>
<td>potassium hydroxide + nitric acid</td>
</tr>
<tr>
<td>D</td>
<td>copper + water</td>
<td>silver + hydrochloric acid</td>
<td>ammonium nitrate + sodium hydroxide</td>
</tr>
</tbody>
</table>

(2)

[Turn over]
PART 2

A total of 40 marks is available in this part of the paper.

10. Poly(methyl methacrylate) is a synthetic polymer used to manufacture perspex.

(a) What is meant by the term synthetic?

(b) The structure of the methyl methacrylate monomer is shown.

\[
\begin{align*}
H & \quad \text{CH}_3 \\
\text{C} & \quad \text{C} \\
H & \quad \text{COOCH}_3
\end{align*}
\]

methyl methacrylate

(i) Draw a section of the poly(methyl methacrylate) polymer, showing three monomer units joined together.

(ii) Name the type of polymerisation taking place.

(c) Name a toxic gas produced when poly(methyl methacrylate) burns.
11. A student set up an experiment to investigate the breakdown of glucose to form alcohol.

At the start a deflated balloon was attached to the top of the tube.

After two hours the balloon inflates as shown.

**Glucose solution**

+**enzyme**

---

(a) (i) Name the type of chemical reaction taking place in the test tube.

__________________________

(ii) Name the gas produced, which causes the balloon to inflate.

__________________________

(b) The student repeated the experiment at 80°C.

What effect would this have on how much the balloon inflates?

__________________________

__________________________

__________________________

1 (3)

[Turn over]
12. A student added magnesium ribbon to an excess of dilute sulphuric acid and measured the volume of hydrogen gas produced. The reaction stopped when all the magnesium was used up.

The results are shown in the table.

<table>
<thead>
<tr>
<th>Time/s</th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume of hydrogen gas/cm³</td>
<td>0</td>
<td>20</td>
<td>32</td>
<td>50</td>
<td>52</td>
<td>53</td>
<td>53</td>
</tr>
</tbody>
</table>

(a) State the test for hydrogen gas.

(b) Draw a line graph of the results.

Use appropriate scales to fill most of the graph paper.

(Additional graph paper, if required, will be found on page 24.)
12. (continued)

(e) Using your graph, predict the volume of hydrogen gas produced during the first 30 seconds.

\[ \text{ cm}^3 \]

1

(d) The student repeated the experiment using a higher concentration of acid. The same volume of acid and the same mass of magnesium ribbon were used. What volume of hydrogen gas would have been produced after 60 seconds?

\[ \text{ cm}^3 \]

1

(e) Calculate the mass of hydrogen produced when 4.9 g of magnesium reacts with an excess of dilute sulphuric acid.

\[ \text{Mg} + \text{H}_2\text{SO}_4 \rightarrow \text{MgSO}_4 + \text{H}_2 \]

\[ \text{ g} \]

2

(7)

[Turn over]
13. A student set up the following experiment to investigate the colour of ions in nickel(II) chromate solution.

The results are shown.

Green colour moves towards electrode A
Yellow colour moves towards electrode B

(a) Why must a d.c. supply be used?

(b) State the colour of the nickel(II) ions.

(c) Write the ionic formula for nickel(II) chromate.
14. The Eurofighter “Typhoon” is made from many newly developed materials including titanium alloys.

(a) The first step in extracting titanium from its ore is to convert it into titanium(IV) chloride.

Titanium(IV) chloride is a liquid at room temperature and does not conduct electricity.

What type of bonding, does this suggest, is present in titanium(IV) chloride?

(b) Titanium(IV) chloride is then reduced to titanium metal.

The equation for the reaction taking place is:

\[ \text{TiCl}_4 + \text{Na} \rightarrow \text{Ti} + \text{NaCl} \]

(i) Balance the equation.

(ii) What does this reaction suggest about the reactivity of titanium compared to that of sodium?

---

Marks

1

1

1

(3)
15. Scuba divers can suffer from painful and potentially fatal problems if they rise to the surface of the water too quickly. This causes dissolved nitrogen in their blood to form bubbles of nitrogen gas.

<table>
<thead>
<tr>
<th>Distance from surface of water/m</th>
<th>Concentration of dissolved nitrogen/units</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>11.5</td>
</tr>
<tr>
<td>10</td>
<td>23.0</td>
</tr>
<tr>
<td>20</td>
<td>34.5</td>
</tr>
<tr>
<td>30</td>
<td>46.0</td>
</tr>
<tr>
<td>40</td>
<td>57.5</td>
</tr>
</tbody>
</table>

(a) Describe the relationship between the distance from the surface of the water and the concentration of dissolved nitrogen.

__________________________________________________________________________

__________________________________________________________________________ 1

(b) Predict the concentration of dissolved nitrogen at 60 m.

____________________ units 1

(c) A nitrogen molecule is held together by three covalent bonds. Circle the correct words to complete the sentence.

In a covalent bond the atoms are held together by the attraction between the positive \{protons\} and the shared pair of negative \{electrons\}. 1

\{electrons\} \{neutrons\} \{protons\}.

(3)
16. (a) Galena is an ore containing lead sulphide, PbS.

(i) What is the charge on this lead ion?

(ii) Calculate the percentage by mass of lead in galena, PbS.

(b) Most metals have to be extracted from their ores.

(i) Name the metal extracted in a Blast furnace.

(ii) Place the following metals in the correct space in the table.

copper, mercury, aluminium

You may wish to use the data booklet to help you.

<table>
<thead>
<tr>
<th>Metal</th>
<th>Method of extraction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>using heat alone</td>
</tr>
<tr>
<td></td>
<td>electrolysis of molten ore</td>
</tr>
<tr>
<td></td>
<td>heating with carbon</td>
</tr>
</tbody>
</table>

[Turn over]
17. Iron displaces silver from silver(I) nitrate solution. The equation for the reaction is:

\[ \text{Fe}(s) + 2\text{Ag}^+(aq) + 2\text{NO}_3^-(aq) \rightarrow \text{Fe}^{2+}(aq) + 2\text{Ag}(s) + 2\text{NO}_3^-(aq) \]

(a) Circle the spectator ion in the above equation.

(b) Describe a chemical test, including the result, to show that \( \text{Fe}^{2+}(aq) \) ions are formed.

(c) Write the ion-electron equation for the reduction step in the reaction. You may wish to use the data book to help you.

(d) This reaction can also be carried out in a cell.

![Diagram of a corrosion cell with iron(II) nitrate solution and an ion bridge.]

Complete the three labels on the diagram.

(An additional diagram, if required, will be found on page 24.)
18. Ethers are useful chemicals. Some are listed in the table.

<table>
<thead>
<tr>
<th>Structural formula</th>
<th>Name of ether</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH$_3$CH$_2$ – O – CH$_2$CH$_3$</td>
<td>ethoxyethane</td>
</tr>
<tr>
<td>CH$_3$ – O – CH$_2$CH$_2$CH$_3$</td>
<td>methoxypropane</td>
</tr>
<tr>
<td>CH$_3$ – O – CH$_2$CH$_3$</td>
<td>methoxyethane</td>
</tr>
<tr>
<td>CH$_3$CH$_2$ – O – CH$_2$CH$_2$CH$_3$</td>
<td><strong>X</strong></td>
</tr>
</tbody>
</table>

(a) Suggest a name for ether **X**.

(b) The boiling points of ethers and alkanes are approximately the same when they have a similar relative formula mass.

Suggest the boiling point of ethoxyethane (relative formula mass 74).

You may wish to use the data booklet to help you.

\[\text{\underline{\text{\textdegree}C}} \] 1

(2)

[Turn over]
19. A student carried out a titration using the chemicals and apparatus below.

\[
\begin{array}{c}
\text{hydrochloric acid} \\
0.1 \text{ mol/l}
\end{array}
\]

\[
\begin{array}{c}
10 \text{ cm}^3 \\
sodium hydroxide solution + indicator
\end{array}
\]

The results are shown in the table below:

<table>
<thead>
<tr>
<th>Initial burette reading/cm³</th>
<th>1st titre</th>
<th>2nd titre</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3</td>
<td>0.2</td>
<td>0.5</td>
</tr>
<tr>
<td>Final burette reading/cm³</td>
<td>26.6</td>
<td>25.3</td>
</tr>
<tr>
<td>Volume used/cm³</td>
<td>26.3</td>
<td>25.1</td>
</tr>
</tbody>
</table>

\( (a) \) Using the results in the table, calculate the **average** volume of hydrochloric acid required to neutralise the sodium hydroxide solution.

\[
\text{Average volume} = \frac{0.3 + 0.2 + 0.5}{3} = 0.3\text{ cm}^3
\]

\[1\] \[
\text{Average volume} = 0.3\text{ cm}^3
\]

\( (b) \) The equation for the reaction is:

\[
\text{HCl} + \text{NaOH} \rightarrow \text{H}_2\text{O} + \text{NaCl}
\]

Using your answer from part \((a)\), calculate the concentration of the sodium hydroxide solution.

**Show your working clearly.**

\[
\text{Concentration} = \frac{0.3\text{ mol}}{0.01\text{ L}} = 30\text{ mol/l}
\]

\[2\] \[
\text{Concentration} = 30\text{ mol/l}
\]

\[3\]
20. Chemists have discovered a way to insert a \(-\text{CH}_2\,-\) group into any bond which includes an atom of hydrogen.

When a \(-\text{CH}_2\,-\) group is inserted into a methanol molecule the following reaction takes place.

\[
\text{H}_3\text{C}-\text{O}-\text{H} + \text{CH}_3\text{CH}_2\text{OH} \rightarrow \text{H}_3\text{C}\text{CH}_2\text{O}-\text{H} + \text{H}_2\text{C}+\text{H}_2\text{O}
\]

(a) This reaction can be repeated using ethanol.

One of the products for this reaction is shown.

(i) Suggest a name for molecule \(X\).

(ii) Draw a structural formula for another molecule which would be formed in this reaction.

(b) Identify the two products formed when molecule \(X\) is completely burned in a plentiful supply of oxygen.
ADDITIONAL SPACE FOR ANSWERS

ADDITIONAL GRAPH PAPER FOR QUESTION 12(b)

ADDITIONAL DIAGRAM FOR QUESTION 17(d)

ion bridge

iron(II) nitrate solution
<table>
<thead>
<tr>
<th>KU</th>
<th>PS</th>
</tr>
</thead>
</table>

ADDITIONAL SPACE FOR ANSWERS