1 (a) State what is meant by the moment of a force.

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

(b) Fig. 1.1 shows a uniform metre ruler of negligible weight.

The ruler can rotate about a pivot at the 95.0 cm mark.

\[ \text{Fig. 1.1} \]

![Diagram of the metre ruler with a spring and weight at 5.0 cm and 75.0 cm marks]

The spring is attached to the ruler at the 5.0 cm mark.

When a weight \( W \) of 3.6 N is attached to the ruler at the 75.0 cm mark, the ruler is horizontal.

(i) On Fig. 1.1, draw an arrow to show the position and direction of the force applied to the ruler by the spring. [1]

(ii) Calculate the moment produced by \( W \) about the pivot.

Show your working and give the unit.

\[ \text{moment} = \text{.......................... unit ..................} [3] \]
(iii) Use your answer to (ii) to calculate the force applied to the ruler by the spring.

\[
\text{force} = \text{...................................................... N} \quad [2]
\]

(iv) Describe what is observed when the weight \( W \) is moved along the ruler towards the spring.

Give a reason for your answer.

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

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

........................................................................................................................................... \quad [2]

[Total: 10]
2 Iron is a metal.

(a) Describe the bonding in iron.

You may draw a labelled diagram to help your answer.

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

(b) Iron rusts to form iron(III) oxide.

(i) Write a balanced symbol equation for this reaction.
.................................................................................................................................................. [2]

(ii) Iron is galvanised to prevent rusting.

Name the metal used to galvanise iron and explain how this metal helps prevent rusting.
metal ..........................................................................................................................................
explanation ...................................................................................................................................
...................................................................................................................................................
...................................................................................................................................................
...................................................................................................................................................
[3]

(iii) Suggest why sodium would not be a suitable metal to use to prevent iron from rusting.
..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................
[1]
(c) Table 2.1 shows the colour and typical use of two compounds, A and B.

<table>
<thead>
<tr>
<th></th>
<th>compound A</th>
<th>compound B</th>
</tr>
</thead>
<tbody>
<tr>
<td>colour of compound</td>
<td>white solid</td>
<td>green solid</td>
</tr>
<tr>
<td>typical use</td>
<td>preservative</td>
<td>catalyst</td>
</tr>
</tbody>
</table>

State which compound, A or B, is most likely to contain iron.

Explain your answer.

compound .................................................................

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

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

(d) Explain why aluminium resists corrosion.

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

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

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

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

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

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

(e) An alloy of iron is stronger and less malleable than iron metal.

Explain, in terms of atoms, how the structure of an alloy makes it less malleable than iron metal.

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

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

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

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

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

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

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

[Total: 16]
3 A student calibrates an unmarked liquid-in-glass thermometer.

He places the thermometer bulb in ice at 0 °C and marks the position of the end of the liquid thread.

He then places the thermometer bulb in steam at 100 °C and marks the position of the end of the liquid thread.

(a) Explain why the student places the thermometer bulb in melting ice and in steam.

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

(b) Fig. 3.1 shows the thermometer next to a ruler.

Line **A** is the mark made when the thermometer bulb is in the ice.

Line **B** is the mark made when the thermometer bulb is in the steam.

![Fig. 3.1](image)

**Fig. 3.1**

Calculate the temperature when the liquid thread is at the position shown in Fig. 3.1.

\[
\text{temperature} = \text{......................... °C} \quad [3]
\]
Fig. 3.2 shows a different thermometer with a scale marked on it.

![Thermometer Image](image)

**Fig. 3.2**

(i) State the range of this thermometer.

\[ \text{range} = \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \text{°C} \quad [1] \]

(ii) Describe one change in the design of a liquid-in-glass thermometer that would increase its sensitivity.

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

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

[Total: 6]
4 (a) Use words from the box to complete the sentences about making a water-soluble salt.

Acid in a conical flask is reacted with a base that is .................................. .

The reaction is complete when the solution is .................................. .

The solution is then .................................. to evaporate some of the water.

Slower evaporation forms .................................. crystals than faster evaporation.

(b) State the meaning of the term *acid*, using ideas of proton transfer.

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

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

c) Table 4.1 shows the solubility in water of some salts and other compounds.

<table>
<thead>
<tr>
<th>salts and other compounds</th>
<th>solubility</th>
</tr>
</thead>
<tbody>
<tr>
<td>most salts of sodium</td>
<td>soluble</td>
</tr>
<tr>
<td>most carbonates</td>
<td>insoluble</td>
</tr>
<tr>
<td>most sulfates</td>
<td>soluble</td>
</tr>
</tbody>
</table>

A student wants to make magnesium carbonate using magnesium sulfate and sodium carbonate.

Use information from Table 4.1 to suggest why the student cannot use the process described in (a) to make magnesium carbonate.

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

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

[Total: 6]
Fig. 5.1 is a ray diagram showing how an image is formed by a converging lens.

(a) (i) On Fig. 5.1, mark the principal focus of the lens and label it F. [1]
(ii) On Fig. 5.1, draw the image of the object formed by the lens and label it I. [2]
(iii) State how Fig. 5.1 shows that the image is real.

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

(b) The object is moved closer to the lens and a virtual image is formed.

(i) Describe, in terms of rays, how a virtual image is seen by an observer.
...........................................................................................................................................
........................................................................................................................................... [1]

(ii) State one use of the converging lens when it produces a virtual image in this way.
...........................................................................................................................................
........................................................................................................................................... [1]

[Total: 6]
6 Ethane combusts in excess oxygen. The reaction is shown by the following equation.

\[2\text{C}_2\text{H}_6 + 7\text{O}_2 \rightarrow 4\text{CO}_2 + 6\text{H}_2\text{O}\]

(a) Calculate the volume at room temperature and pressure of the carbon dioxide produced by the complete combustion of 2.0 kg of ethane.

Show your working in the box.

\[A_r: \text{C}, 12; \text{H}, 1; \text{O}, 16\]

\[\text{[At room temperature and pressure 1 mole of any gas has a volume of 24 dm}^3].\]

| volume of carbon dioxide gas = .................................................. dm}^3 [4] |

(b) (i) Suggest the products formed when ethane combusts in a limited supply of oxygen.

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

(ii) State one adverse effect of the combustion of ethane on the environment.

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

[Total: 7]
7 Fig. 7.1 shows a circuit diagram.

The battery of cells has an e.m.f. of 6.0 V.

![Circuit Diagram]

**Fig. 7.1**

**(a)** Resistor $R_1$ has a resistance of 5.0 $\Omega$.

Calculate the current through the ammeter when switch $S$ is open.

Show your working.

Current = ...................................................... A [2]

**(b)** When switch $S$ is closed, the current through the ammeter is 3.0 A.

Calculate the resistance of resistor $R_2$.

Show your working.

Resistance = ...................................................... $\Omega$ [2]

**(c)** Calculate the power output from the battery when switch $S$ is closed.

Show your working.

Power = ...................................................... W [2]

[Total: 6]
8 Ethanol is produced in the following reaction.

\[ \text{C}_2\text{H}_4 + \text{H}_2\text{O} \rightarrow \text{C}_2\text{H}_5\text{OH} \]

A small amount of phosphoric acid is also added to the reaction mixture.

(a) Suggest why phosphoric acid is added. Give a reason for your answer.
...................................................................................................................................................
...................................................................................................................................................
...................................................................................................................................................
................................................................................................................................................... [2]

(b) Ethanol reacts with sodium to form the compound sodium ethoxide.

The formula of an ethoxide ion is \( \text{CH}_3\text{CH}_2\text{O}^- \).

Use this information and your knowledge of the Periodic Table to deduce the formula of sodium ethoxide.

formula of sodium ethoxide .......................................................... [1]

(c) \( \text{C}_2\text{H}_4 \) also reacts with bromine. During the reaction the bromine is decolourised.

(i) Name this type of reaction.
................................................................................................................................................. [1]

(ii) Name the homologous series that includes \( \text{C}_2\text{H}_4 \).
................................................................................................................................................. [1]

[Total: 5]
9 Fig. 9.1 shows the structure of a simple transformer.

(a) (i) On Fig. 9.1, complete labels 1 and 2. [2]

(ii) State the evidence from Fig. 9.1 that shows the output voltage is smaller than the supply voltage.

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

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

(b) Explain how an a.c. power supply produces a power output from the transformer.

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

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

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

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

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

(c) Suggest one use of this type of transformer.

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

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

[Total: 8]
Plants use the process of photosynthesis to produce glucose.

(a) Complete the **word** equation for the reaction by writing in the boxes.

\[ \text{[ ] } + \text{[ ] } \rightarrow \text{glucose } + \text{[ ] } \]  

(b) State the source of energy for this reaction.

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

[Total: 3]

A student places a radiation detector 1 mm from a radioactive source. The detector is connected to a counter.

She zeroes the counter and then records the count after 5 minutes. She repeats the experiment three more times.

Her results are shown in Table 11.1.

<table>
<thead>
<tr>
<th>experiment number</th>
<th>count after 5 minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2489</td>
</tr>
<tr>
<td>2</td>
<td>2470</td>
</tr>
<tr>
<td>3</td>
<td>2501</td>
</tr>
<tr>
<td>4</td>
<td>2481</td>
</tr>
</tbody>
</table>

She observes that the counts are different each time.

(a) State the nature of radioactive decay that causes variation in the count.

..............................................................................................................................................[1]
(b) The student removes the radioactive source and repeats the experiment with no source present another four times.

Her results are shown in Table 11.2.

Table 11.2

<table>
<thead>
<tr>
<th>experiment number</th>
<th>count after 5 minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>8</td>
<td>9</td>
</tr>
</tbody>
</table>

State why radiation is still detected when the radioactive source is removed.
...................................................................................................................................................
.............................................................................................................................................. [1]

(c) She places the radioactive source at a point 10 cm away from the detector and repeats the experiment another four times.

Her results are shown in Table 11.3.

Table 11.3

<table>
<thead>
<tr>
<th>experiment number</th>
<th>count after 5 minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>15</td>
</tr>
<tr>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>12</td>
<td>14</td>
</tr>
</tbody>
</table>

Use the information from the experiments to identify the type of radiation emitted by the radioactive source. Give a reason for your answer.

type of radiation ...........................................................................................................................
reason ...............................................................................................................................................
[2]

[Total: 4]
Complete Table 12.1 to identify each oxide as acidic, basic, neutral or amphoteric.

Table 12.1

<table>
<thead>
<tr>
<th>oxide</th>
<th>acidic, basic, neutral or amphoteric</th>
</tr>
</thead>
<tbody>
<tr>
<td>aluminium oxide</td>
<td></td>
</tr>
<tr>
<td>carbon monoxide</td>
<td></td>
</tr>
<tr>
<td>iron oxide</td>
<td></td>
</tr>
<tr>
<td>sulfur dioxide</td>
<td></td>
</tr>
</tbody>
</table>

[3]

[Total: 3]
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>VIII</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>Key</td>
<td>atomic number</td>
<td>atomic symbol</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>lithium 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>boron 5</td>
<td>carbon 6</td>
<td>nitrogen 7</td>
<td>oxygen 8</td>
<td>fluorine 9</td>
<td>neon 10</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>sodium 11</td>
<td>magnesium 12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>potassium 19</td>
<td>calcium 20</td>
<td>scandium 21</td>
<td>titanium 22</td>
<td>vanadium 23</td>
<td>chromium 24</td>
<td>manganese 25</td>
<td>iron 26</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>rubidium 37</td>
<td>strontium 38</td>
<td>yttrium 39</td>
<td>zirconium 40</td>
<td>niobium 41</td>
<td>tantalum 42</td>
<td>technetium 43</td>
<td>rhenium 44</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>cesium 55</td>
<td>barium 56</td>
<td>lanthanum 57</td>
<td>hafnium 58</td>
<td>tantalum 59</td>
<td>rutherfordium 60</td>
<td>dubnium 61</td>
<td>seaborgium 62</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>francium 87</td>
<td>radium 88</td>
<td>actinium 89</td>
<td>thorium 90</td>
<td>protactinium 91</td>
<td>neptunium 92</td>
<td>plutonium 93</td>
<td></td>
</tr>
<tr>
<td>lanthanoids</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>lutetium 104</td>
<td>cerium 105</td>
<td>praseodymium 106</td>
<td>neodymium 107</td>
<td>promethium 108</td>
<td>samarium 109</td>
<td>europium 110</td>
<td>gadolinium 111</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>lutetium 112</td>
<td>hafnium 113</td>
<td>tantalum 114</td>
<td>rutherfordium 115</td>
<td>dubnium 116</td>
<td>seaborgium 117</td>
<td></td>
<td></td>
</tr>
<tr>
<td>actinoids</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>americium 122</td>
<td>curium 123</td>
<td>berkelium 124</td>
<td>californium 125</td>
<td>einsteinium 126</td>
<td>fermium 127</td>
<td>mendelevium 128</td>
<td>lawrencium 129</td>
</tr>
</tbody>
</table>

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