For Examiner’s Use

<table>
<thead>
<tr>
<th>Question</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
</tr>
</tbody>
</table>

Materials

For this paper you must have:
- a ruler
- a protractor
- a scientific calculator
- the periodic table (enclosed)
- the Physics Equations Sheet (enclosed).

Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer all questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- In all calculations, show clearly how you work out your answer.

Information

- The maximum mark for this paper is 100.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.
01

Crude oil is a mixture of hydrocarbons.

01.1 Name the two elements in a hydrocarbon. [2 marks]
1 
2 

01.2 What was crude oil formed from? [1 mark]
Tick one box.

Acids 
Enzymes 
Metals 
Plankton
**Figure 1** shows how crude oil is separated to produce different fuels.

**Figure 1**

What is the name of this process?

Tick one box.

- Combustion
- Fractional distillation
- Phytomining
- Steam cracking

[1 mark]

**Question 1 continues on the next page**
**01.4** Why is the crude oil heated?  

[1 mark]

---

**Table 1** shows some properties of the fuels produced by the process.

**Table 1**

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Number of carbon atoms in chain</th>
<th>Lowest boiling point in °C</th>
<th>Highest boiling point in °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petrol</td>
<td>5–10</td>
<td>20</td>
<td>200</td>
</tr>
<tr>
<td>Kerosene</td>
<td>10–16</td>
<td>180</td>
<td>260</td>
</tr>
<tr>
<td>Diesel oil</td>
<td>14–20</td>
<td>260</td>
<td>340</td>
</tr>
<tr>
<td>Fuel oil</td>
<td>20–70</td>
<td>370</td>
<td>600</td>
</tr>
</tbody>
</table>

---

**01.5** Which of the fuels has the largest boiling point range?  

[1 mark]

Tick **one** box.

- Petrol
- Kerosene
- Diesel oil
- Fuel oil
Plot the data for diesel oil from Table 1 on Figure 2.

Figure 2

Temperature in °C

Key
- Lowest boiling point
- Highest boiling point

Fuel
- Petrol
- Kerosene

Turn over for the next question
This question is about Group 1 elements.

A teacher demonstrated the reaction of Group 1 elements with water. **Figure 3** shows the apparatus.

**Figure 3**

![Lithium and Water](image)

---

02.1 What name is given to Group 1 elements? [1 mark]

Tick one box.

- Alkali metals
- Halogens
- Noble gases
- Non-metals

02.2 The teacher wore safety glasses and used tongs to handle the elements.

Suggest one other safety precaution the teacher should take. [1 mark]

---
Table 2 shows the teacher's results.

<table>
<thead>
<tr>
<th>Element</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lithium</td>
<td>• bubbles form</td>
</tr>
<tr>
<td></td>
<td>• lithium moves slowly on surface</td>
</tr>
<tr>
<td>Sodium</td>
<td>• bubbles form</td>
</tr>
<tr>
<td></td>
<td>• sodium moves quickly on surface</td>
</tr>
<tr>
<td></td>
<td>• sodium melts to form a ball</td>
</tr>
<tr>
<td>Potassium</td>
<td>• bubbles form</td>
</tr>
<tr>
<td></td>
<td>• potassium moves very quickly on surface</td>
</tr>
<tr>
<td></td>
<td>• potassium melts to form a ball</td>
</tr>
<tr>
<td></td>
<td>• a lilac flame is seen</td>
</tr>
</tbody>
</table>

Describe the trend in reactivity in Group 1.

Give two observations from Table 2 which provide evidence for the trend. [3 marks]

Question 2 continues on the next page
Rubidium is a Group 1 element.
Rubidium is below potassium in the periodic table.

Suggest why the teacher did not demonstrate the reaction between rubidium and water. [1 mark]

Complete the balanced equation for the reaction between sodium and water. [1 mark]

____ Na + ____ H₂O → ____ NaOH + H₂

What is the name of the compound with the formula NaOH? [1 mark]

Tick one box.

Sodium dioxide
Sodium hydrate
Sodium hydroxide
Sodium oxide
Table 3 shows the diameter of atoms of Group 1 elements.

Table 3

<table>
<thead>
<tr>
<th>Element</th>
<th>Diameter of atom in nanometres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lithium</td>
<td>0.304</td>
</tr>
<tr>
<td>Sodium</td>
<td>0.372</td>
</tr>
<tr>
<td>Potassium</td>
<td>X</td>
</tr>
<tr>
<td>Rubidium</td>
<td>0.496</td>
</tr>
<tr>
<td>Caesium</td>
<td>0.530</td>
</tr>
</tbody>
</table>

02.7 Predict value X in Table 3. [1 mark]

X = ____________________ nanometres

02.8 1 nanometre is $10^{-9}$ metres.

What is the diameter of a lithium atom in metres? [1 mark]

Tick one box.

3.04 x $10^{-8}$ m

3.04 x $10^{-9}$ m

3.04 x $10^{-10}$ m

3.04 x $10^{-11}$ m

Question 2 continues on the next page
Figure 4 shows the use of lithium and lithium compounds in 2007 and 2017.

Describe how the use of lithium and lithium compounds changed between 2007 and 2017.

You must include data from Figure 4 in your answer.

[3 marks]

__________________________
__________________________
__________________________
__________________________
__________________________
__________________________
Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED
A student investigated how the number of turns of wire on an electromagnet affects how many paper clips the electromagnet can pick up.

**Figure 5** shows the apparatus used.

![Figure 5](image)

This is the method used.

1. Wrap wire around an iron nail.
2. Count the number of turns of wire.
3. Connect the wire to a battery to make the electromagnet.
4. Switch on the electromagnet and place it near the paper clips.
5. Count the number of paper clips picked up.
6. Repeat steps 1–5 for different numbers of turns of wire.

**Table 4** shows the results.

<table>
<thead>
<tr>
<th>Number of turns of wire on electromagnet</th>
<th>Number of paper clips picked up</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>25</td>
<td>2</td>
</tr>
<tr>
<td>40</td>
<td>4</td>
</tr>
<tr>
<td>55</td>
<td>5</td>
</tr>
<tr>
<td>60</td>
<td>6</td>
</tr>
</tbody>
</table>
03.1 Plot the data from Table 4 on Figure 6.

Draw a line of best fit.

[3 marks]

Figure 6

0 2 4 6 8

Number of paper clips picked up

0 10 20 30 40 50 60

Number of turns of wire on electromagnet

03.2 Describe the relationship between the number of paper clips picked up and the number of turns on the electromagnet.

[1 mark]

Question 3 continues on the next page
Suggest what would happen if the student used 5 turns of wire in the investigation.

Give a reason for your answer. [2 marks]

Describe one way the student's investigation could have been improved.

Give a reason for the improvement. [2 marks]

Which two factors would affect the strength of the magnetic field around the electromagnet?

Tick two boxes.

The colour of the insulation around the wire

The direction of the current through the wire

The distance from the electromagnet

The size of the paper clips

The size of the current through the wire
Figure 7 shows the main energy transfers from a house.

Which two changes to the house would reduce the rate of energy transfer? [2 marks]

Tick two boxes.

- Add thermal insulation to the roof
- Increase the temperature of the house
- Decrease the thickness of the walls
- Replace the single-glazed windows with double-glazed windows
- Use materials with a higher thermal conductivity

Question 4 continues on the next page
The temperature inside the house is controlled using a thermostat.

The thermostat switches the heating on when the temperature drops below a chosen value.

The thermostat switches the heating off when the temperature rises above the chosen value.

**Figure 8** shows how the temperature of the house changes over a 150 minute period.

**Figure 8**

For how many minutes was the heating switched on?

Number of minutes = 4.2
The householder installs cavity wall insulation.

What would happen to the time taken for the temperature to fall between points A and B?

Tick one box.

- The time taken decreases
- The time taken increases
- The time taken stays the same

The householder has solar panels installed on the roof to heat water.

The householder can also heat water with an immersion heater which uses mains electricity.

Explain one advantage and one disadvantage of using a solar panel to heat water for the house, compared to the immersion heater.

Advantage

Disadvantage
**Figure 9** shows the apparatus used to pass a current through copper sulfate solution.

![Diagram of apparatus](image)

**Figure 9**

What is the name of component X in **Figure 9**?

**Tick one box.**

- Ammeter
- Battery
- Fuse
- Switch

[1 mark]
What is the name of the process happening in Figure 9?

Tick one box.

- Combustion
- Crystallisation
- Distillation
- Electrolysis

[1 mark]

A student investigated how the concentration of copper sulfate solution affects the mass of copper deposited on the negative electrode.

What are the independent and dependent variables in this investigation?

Draw one line from each type of variable to the correct description.

[2 marks]

<table>
<thead>
<tr>
<th>Type of variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Independent variable</td>
<td>Concentration of copper sulfate solution</td>
</tr>
<tr>
<td>Dependent variable</td>
<td>Distance between electrodes</td>
</tr>
<tr>
<td></td>
<td>Mass of copper deposited</td>
</tr>
<tr>
<td></td>
<td>Time circuit is switched on for</td>
</tr>
</tbody>
</table>

Question 5 continues on the next page
Table 5 shows the student’s results.

<table>
<thead>
<tr>
<th>Concentration of copper sulfate solution in g/dm$^3$</th>
<th>Mass of copper deposited in grams</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>0.04</td>
</tr>
<tr>
<td>60</td>
<td>0.08</td>
</tr>
<tr>
<td>90</td>
<td>0.12</td>
</tr>
<tr>
<td>120</td>
<td>0.07</td>
</tr>
<tr>
<td>150</td>
<td>0.20</td>
</tr>
</tbody>
</table>

The result for the concentration of 120 g/dm$^3$ is anomalous.

What may have caused the anomalous result?

Tick one box.

- Some copper fell off the electrode
- The circuit was switched on for too much time
- The concentration of the solution was too high

Predict the expected mass of copper deposited for the concentration of 120 g/dm$^3$

Use Table 5.

Mass of copper = _____________ g
During the investigation copper ions move to the negative electrode.

Complete the sentence.

Choose the answer from the box. [1 mark]

| a negative charge | a positive charge | no charge |

Copper ions move to the negative electrode because copper ions have ________________________________.

Solid copper sulfate does not conduct electricity.

What is the reason for this? [1 mark]

Tick one box.

- The charge on the ions is too high
- The ions are too big
- The ions are too small
- The ions cannot move

Question 5 continues on the next page
In a different investigation, a student passed a current of 0.6 A through copper sulfate solution for 300 s.

Calculate the charge flow through the solution.

Use the equation:

\[
\text{charge flow} = \text{current} \times \text{time}
\]

[2 marks]

\[
\text{charge flow} = \text{\underline{\hspace{2cm}}} \text{ coulombs}
\]

10
A student investigated the frictional force between an object and a surface. The student used a string to pull a small wooden block across different surfaces. The block was pulled at a constant speed in a straight line. Pulling the block causes a tension force in the string.

The student kept the angle of the string the same each time. **Figure 10** represents the block being pulled across a piece of carpet.

**Figure 10**

Measure angle $A$ on **Figure 10**. [1 mark]

Angle $A =$ ____________ degrees

Complete the sentences. Choose answers from the box. [2 marks]

<table>
<thead>
<tr>
<th>controlled</th>
<th>dependent</th>
<th>scalar</th>
<th>valid</th>
<th>vector</th>
</tr>
</thead>
</table>

Force has both magnitude and direction, so is a ______________ quantity.

A quantity with magnitude only is a ______________ quantity.
Two forces acting on the block are tension and friction.

Name one other force acting on the block.  

[1 mark]

When the student pulled the block with a constant force, the velocity of the block did not change.

What is the best explanation for this?  

Tick one box.

Force is directly proportional to velocity

No work is done by the pulling force

The block is moving in a straight line

The resultant force on the block is zero

[1 mark]

Question 6 continues on the next page
The student pulled the block along four different surfaces:

- cardboard
- carpet
- glass
- sandpaper.

Give two control variables for this investigation. [2 marks]

Table 6 shows the results.

<table>
<thead>
<tr>
<th>Surface</th>
<th>Force to pull the block in newtons</th>
<th>Mean force in newtons</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Trial 1</td>
<td>Trial 2</td>
</tr>
<tr>
<td>cardboard</td>
<td>1.4</td>
<td>1.6</td>
</tr>
<tr>
<td>carpet</td>
<td>2.5</td>
<td>3.0</td>
</tr>
<tr>
<td>glass</td>
<td>0.7</td>
<td>0.8</td>
</tr>
<tr>
<td>sandpaper</td>
<td>5.2</td>
<td>5.6</td>
</tr>
</tbody>
</table>

Calculate value X in Table 6. [1 mark]

\[ X = \text{___________ N} \]

Which surface produced the lowest friction force? [1 mark]
Astronauts have been to the Moon.

Astronauts moved around the surface of the Moon in a lunar rover. **Figure 11** shows a lunar rover.

**Figure 11**

The batteries on the lunar rover provided a potential difference of 36 V

The total charge stored in the batteries was 870 000 C

Calculate the maximum energy that could have been transferred from the batteries. Use the equation:

\[
\text{energy transferred} = \text{charge flow} \times \text{potential difference}
\]

Maximum energy transferred = ______________ J

**Question 7 continues on the next page**
Not all of the energy from the batteries was usefully transferred to the kinetic energy of the lunar rover.

Explain why. [2 marks]

The astronauts collected rock samples from the Moon.

Scientists analysed the percentages of elements in Moon rock and Earth rock.

Table 7 shows the results.

<table>
<thead>
<tr>
<th>Element</th>
<th>Percentage in Moon rock</th>
<th>Percentage in Earth rock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminium</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Iron</td>
<td>13</td>
<td>5</td>
</tr>
<tr>
<td>Oxygen</td>
<td>42</td>
<td>47</td>
</tr>
<tr>
<td>Silicon</td>
<td>X</td>
<td>28</td>
</tr>
<tr>
<td>Other elements</td>
<td>10</td>
<td>12</td>
</tr>
</tbody>
</table>

Calculate value X in Table 7. [1 mark]

\[ X = \underline{\text{___________}} \% \]
Give one similarity and one difference between Moon rock and Earth rock. Use Table 7. [2 marks]

<table>
<thead>
<tr>
<th>Similarity</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

07.5 Scientists used to think the Earth and Moon formed separately. Scientists now believe that the Moon formed after a collision between the Earth and a small planet. This new idea came from the study of Moon rocks. Why do scientific theories sometimes change? [1 mark]

Tick one box.

- Scientists agree that the existing theory is old-fashioned
- Scientists change their theories to make the theories more popular
- Scientists decide that the new theory is more exciting
- Scientists discover new evidence which the existing theory cannot explain

Question 7 continues on the next page
Write down the equation which links gravitational field strength, gravitational potential energy, height and mass.

[1 mark]

When the astronauts left the Moon, they used a spacecraft with a mass of 2150 kg.

Calculate the height reached by the spacecraft at the point where it had a gravitational potential energy of 86 000 000 J.

The gravitational field strength of the Moon is 1.6 N/kg.

[3 marks]

Height = ___________ m
A light dependent resistor (LDR) is connected in a circuit.

Draw the circuit symbol for an LDR.  

[1 mark]

A student investigated the relationship between current and potential difference for an LDR.

How should the student have connected the ammeter and voltmeter in the circuit? 

Tick one box.

<table>
<thead>
<tr>
<th>Ammeter</th>
<th>Voltmeter</th>
</tr>
</thead>
<tbody>
<tr>
<td>in parallel with LDR</td>
<td>in parallel with LDR</td>
</tr>
<tr>
<td>in parallel with LDR</td>
<td>in series with LDR</td>
</tr>
<tr>
<td>in series with LDR</td>
<td>in parallel with LDR</td>
</tr>
<tr>
<td>in series with LDR</td>
<td>in series with LDR</td>
</tr>
</tbody>
</table>

Question 8 continues on the next page
Figure 12 shows a sketch graph of the student’s results.

The LDR was in a constant bright light.

**Figure 12**

![Sketch Graph](image.png)

The student concluded that the current in the LDR is inversely proportional to the potential difference across the LDR.

Explain why the student’s conclusion is incorrect.  

[2 marks]

The student repeated the investigation with the LDR in constant dark conditions.

Sketch on **Figure 12** the graph for the LDR in constant dark conditions.  

[2 marks]
The LDR was placed near a light source.

The following results were recorded:

potential difference = 5.50 V
current = 12.5 mA

Write down the equation that links current, potential difference and resistance.

[1 mark]

Calculate the resistance of the LDR.

[4 marks]

Resistance = \[ \frac{\text{potential difference}}{\text{current}} \] \[ \text{Ω} \]
Supermarket carrier bags can be made from poly(ethene).

Poly(ethene) is produced from ethene.

The structure of ethene is:

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

Complete the structure of poly(ethene).

\[
\left(\begin{array}{c}
\text{H} \\
\text{H} \\
\text{C} \\
\text{H} \\
\end{array}\right)_n
\]
There are two types of poly(ethene): HD poly(ethene) and LD poly(ethene).

Figure 13 shows the polymer chains in HD poly(ethene) and LD poly(ethene).

**Figure 13**

Describe the differences in the structure and arrangement of the polymer chains in the two types of poly(ethene).

[2 marks]

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

Question 9 continues on the next page
A student investigated how poly(ethene) extends when a force is applied.

09.3 Describe a method to investigate how the extension of poly(ethene) changes with the force applied.

[4 marks]

Figure 14 shows the results for HD poly(ethene) and LD poly(ethene).

Figure 14
Give two comparisons between the results for HD poly(ethene) and for LD poly(ethene).

Use Figure 14. [2 marks]

1

2

Carrier bags in supermarkets used to be provided free. Supermarkets now make customers pay for carrier bags.

When they were free, 8.0 billion new carrier bags were used each year.

After supermarkets started making customers pay for carrier bags, the use of new bags dropped by 85%

Calculate how many carrier bags are now used each year. [2 marks]

Number of bags =

Question 9 continues on the next page
There are two types of carrier bag in common use:

- disposable bags
- bags for life.

Bags for life can be returned to the supermarket when no longer usable.

The supermarket replaces the bag for life free of charge and arranges for the bag to be recycled.

Table 8 shows data from a life cycle assessment (LCA) for the two types of carrier bag.

<table>
<thead>
<tr>
<th></th>
<th>Disposable bag</th>
<th>Bag for life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of polymer</td>
<td>HD poly(ethene)</td>
<td>LD poly(ethene)</td>
</tr>
<tr>
<td>Raw material from which polymer is made</td>
<td>Crude oil</td>
<td>Crude oil</td>
</tr>
<tr>
<td>Mass of waste material per bag from production in grams</td>
<td>0.42</td>
<td>0.17</td>
</tr>
<tr>
<td>Mass of carbon dioxide emitted per bag during production and transport in grams</td>
<td>1.6</td>
<td>6.9</td>
</tr>
<tr>
<td>Mean number of times used</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Possible disposal methods</td>
<td>Landfill Incineration Recycling</td>
<td>Landfill Incineration Recycling</td>
</tr>
</tbody>
</table>
Evaluate the use of each type of carrier bag.

Use data from Table 8 and your own knowledge. [6 marks]

END OF QUESTIONS