Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname ______________________________

Forename(s) ______________________________

Candidate signature ______________________________

GCSE
COMBINED SCIENCE: SYNERGY

F

Foundation Tier   Paper 4 Physical sciences

Wednesday 13 June 2018   Morning   Time allowed: 1 hour 45 minutes

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.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
TOTAL	

Do not write outside the box

0 1 Crude oil is a mixture of hydrocarbons.

0 1 . 1 Name the **two** elements in a hydrocarbon.

[2 marks]

1 ____________________

2 ____________________

0 1 . 2 What was crude oil formed from?

[1 mark]

Tick **one** box.

Acids ☐

Enzymes ☐

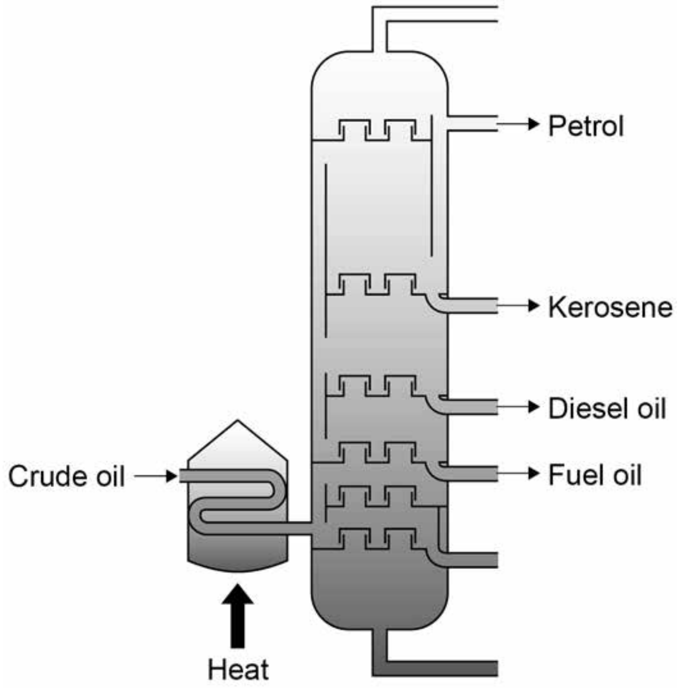
Metals ☐

Plankton ☐

Do not write outside the box

Figure 1 shows how crude oil is separated to produce different fuels.

Figure 1



0 1 . 3 What is the name of this process?

[1 mark]

Tick **one** box.

Combustion ☐

Fractional distillation ☐

Phytomining ☐

Steam cracking ☐

Question 1 continues on the next page

Do not write outside the box

0 1 . 4 Why is the crude oil heated?

[1 mark]

____

____

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

Table 1

Fuel	**Number of carbon atoms in chain**	**Lowest boiling point in °C**	**Highest boiling point in °C**
Petrol	5–10	20	200
Kerosene	10–16	180	260
Diesel oil	14–20	260	340
Fuel oil	20–70	370	600

0 1 . 5 Which of the fuels has the largest boiling point range?

[1 mark]

Tick **one** box.

Petrol ☐

Kerosene ☐

Diesel oil ☐

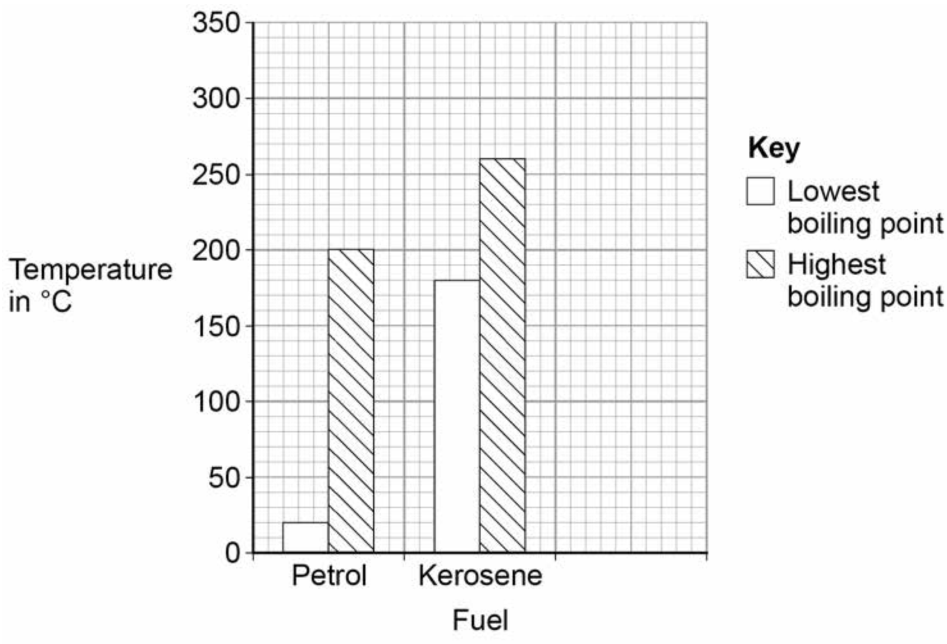
Fuel oil ☐

Do not write outside the box

0 1 . 6 Plot the data for diesel oil from **Table 1** on **Figure 2**.

[3 marks]

Figure 2



9

Turn over for the next question

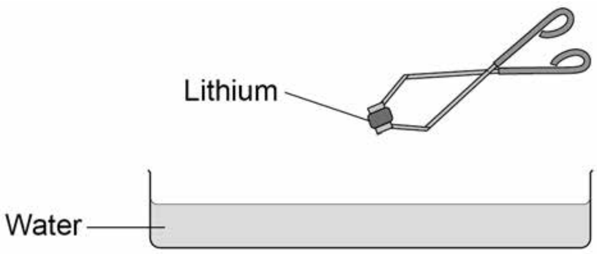
Do not write outside the box

0 2 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



0 2 . 1 What name is given to Group 1 elements?

[1 mark]

Tick **one** box.

Alkali metals ☐

Halogens ☐

Noble gases ☐

Non-metals ☐

0 2 . 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 2

Element	**Observations**
Lithium	• bubbles form • lithium moves slowly on surface
Sodium	• bubbles form • sodium moves quickly on surface • sodium melts to form a ball
Potassium	• bubbles form • potassium moves very quickly on surface • potassium melts to form a ball • a lilac flame is seen

0 2 . 3 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

Do not write outside the box

0 2 . 4 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]

____

____

0 2 . 5 Complete the balanced equation for the reaction between sodium and water.

[1 mark]

$$\_\_\_\_\_\ Na + \_\_\_\_\_\ H_2O \rightarrow \_\_\_\_\_\ NaOH + H_2$$

0 2 . 6 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

Element	**Diameter of atom in nanometres**
Lithium	0.304
Sodium	0.372
Potassium	**X**
Rubidium	0.496
Caesium	0.530

0 2 . 7 Predict value **X** in **Table 3**.

[1 mark]

X = ______________________ nanometres

0 2 . 8 1 nanometre is 10^{-9} metres.

What is the diameter of a lithium atom in metres?

[1 mark]

Tick **one** box.

3.04×10^{-8} m ☐

3.04×10^{-9} m ☐

3.04×10^{-10} m ☐

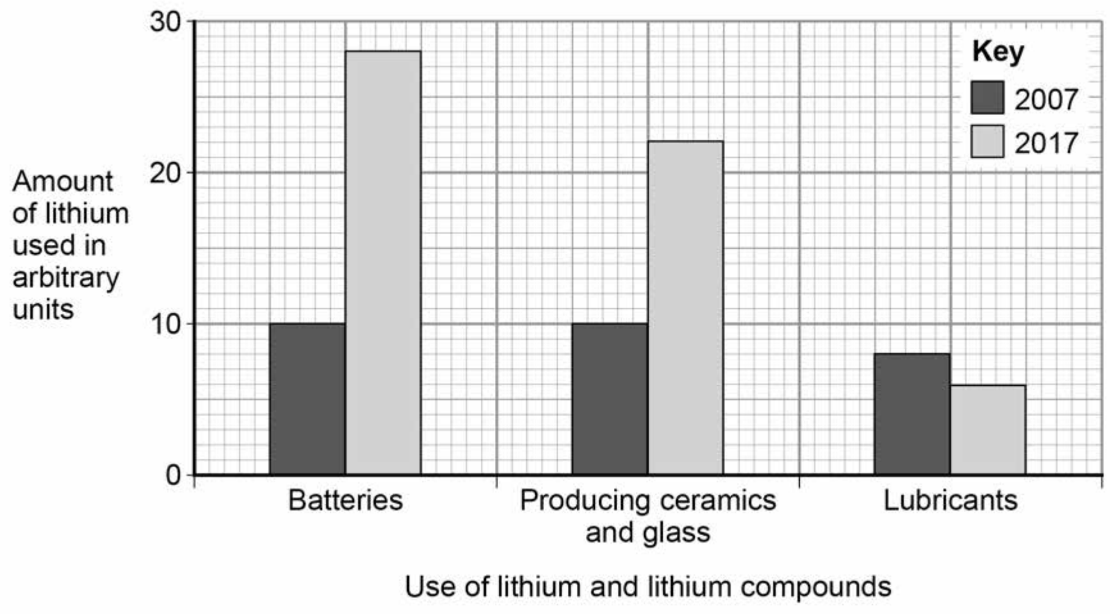
3.04×10^{-11} m ☐

Question 2 continues on the next page

Do not write outside the box

Figure 4 shows the use of lithium and lithium compounds in 2007 and 2017.

Figure 4



0 2 . 9 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]

13

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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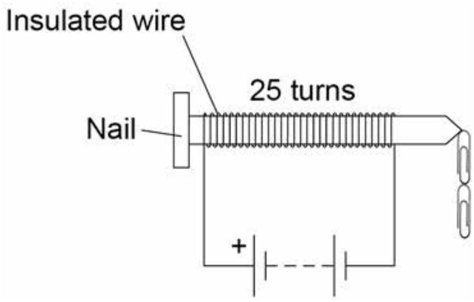
0 3 A student investigated how the number of turns of wire on an electromagnet affects how many paper clips the electromagnet can pick up.

Figure 5 shows the apparatus used.

Figure 5



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 4

Number of turns of wire on electromagnet	Number of paper clips picked up
10	1
25	2
40	4
55	5
60	6

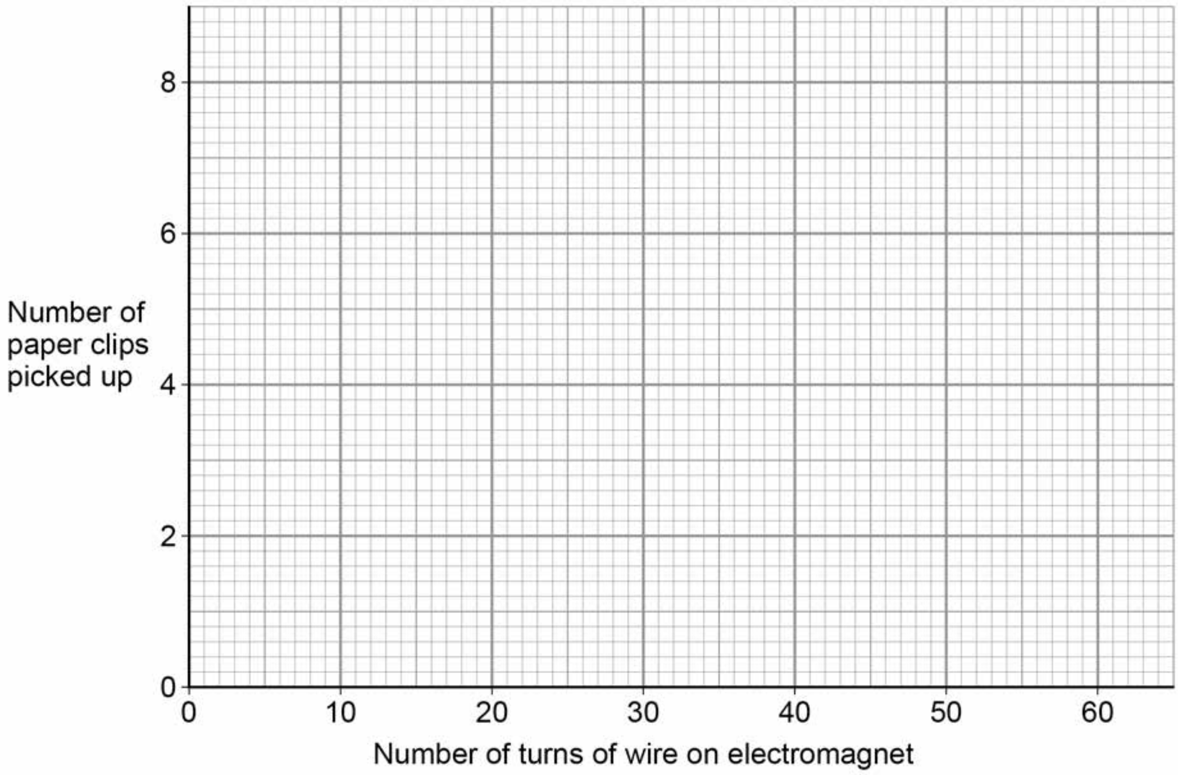
Do not write outside the box

0 3 . 1 Plot the data from **Table 4** on **Figure 6**.

Draw a line of best fit.

[3 marks]

Figure 6



0 3 . 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

Do not write outside the box

0 3 . 3 Suggest what would happen if the student used 5 turns of wire in the investigation.

Give a reason for your answer.

[2 marks]

0 3 . 4 Describe **one** way the student's investigation could have been improved.

Give a reason for the improvement.

[2 marks]

Improvement

Reason

0 3 . 5 Which **two** factors would affect the strength of the magnetic field around the electromagnet?

[2 marks]

Tick **two** boxes.

The colour of the insulation around the wire ☐

The direction of the current through the wire ☐

The distance from the electromagnet ☐

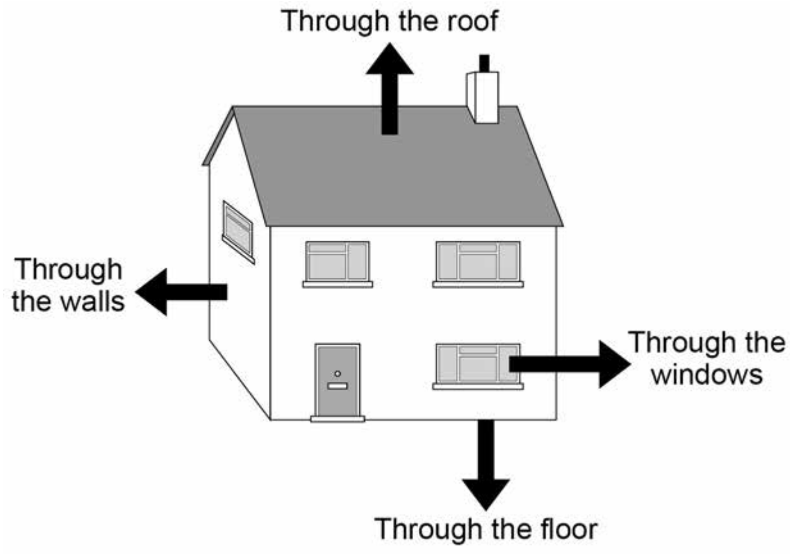
The size of the paper clips ☐

The size of the current through the wire ☐

10

0 4 **Figure 7** shows the main energy transfers from a house.

Figure 7



0 4 . 1 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

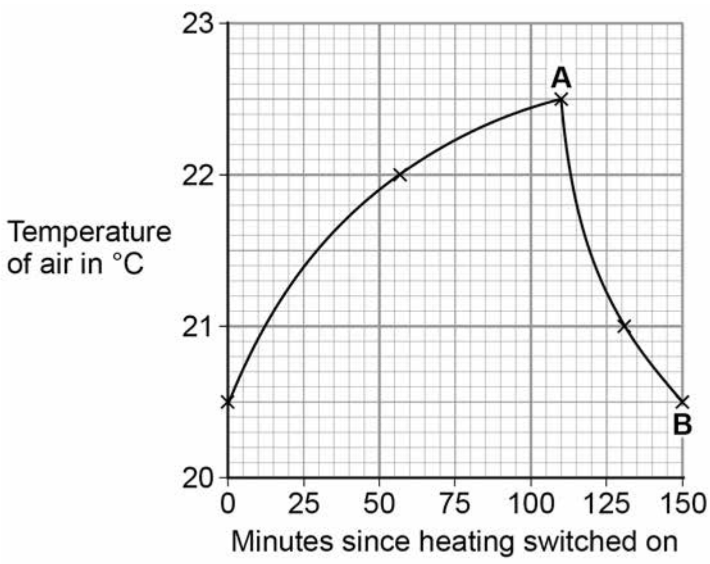
The temperature inside the house is controlled using a thermostat.

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



0 4 . 2 For how many minutes was the heating switched on?

[1 mark]

Number of minutes = ______________________

Do not write outside the box

0 4 . 3 The householder installs cavity wall insulation.

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

[1 mark]

Tick **one** box.

The time taken decreases ☐

The time taken increases ☐

The time taken stays the same ☐

0 4 . 4 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.

[4 marks]

Advantage ______________________________

____

____

____

Disadvantage ______________________________

____

____

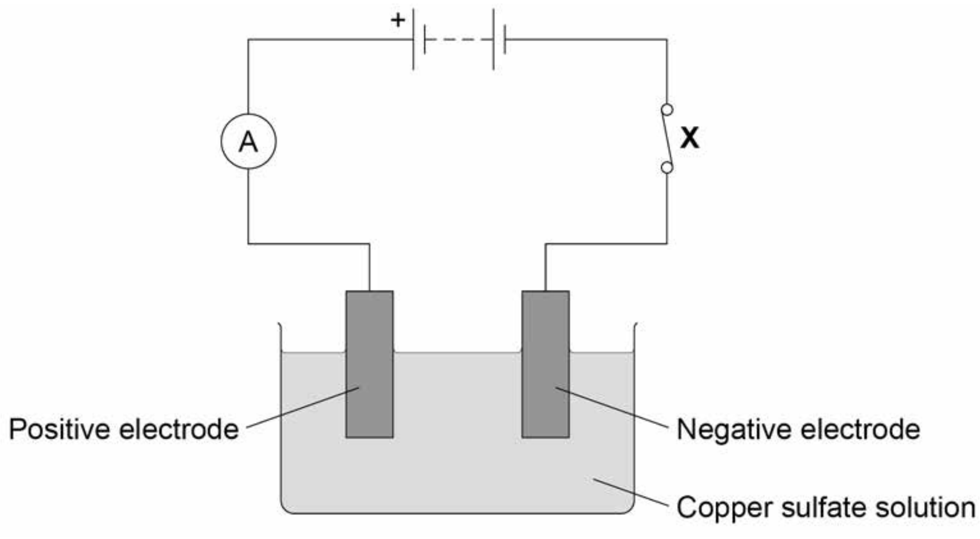
____

8

Turn over for the next question

0 5 **Figure 9** shows the apparatus used to pass a current through copper sulfate solution.

Figure 9



0 5 . 1 What is the name of component **X** in **Figure 9**?

[1 mark]

Tick **one** box.

Ammeter ☐

Battery ☐

Fuse ☐

Switch ☐

0 5 . 2 What is the name of the process happening in **Figure 9**?

[1 mark]

Tick **one** box.

Combustion ☐

Crystallisation ☐

Distillation ☐

Electrolysis ☐

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

0 5 . 3 What are the independent and dependent variables in this investigation?

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

[2 marks]

Type of variable	Description
	Concentration of copper sulfate solution
Independent variable	Distance between electrodes
Dependent variable	Mass of copper deposited
	Time circuit is switched on for

Question 5 continues on the next page

Table 5 shows the student's results.

Table 5

Concentration of copper sulfate solution in g/dm^3	**Mass of copper deposited in grams**
30	0.04
60	0.08
90	0.12
120	0.07
150	0.20

0 5 . 4 The result for the concentration of 120 g/dm^3 is anomalous.

What may have caused the anomalous result?

[1 mark]

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 ☐

0 5 . 5 Predict the expected mass of copper deposited for the concentration of 120 g/dm^3

Use **Table 5**.

[1 mark]

Mass of copper = ________________ g

Do not write outside the box

0 5 . 6 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

____________________________________.

0 5 . 7 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

Do not write outside the box

0 5 . 8 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:

charge flow = current $\times$ time

[2 marks]

____

____

____

charge flow = __________________ coulombs

10

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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0 6 A student investigated the frictional force between an object and a surface.

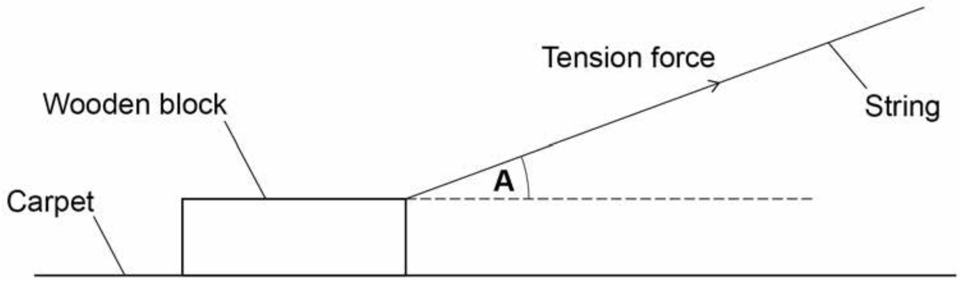
The student used a string to pull a small wooden block across different surfaces.
The block was pulled at a constant speed in a straight line.

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



0 6 . 1 Measure angle **A** on **Figure 10**.

[1 mark]

Angle **A** = ______________ degrees

0 6 . 2 Complete the sentences.

Choose answers from the box.

[2 marks]

controlled	**dependent**	**scalar**	**valid**	**vector**

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

A quantity with magnitude only is a ______________________ quantity.

Do not write outside the box

0 6 . 3 Two forces acting on the block are tension and friction.

Name **one** other force acting on the block.

[1 mark]

---

0 6 . 4 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?

[1 mark]

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 ☐

Question 6 continues on the next page

Do not write outside the box

The student pulled the block along four different surfaces:

- cardboard
- carpet
- glass
- sandpaper.

0 6 . 5 Give **two** control variables for this investigation.

[2 marks]

1 ____________________

2 ____________________

Table 6 shows the results.

Table 6

Surface	Force to pull the block in newtons			Mean force in newtons
	Trial 1	Trial 2	Trial 3	
cardboard	1.4	1.6	1.5	1.5
carpet	2.5	3.0	3.9	3.2
glass	0.7	0.8	0.6	0.7
sandpaper	5.2	5.6	5.4	**X**

0 6 . 6 Calculate value **X** in **Table 6**.

[1 mark]

____

____

X = ____________ N

0 6 . 7 Which surface produced the lowest friction force?

[1 mark]

____

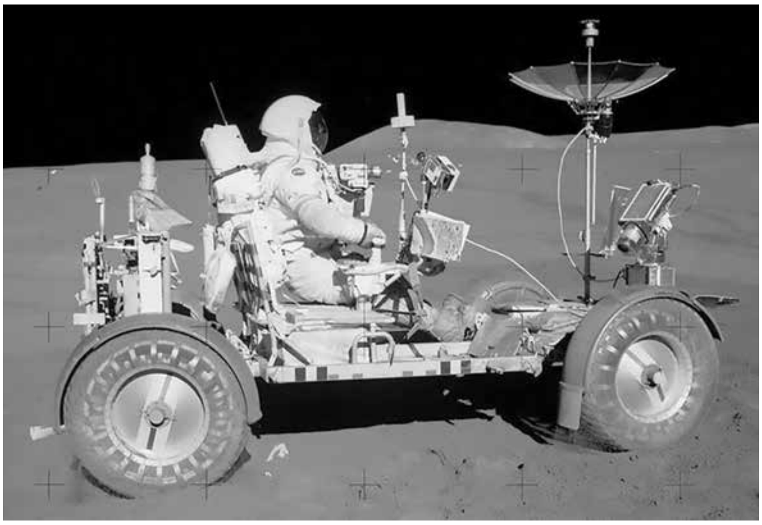
9

0 7 Astronauts have been to the Moon.

0 7 . 1 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:

energy transferred = charge flow x potential difference

[2 marks]

____

____

____

____

Maximum energy transferred = ____________________ J

Question 7 continues on the next page

Do not write outside the box

0 7 . 2 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 7

Element	**Percentage in Moon rock**	**Percentage in Earth rock**
Aluminium	8	8
Iron	13	5
Oxygen	42	47
Silicon	**X**	28
Other elements	10	12

0 7 . 3 Calculate value **X** in **Table 7**.

[1 mark]

X = ____________ %

Do not write outside the box

0 7 . 4 Give **one** similarity and **one** difference between Moon rock and Earth rock.

Use **Table 7**.

[2 marks]

Similarity ____

____

Difference ____

____

0 7 . 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

Do not write outside the box

0 7 . 6 Write down the equation which links gravitational field strength, gravitational potential energy, height and mass.

[1 mark]

0 7 . 7 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

12

Do not write outside the box

0 8 A light dependent resistor (LDR) is connected in a circuit.

0 8 . 1 Draw the circuit symbol for an LDR.

[1 mark]

0 8 . 2 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?

[1 mark]

Tick **one** box.

Ammeter	Voltmeter	
in parallel with LDR	in parallel with LDR	☐
in parallel with LDR	in series with LDR	☐
in series with LDR	in parallel with LDR	☐
in series with LDR	in series with LDR	☐

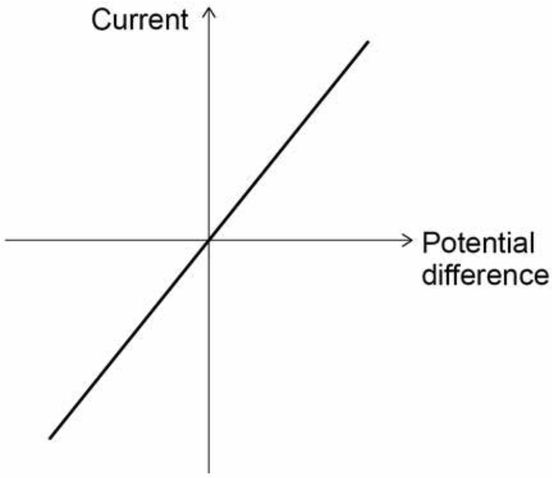
Question 8 continues on the next page

Do not write outside the box

Figure 12 shows a sketch graph of the student's results.

The LDR was in a constant bright light.

Figure 12



0 8 . 3 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]

____

____

____

____

0 8 . 4 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

0 8 . 5 Write down the equation that links current, potential difference and resistance.

[1 mark]

____

0 8 . 6 Calculate the resistance of the LDR.

[4 marks]

____

____

____

____

____

Resistance = ____________ Ω

11

Turn over for the next question

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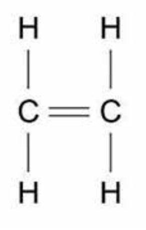
0 9 Supermarket carrier bags can be made from poly(ethene).

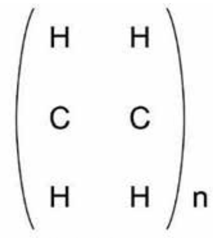
0 9 . 1 Poly(ethene) is produced from ethene.

The structure of ethene is:



Complete the structure of poly(ethene).

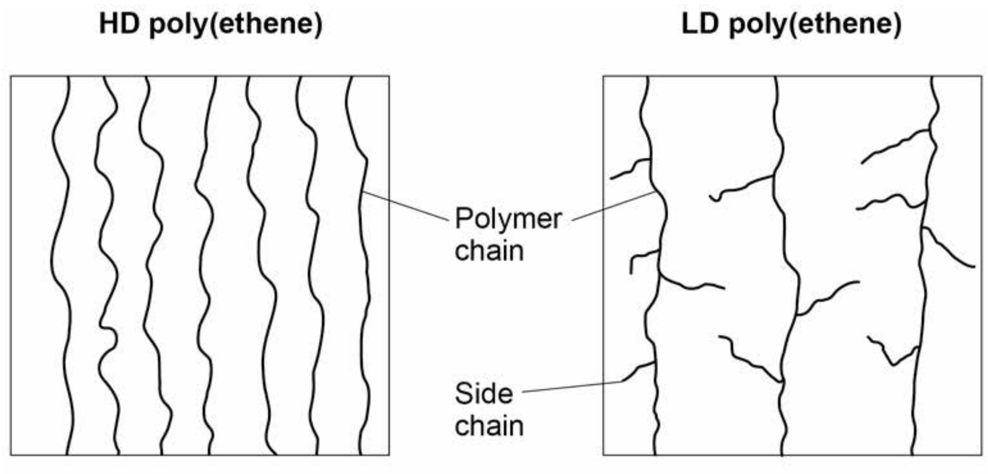
[2 marks]



There are two types of poly(ethene): HD poly(ethene) and LD poly(ethene).

0 9 . 2 **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

Do not write outside the box

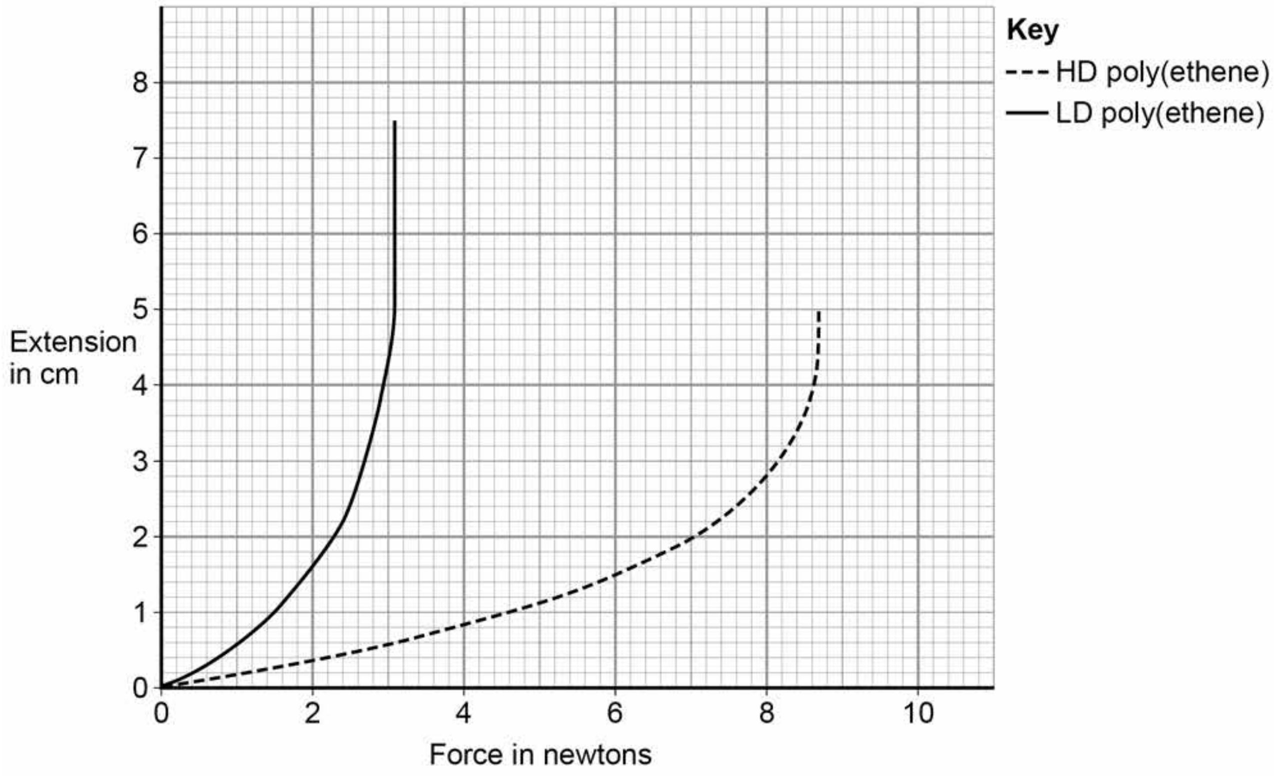
A student investigated how poly(ethene) extends when a force is applied.

0 9 . 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



0 9 . 4 Give **two** comparisons between the results for HD poly(ethene) and for LD poly(ethene).

Use **Figure 14**.

[2 marks]

1 ____

____

2 ____

____

0 9 . 5 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

0 9 . 6 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 8

	Disposable bag	Bag for life
Type of polymer	HD poly(ethene)	LD poly(ethene)
Raw material from which polymer is made	Crude oil	Crude oil
Mass of waste material per bag from production in grams	0.42	0.17
Mass of carbon dioxide emitted per bag during production and transport in grams	1.6	6.9
Mean number of times used	1	6
Possible disposal methods	Landfill Incineration Recycling	Landfill Incineration Recycling

Do not write outside the box

Evaluate the use of each type of carrier bag.

Use data from **Table 8** and your own knowledge.

[6 marks]

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END OF QUESTIONS

There are no questions printed on this page

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