AQA

Please write clearly in block capitals.

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

Surname ______________________

Forename(s) ______________________

Candidate signature ______________________

GCSE
COMBINED SCIENCE: SYNERGY

H

Higher 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	
TOTAL	

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There are no questions printed on this page

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ANSWER IN THE SPACES PROVIDED

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0 1 A light dependent resistor (LDR) is connected in a circuit.

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

[1 mark]

0 1 . 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.

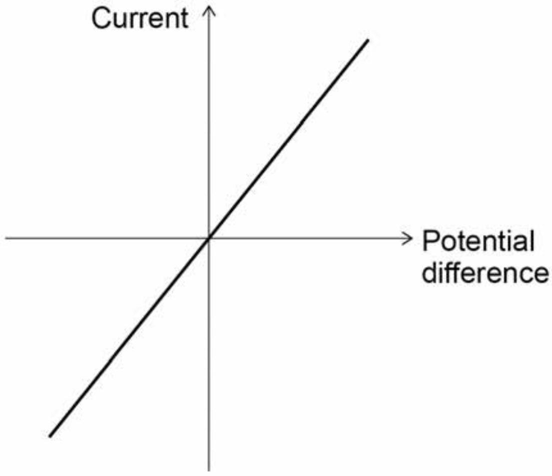
Ammeter	**Voltmeter**	
in parallel with LDR	in parallel with LDR	☐
in parallel with LDR	in series with LDR	☐
in series with LDR	in parallel with LDR	☐
in series with LDR	in series with LDR	☐

Question 1 continues on the next page

Figure 1 shows a sketch graph of the student's results.

The LDR was in a constant bright light.

Figure 1



0 1 . 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]

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0 1 . 4 The student repeated the investigation with the LDR in constant dark conditions.

Sketch on **Figure 1** the graph for the LDR in constant dark conditions.

[2 marks]

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The LDR was placed near a light source.

The following results were recorded:

potential difference = 5.50 V

current = 12.5 mA

0 1 . 5 Write down the equation that links current, potential difference and resistance.

[1 mark]

____

0 1 . 6 Calculate the resistance of the LDR.

[4 marks]

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Resistance = ____________ Ω

11

Turn over for the next question

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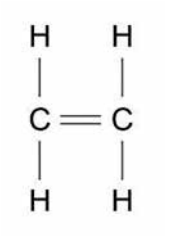
0 2 Supermarket carrier bags can be made from poly(ethene).

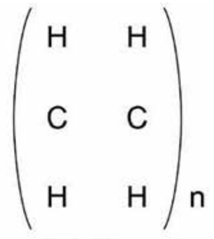
0 2 . 1 Poly(ethene) is produced from ethene.

The structure of ethene is:



Complete the structure of poly(ethene).

[2 marks]



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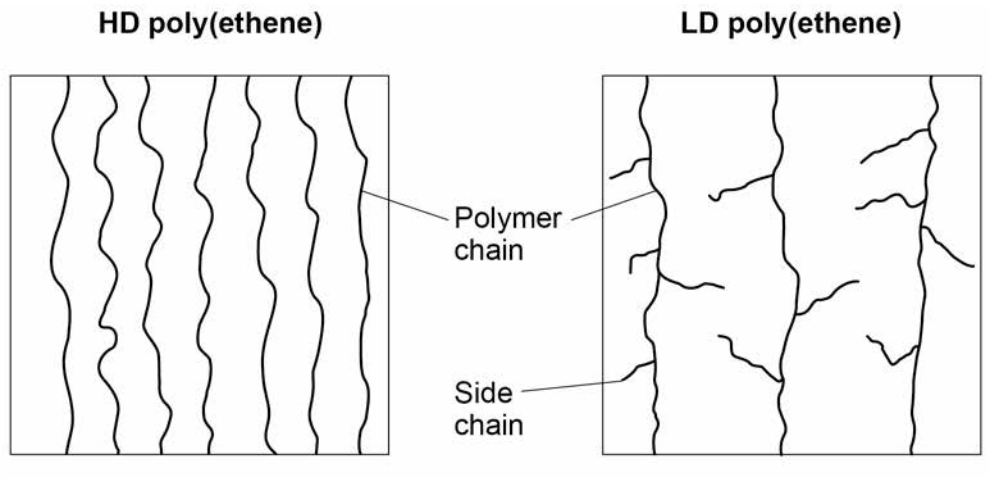
There are two types of poly(ethene): HD poly(ethene) and LD poly(ethene).

0 2 . 2 **Figure 2** shows the polymer chains in HD poly(ethene) and LD poly(ethene).

Figure 2



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

[2 marks]

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Question 2 continues on the next page

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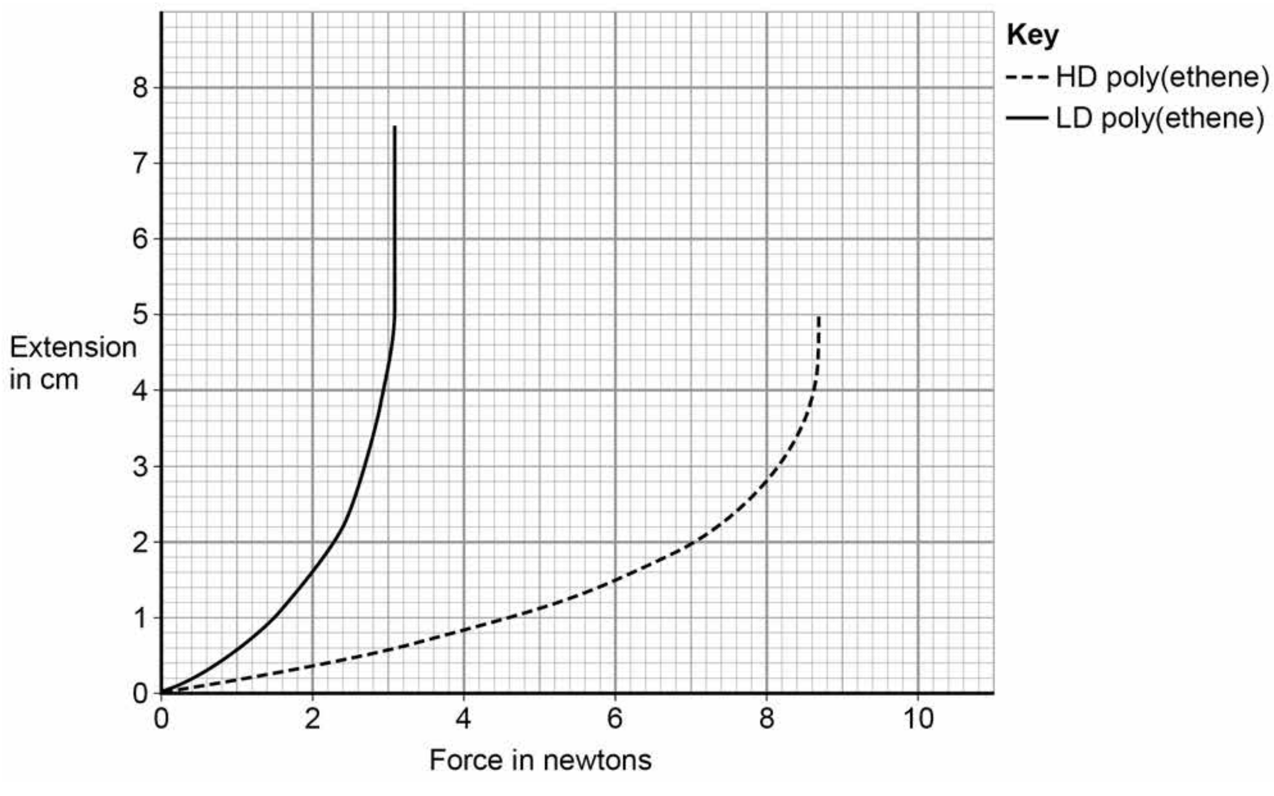
A student investigated how poly(ethene) extends when a force is applied.

0 2 . 3 Describe a method to investigate how the extension of poly(ethene) changes with the force applied.

[4 marks]

Figure 3 shows the results for HD poly(ethene) and LD poly(ethene).

Figure 3



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0 2 . 4 Give **two** comparisons between the results for HD poly(ethene) and for LD poly(ethene).

Use **Figure 3**.

[2 marks]

1 ____

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2 ____

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0 2 . 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]

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Number of bags = ____________________

Question 2 continues on the next page

0 2 . 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 1 shows data from a life cycle assessment (LCA) for the two types of carrier bag.

Table 1

	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

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Evaluate the use of each type of carrier bag.

Use data from **Table 1** and your own knowledge.

[6 marks]

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Turn over for the next question

Do not write outside the box

0 3 Forces are vector quantities.

0 3 . 1 What is the difference between a vector quantity and a scalar quantity?

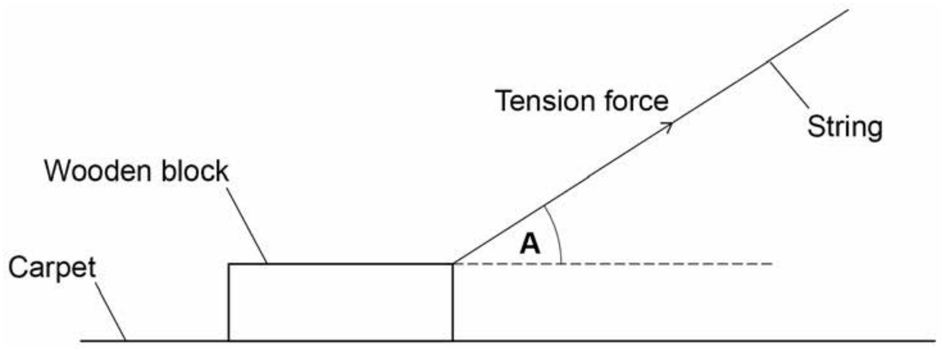
[2 marks]

Figure 4 represents a wooden block being pulled across a surface at a constant speed in a straight line.

The block is in contact with the surface.

The arrow in **Figure 4** represents the tension force in the string pulling the block.

Figure 4



0 3 . 2 Complete **Figure 4** to show the other three forces acting on the block.

[3 marks]

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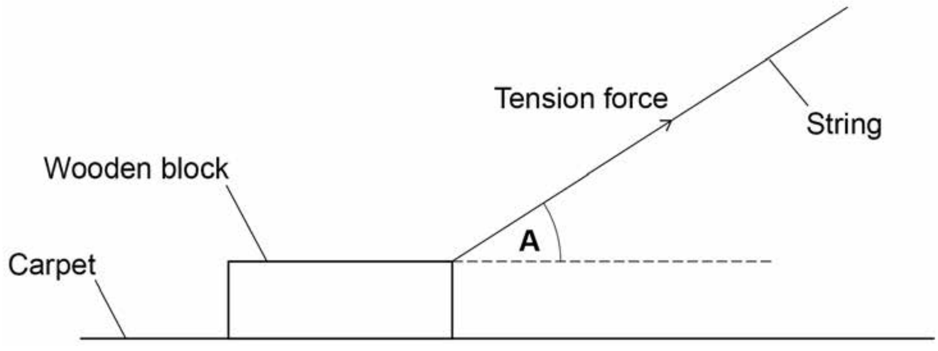
Figure 5 is a copy of **Figure 4** to help you answer the following question.

Figure 5



0 3 . 3 **Figure 5** is drawn to scale. The scale is 1 cm : 0.5 N

Determine the horizontal and vertical components of the tension in the string.

Show these components on **Figure 5**.

[3 marks]

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Horizontal component = ________________ N

Vertical component = ________________ N

Question 3 continues on the next page

A student collects data on the size of the force required to pull the block across different surfaces at a constant speed.

Table 2 shows the results.

Table 2

Type of surface	**Force in N**			**Mean force in N**
	Trial 1	**Trial 2**	**Trial 3**	
Cardboard	1.4	1.6	1.5	1.5
Carpet	2.6	3.1	3.9	3.2
Glass	0.7	0.8	0.6	0.7
Sandpaper	5.2	**X**	5.3	5.4

0 3 . 4 Calculate value **X** in **Table 2**.

[2 marks]

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X = ____________ N

0 3 . 5 Give **three** control variables for this investigation.

[3 marks]

1 ______________________________

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2 ______________________________

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3 ______________________________

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Turn over for the next question

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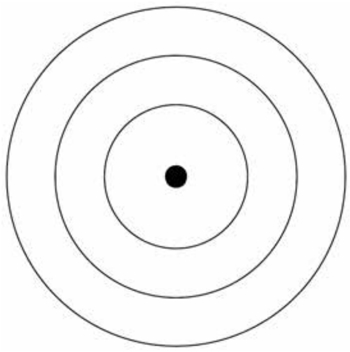
0 4 This question is about Group 1 elements.

0 4 . 1 A sodium atom is represented as ${}^{23}_{11}Na$

Complete **Figure 6** to show the electronic structure of a sodium atom.

[1 mark]

Figure 6



A teacher demonstrated the reaction between lithium and water.

The teacher repeated the demonstration using sodium and then potassium with water.

0 4 . 2 The teacher wore eye protection.

Suggest **two** other safety precautions the teacher should take.

[2 marks]

1 ____

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2 ____

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Do not write outside the box

0 4 . 3 Universal indicator is added to the solution formed in the reaction between potassium and water. The universal indicator becomes purple in colour.

Which ion causes universal indicator to turn purple?

[1 mark]

Tick **one** box.

H^+ ☐

K^+ ☐

$OH^–$ ☐

$O^{2–}$ ☐

Question 4 continues on the next page

Turn over ►

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0 4 . 4 **Table 3** gives the diameter of atoms of Group 1 elements.

Table 3

Element	**Diameter of atom in nm**
Lithium	0.304
Sodium	0.372
Potassium	0.454
Rubidium	0.496
Caesium	0.530

Explain how the diameter of the atom affects the reactivity of Group 1 elements.

[4 marks]

8

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Turn over for the next question

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0 5 Two students investigated the electrolysis of copper sulfate solution.

When copper sulfate solution is electrolysed, copper is produced at the negative electrode.

0 5 . 1 What substance is produced at the positive electrode when copper sulfate solution is electrolysed?

[1 mark]

Tick **one** box.

Hydrogen ☐

Oxygen ☐

Sulfur ☐

Sulfur dioxide ☐

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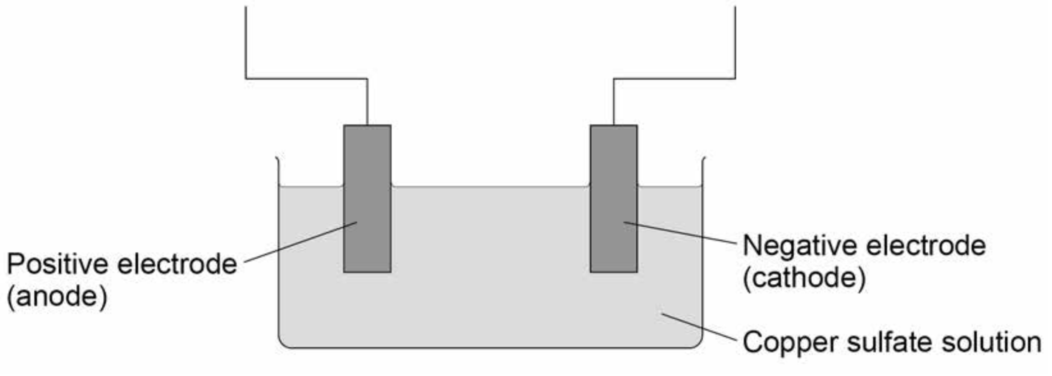
0 5 . 2 The students varied and measured the current in the circuit.

Complete **Figure 7** to show a circuit that could be used.

Use the correct circuit symbols.

[3 marks]

Figure 7



Question 5 continues on the next page

The students made the following hypothesis:

'The mass of copper deposited on the negative electrode will be directly proportional to the current.'

Table 4 shows the students' results.

Table 4

Current in amps	**Mass of copper deposited on the negative electrode in grams**
0.12	0.024
0.24	0.047
0.36	0.057
0.48	0.095
0.60	0.118
0.72	0.142

0 5 . 3 Student **A** said that the results did support the hypothesis.

Student **B** said that the results did **not** support the hypothesis.

Explain the extent to which the data in **Table 4** supports the students' hypothesis.

[4 marks]

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0 5 . 4 Calculate the number of moles of copper deposited on the negative electrode when the current is 0.72 A

Give your answer in standard form.

Use **Table 4**.

Relative atomic mass (A_r) of copper = 63.5

[2 marks]

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Number of moles = _______________

0 5 . 5 What change to the investigation would increase the mass of copper deposited on the negative electrode?

[1 mark]

Tick **one** box.

Decrease the concentration of copper sulfate solution	☐
Decrease the volume of copper sulfate solution	☐
Increase the distance between the electrodes	☐
Increase the time the circuit is switched on for	☐

11

Turn over for the next question

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0 6 When a conductor carrying a current is placed in a magnetic field a force is exerted on the conductor.

This is called the motor effect.

0 6 . 1 Describe how the direction of the force can be determined using Fleming's Left Hand Rule.

[4 marks]

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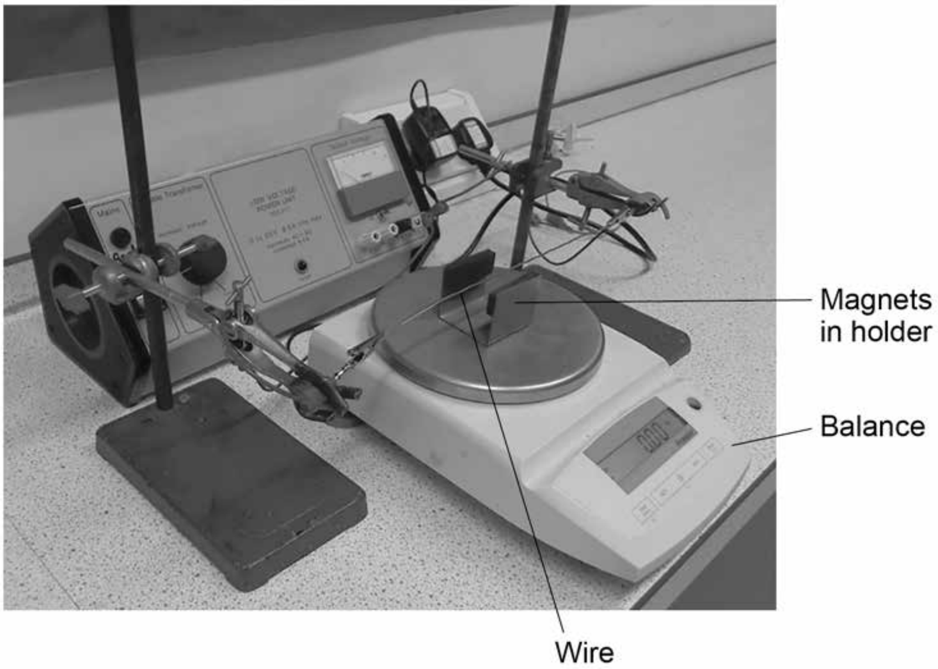
Figure 8 shows apparatus to demonstrate the motor effect.

Figure 8



The piece of wire is fixed so that it cannot move.

This is the method used.

1. Place the pair of magnets in their holder on the balance.
2. Set the reading on the balance to zero.
3. Pass a current through the wire.
4. Record the new reading on the balance.

0 6 . 2 When there is a current in the wire, the reading on the balance increases.

Explain in terms of forces why the reading increases.

[3 marks]

Do not write outside the box

0 6 . 3 In one experiment, the teacher determined that the force on the wire was 2.14 mN

The current in the wire was 0.32 A

The length of wire within the magnetic field was 0.048 m

Calculate the magnetic flux density between the two magnets.

Use the Physics Equations Sheet.

Give your answer to 2 significant figures.

[4 marks]

Magnetic flux density = ____________________ T

11

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0 7 Astronauts have landed on the Moon on six separate occasions.

0 7 . 1 The Moon is in a circular orbit around the Earth. The speed of the Moon is constant.

Explain why the Moon is accelerating.

[3 marks]

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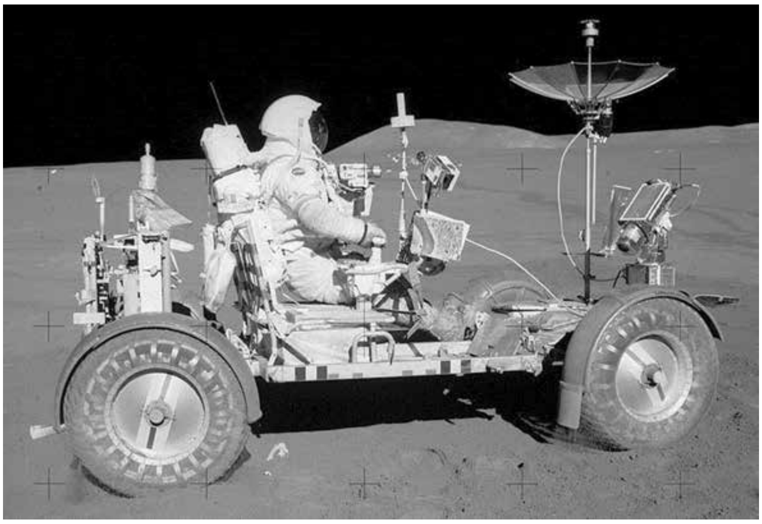
Question 7 continues on the next page

The astronauts moved around the surface of the Moon in a lunar rover.

Figure 9 shows a lunar rover.

Figure 9



0 7 . 2 At one point, the lunar rover accelerated from 1.4 m/s to 2.6 m/s

The acceleration of the lunar rover was 0.31 m/s^2

Which calculation could be used to calculate the distance travelled *s* during this acceleration?

[1 mark]

Tick **one** box.

$$s = \sqrt{2.6^2 - 1.4^2 - 2 \times 0.31}$$ ☐

$$s = \frac{1.4^2 - 2.6^2}{2 \times 0.31}$$ ☐

$$s = \frac{2.6^2 - 1.4^2}{2 \times 0.31}$$ ☐

$$s = \frac{2 \times (2.6^2 - 1.4^2)}{0.31}$$ ☐

Do not write outside the box

0 7 . 3 The lunar rover used four electric motors connected in parallel to a 36 V battery.

The maximum output power of one motor was 190 W

The efficiency of each motor was 72%

Calculate the current drawn from the battery when all four motors were operating at maximum power.

[6 marks]

Current = ________________ A

Question 7 continues on the next page

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0 7 . 4 Scientists once thought that the Moon formed elsewhere in the solar system and later came to orbit the Earth.

Studies of Moon rocks brought back by the astronauts showed that the rocks were extremely similar to those found on Earth.

This led to a new theory about how the Moon formed called the ‘Giant Impact Hypothesis’.

According to the Giant Impact Hypothesis, a small planet collided with the Earth. Molten rock thrown up by the collision then formed the Moon.

Suggest why a new theory was developed.

[2 marks]

12

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0 8 Crude oil is a mixture of hydrocarbons.

Hydrocarbons can be used as fuels.

0 8 . 1 One alkane hydrocarbon contains 34 hydrogen atoms.

What is the formula of the hydrocarbon?

[1 mark]

Tick **one** box.

$C_{15}H_{34}$ ☐

$C_{16}H_{34}$ ☐

$C_{17}H_{34}$ ☐

$C_{18}H_{34}$ ☐

Question 8 continues on the next page

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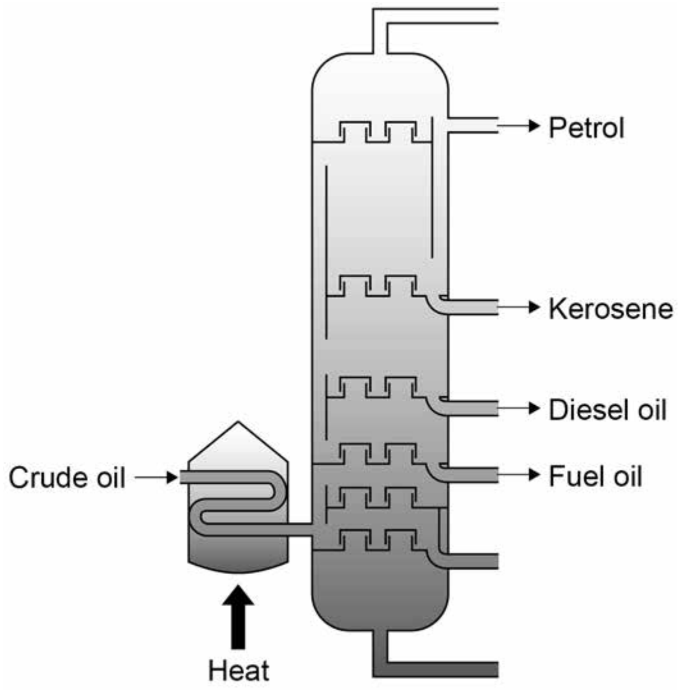
0 8 . 2 **Figure 10** represents a fractionating column used to separate crude oil.

Figure 10



Describe how crude oil is separated using fractional distillation.

[4 marks]

0 8 . 3 Propane is a hydrocarbon fuel obtained from crude oil.

Figure 11 shows the displayed equation for the complete combustion of propane.

Figure 11

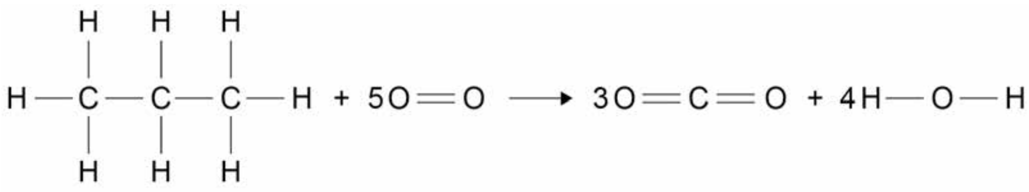


Table 5 shows bond energies.

Table 5

Bond	**Bond energy in kJ/mol**
C–C	347
C–H	413
O=O	495
C=O	799
O–H	467

Calculate the overall energy change in kJ/mol for the reaction.

Use **Figure 11** and **Table 5**.

[3 marks]

Overall energy change = ______________ kJ/mol

Turn over ►

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0 8 . 4 Some fuels are obtained from plants.

Evaluate the environmental impact of fuels obtained from plants and from crude oil.

[4 marks]

Do not write outside the box

0 8 . 5 Butane is another hydrocarbon fuel obtained from crude oil.

The equation for the complete combustion of butane is:

$$2C_4H_{10} + 13O_2 \longrightarrow 8CO_2 + 10H_2O$$

14.5 g of butane was burned in 72.0 g of oxygen.

Determine the limiting reactant.

You must include calculations in your answer.

Relative atomic masses (A_r): C = 12 H = 1 O = 16

[4 marks]

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END OF QUESTIONS

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