Candidate Name	Centre Number					Candidate Number				

GCSE COMBINED SCIENCE

COMPONENT 4

Applications in Science

FOUNDATION TIER

SAMPLE PAPER

(1 hour 45 minutes)

	For Examiner's use only		
	Question	**Maximum Mark**	**Mark Awarded**
Section A	**1.**	**3**	
	2.	**9**	
	3.	**11**	
	4.	**11**	
	5.	**7**	
	6.	**9**	
	7.	**11**	
	8.	**6**	
	9.	**8**	
Section B	**10.**	**15**	
	Total	**90**	

ADDITIONAL MATERIALS

In addition to this examination paper you will need a calculator, a ruler and a resource booklet.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen. Do not use correction fluid.
Write your name, centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

This paper is in 2 sections, **A** and **B**.
Section **A**: 75 marks. Answer **all** questions. You are advised to spend about 1 hour 20 minutes on this section.
Section **B**: 15 marks. Read the article in the resource booklet carefully then answer **all** questions. You are advised to spend about 25 minutes on this section.
The number of marks is given in brackets at the end of each question or part-question.
The assessment of the quality of extended response (QER) will take place in question **8**.

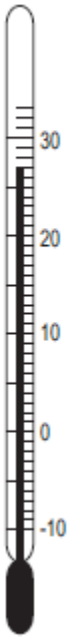
EQUATION LIST

final velocity = initial velocity + acceleration × time	$v = u + at$
distance = ½ (initial velocity + final velocity) × time	$x = \frac{1}{2}(u + v)t$
(final velocity)^2 = (initial velocity)^2 + 2 × acceleration × distance	$v^2 = u^2 + 2ax$
change in thermal energy = mass × specific heat capacity × change in temperature	$\Delta Q = mc\Delta\theta$
thermal energy for a change of state = mass × specific latent heat	$Q = mL$
energy transferred in stretching = 0.5 × spring constant × (extension)^2	$E = \frac{1}{2}kx^2$
potential difference across primary coil × current in primary coil = potential difference across secondary coil × current in secondary coil	$V_1I_1 = V_2I_2$

SECTION A

Answer **all** *questions.*

1. Lowri is setting up a water bath for an enzyme experiment. The diagram below shows a piece of laboratory equipment.



(a) State the name of the piece of apparatus shown above. [1]

……

(b) Write down the reading shown and give the unit. [1]

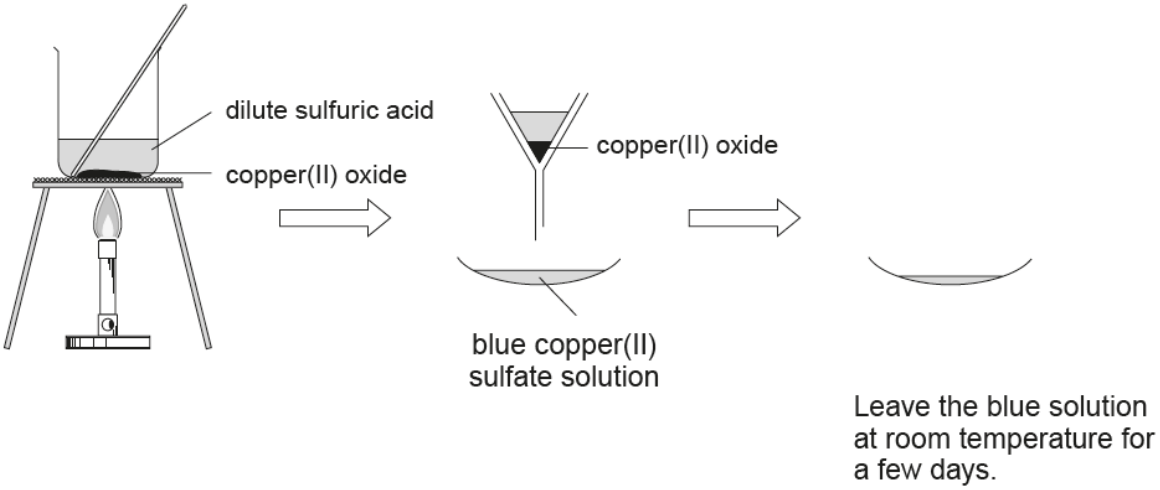
……

(c) Why is this particular piece of apparatus **not** suitable for taking the temperature in this experiment? [1]

.....

3

2. One method used to prepare a salt involves reacting a base with a dilute acid. The diagrams below show the stages a pupil follows to make a salt.



Stage 1 **Stage 2** **Stage 3**

(a) What name is given to the type of reaction occurring in the beaker above? [1]

……

(b) Use the information in the diagrams to decide which of the following statements is correct. Tick (✓) only **one** box. [1]

Exactly the correct amount of copper(II) oxide needed to use up all the sulfuric acid has been added	☐
More sulfuric acid than can react with the copper oxide has been added	☐
More copper(II) oxide than can react with all the sulfuric acid has been added	☐

(c) Name the salt produced in this experiment. [1]

……..

(d) Describe what happens in **Stage 3** and state how this process could be carried out more quickly. [2]

……

……

……

(e) A carbonate also reacts with an acid to give a salt.

(i) Name the other products formed in the reaction between lead carbonate and sulfuric acid other than lead sulfate. [2]

……

(ii) Use the following information to explain whether this could be a suitable method to prepare crystals of either, or both of: [2]

1. lead sulfate from lead carbonate and sulfuric acid;
2. lead nitrate from lead carbonate and nitric acid.

Compound	Soluble in water?
lead carbonate	No
lead sulfate	No
lead nitrate	Yes

……

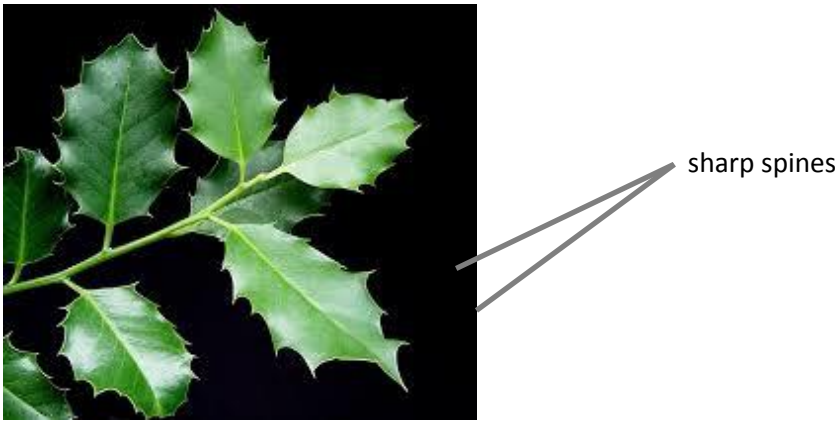
……

……

9

3. Holly (*Ilex*) is a common British tree.

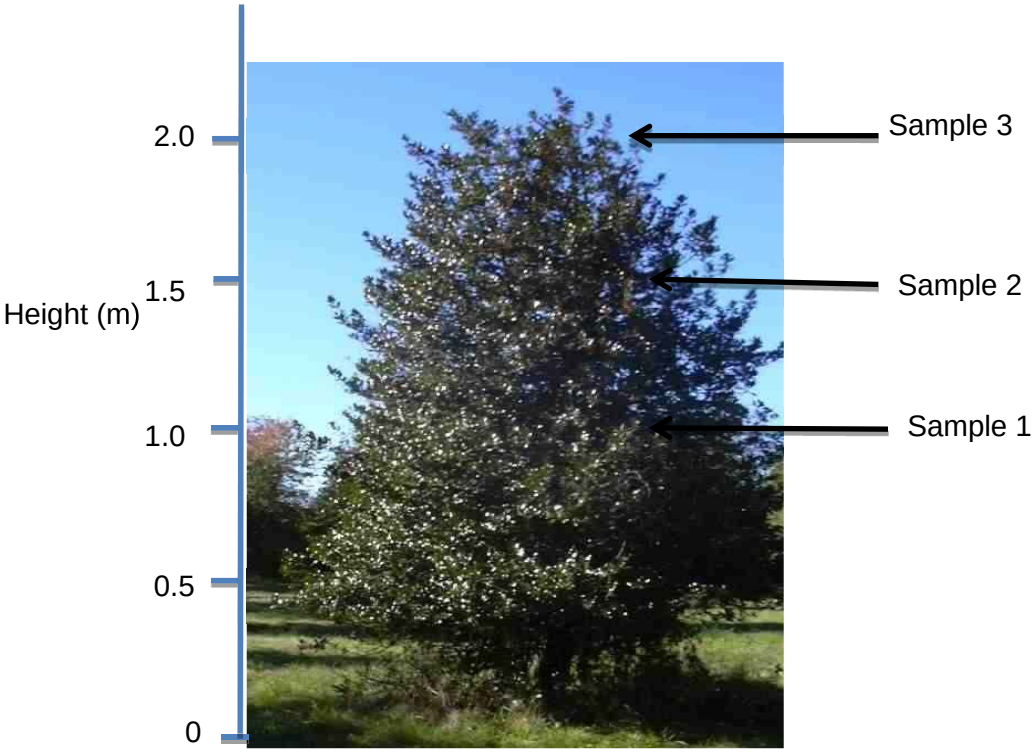
(a) Holly leaves have sharp spines on their edges.



Darren designed an investigation titled:

'Does the number of spines on the leaves of holly trees change with the height of the tree?'

Darren collected leaves from the holly tree shown, at heights of 1.0, 1.5 and 2.0 m from the ground.



The samples he collected are shown below.

Sample 1

Sample 2

Sample 3

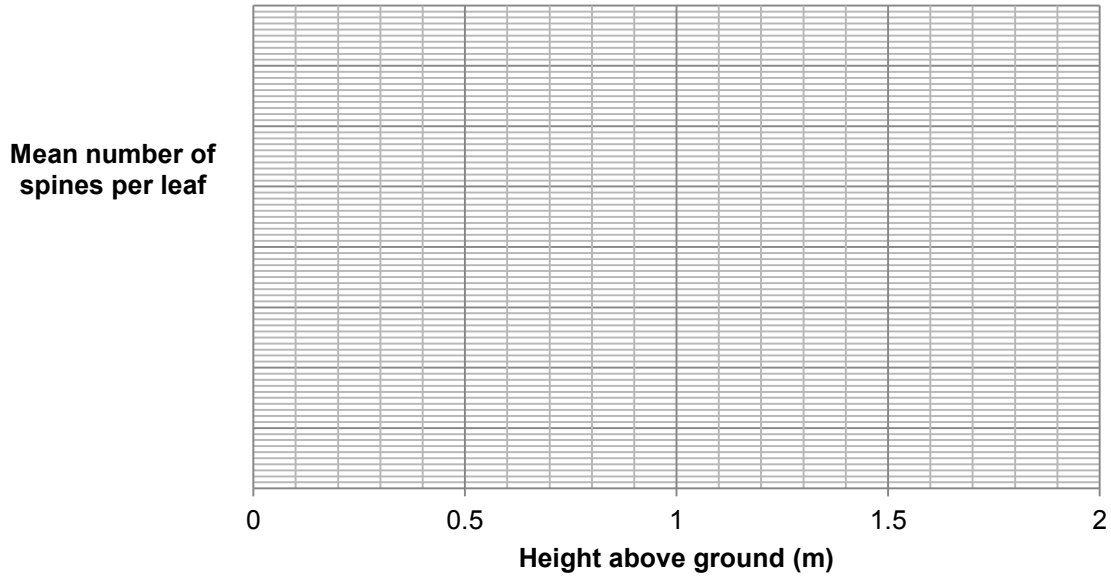
(i) Count the spines on each of Darren's leaf samples and use the results to complete the table below. [3]

Sample number	Height above ground (m)	Number of leaves	Total number of spines	Mean number of spines on each leaf to one decimal place
1				
2				
3				

(ii) Complete a scatter graph for the mean number of spines per leaf on the grid below by:

I choosing a scale for the vertical axis; [1]

II plotting the points for the mean number of spines per leaf to the nearest whole number. [1]



(iii) What conclusion can Darren make from these results? [1]

.....

(iv) Why is it important to calculate the mean in this investigation? [1]

.....

(v) Darren wrote this in his notebook:

'*I need to do further work before I can come to a firm conclusion.*'

What further work should Darren do to increase his confidence in making a firm conclusion? [3]

.....

.....

.....

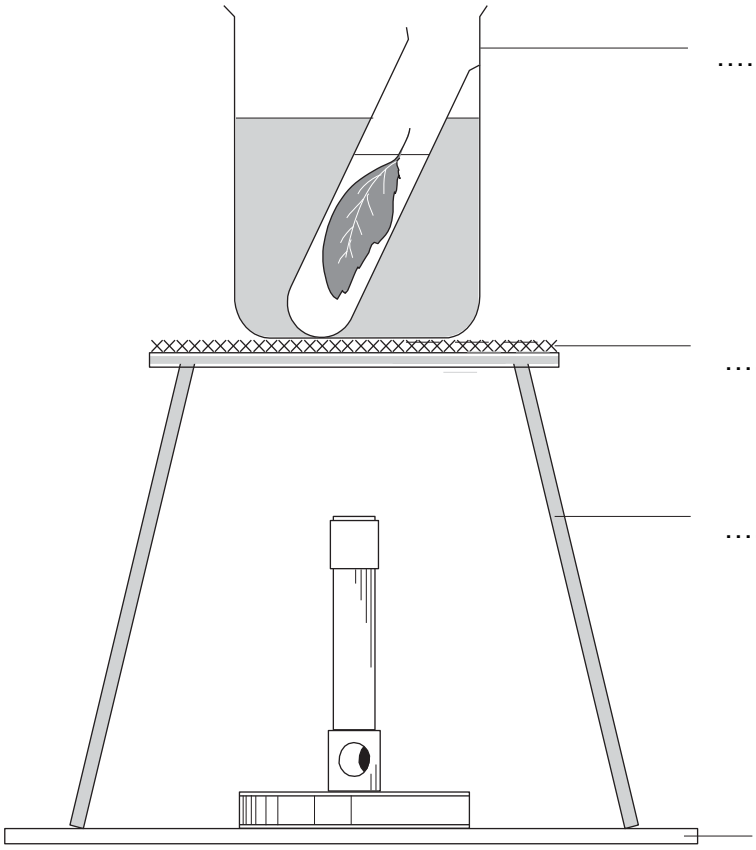
.....

(b) Suggest how sharp spines on the leaves are useful to holly trees. [1]

.....

11

4. Sharon took a leaf from a plant that had been growing in bright light.
She tested the leaf for starch using the following apparatus.



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(a) **Complete the labels** on the diagram. [3]

(b) Before starting the test, Sharon did a risk assessment for using ethanol in her experiment. **Complete** the risk assessment form below. [2]

Hazard	**Risk**	**Control measure**
ethanol is flammable		

(c) State why the ethanol turns green in this experiment. [1]

.....

(d) Sharon removed the leaf from the hot ethanol and rinsed it in water. She then spread the leaf out on a white tile and covered it in iodine solution. State why it is necessary:

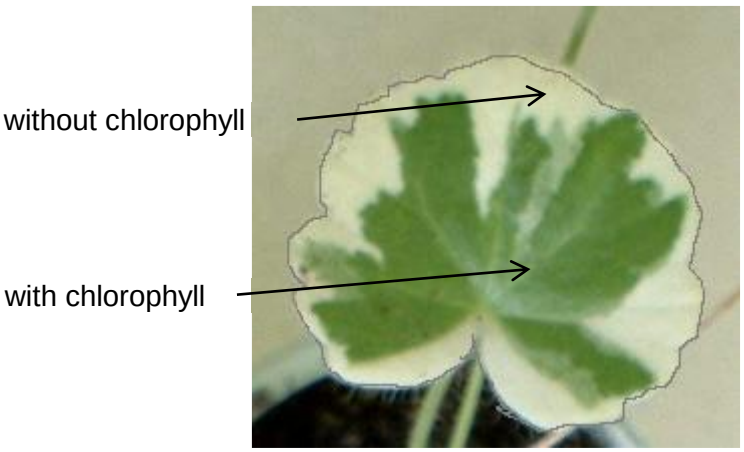
(i) to rinse the leaf in water [1]

.....

(ii) to use a colourless leaf. [1]

.....

(e) Sharon used a leaf in which only part had chlorophyll, as shown in the diagram below.



(i) Complete the table below to show the expected results. [1]

Part of leaf	**Colour of part after adding iodine solution**
with chlorophyll	……
without chlorophyll	……

(ii) Explain your answer for **both** parts of the leaf. [2]

.....

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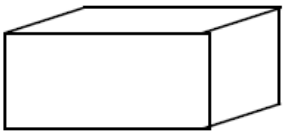
.....

5. (a) Describe how the volume of a regular aluminium block could be found. [2]



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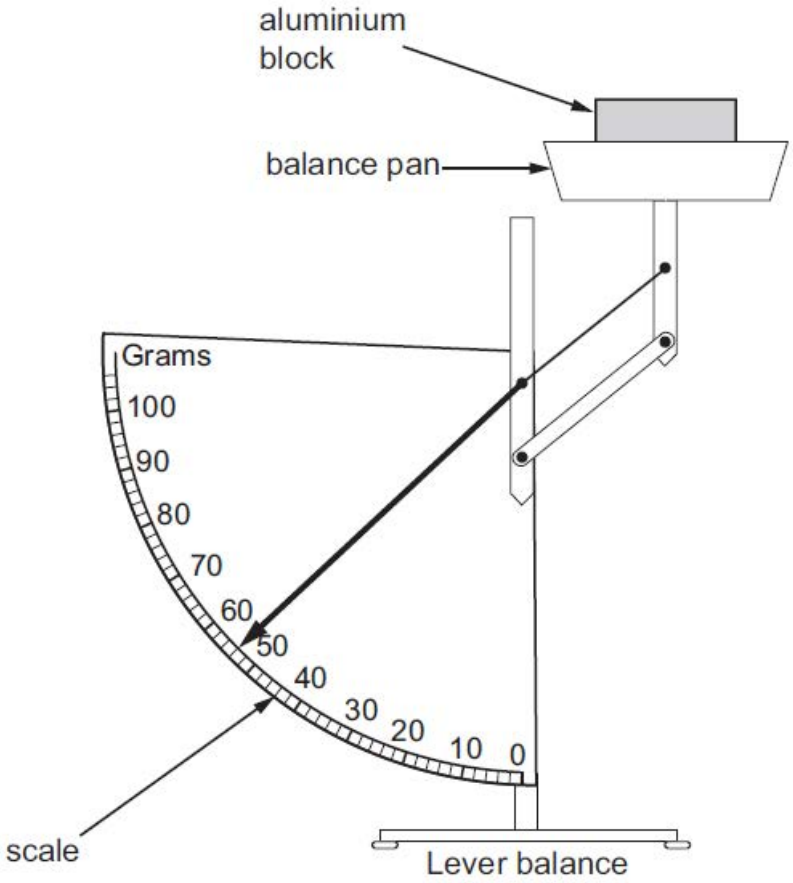
(b) A student weighs an aluminium block on the scales shown.



(i) Write down the mass of the aluminium block shown in the diagram. [1]

mass = ... g

(ii) The volume of the aluminium block is also measured and found to be 20 cm^3. Use the equation:

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

to calculate the density of aluminium. [2]

density = ... g/cm^3

(c) An aluminium block of volume 40 cm^3 (twice as big as the one above) is now weighed.

(i) State its density. [1]

density = ... g/cm^3

(ii) State its mass. [1]

mass = ... g

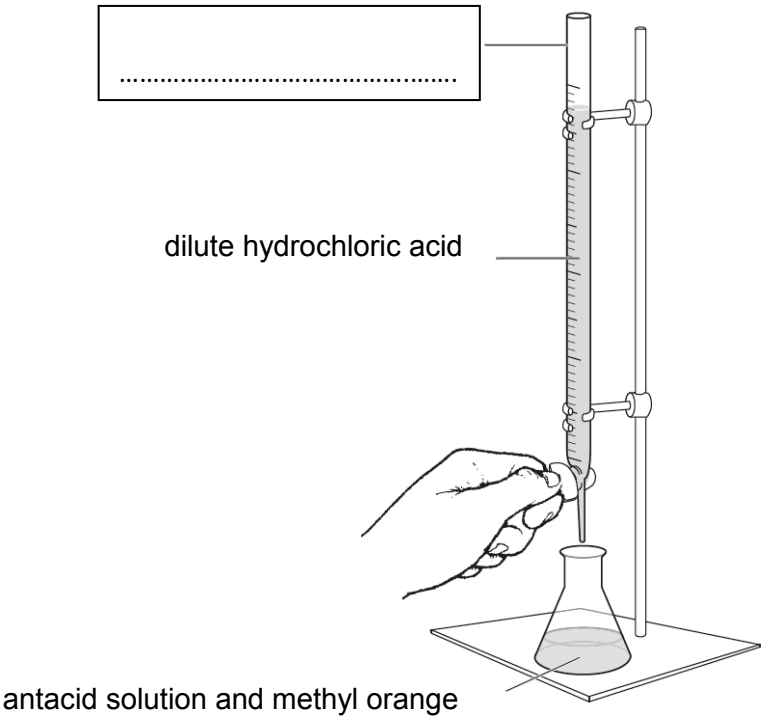
7

6. Antacid tablets are used to treat indigestion which is caused by excess acid in the stomach. Antacids contain calcium carbonate which reacts with the excess acid.

A group of pupils were given three different brands of antacid tablets; **X**, **Y** and **Z**. They carried out the following experiment to find the best antacid to neutralise the excess acid.

1. Tablet **X** was crushed and added to 50 cm^3 of water in a conical flask.
2. Five drops of methyl orange were added.
3. The mixture was titrated with dilute hydrochloric acid.
4. The acid was added 0.5 cm^3 at a time and the flask swirled. This was continued until the methyl orange turned red.
5. The total volume of acid added was recorded.
6. This procedure was repeated using **Y** and then **Z.** The same mass of tablet was used in each case.

Diagram of apparatus



The results collected are shown in the following table.

	Tablet X	**Tablet Y**	**Tablet Z**
Final volume (cm^3)	13.5	27.0	38.0
Initial volume (cm^3)	1.0	13.5	27.0
Volume added (cm^3)	…….	…….	…….

(a) **Add the missing label on the diagram**. [1]

(b) Give the name for substances, such as methyl orange, which have one colour in acids and a different colour in alkalis. [1]

……

(c) Explain why it was necessary to swirl the flask with each addition of hydrochloric acid. [1]

……

……

(d) **Complete the table** of results and use the information to identify the best antacid tablet. Give **one** reason for your answer. [4]

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(e) State how the method could be changed in order to provide more accurate results. Explain your answer. [2]

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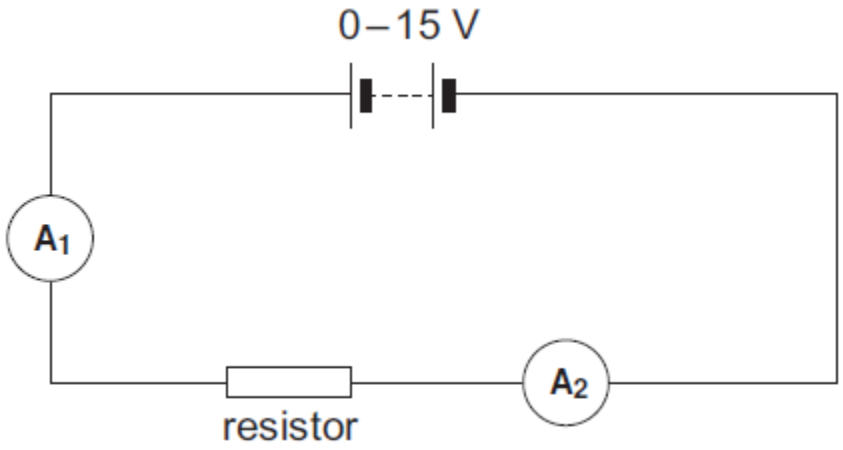
9

7. A group of pupils in a class are asked to find how the current through a resistor changes when the potential difference applied to it is changed.

The circuit they set up is shown below. It contains two ammeters, shown as A_1 and A_2.



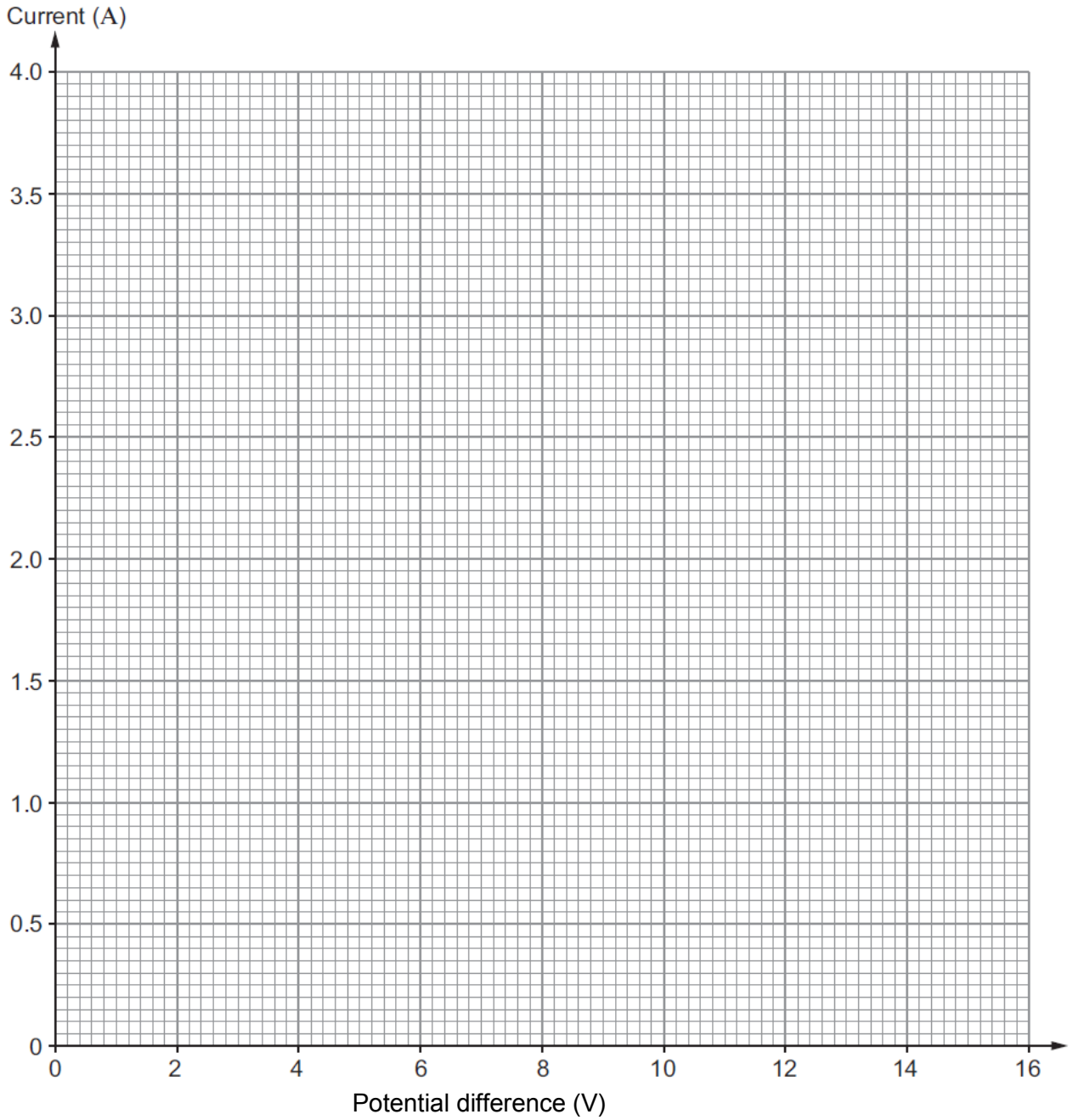
The potential differences and some of the currents are shown in the table below.

Battery potential difference (V)	**Ammeter A_1 reading (A)**
1	0.25
2	
3	0.75
6	1.50
10	2.50
12	3.00
15	3.75

(a) Complete the following sentence by underlining the correct phrase in the brackets. [1]

When ammeter A_1 reads 0.5 A, the reading on ammeter A_2 is (**less than** / **equal to** / **more than**) 0.5 A.

(b) (i) Use the data in the table to plot points on the grid and draw a suitable line. [3]



(ii) Find the current when the voltage is 2 V. [1]

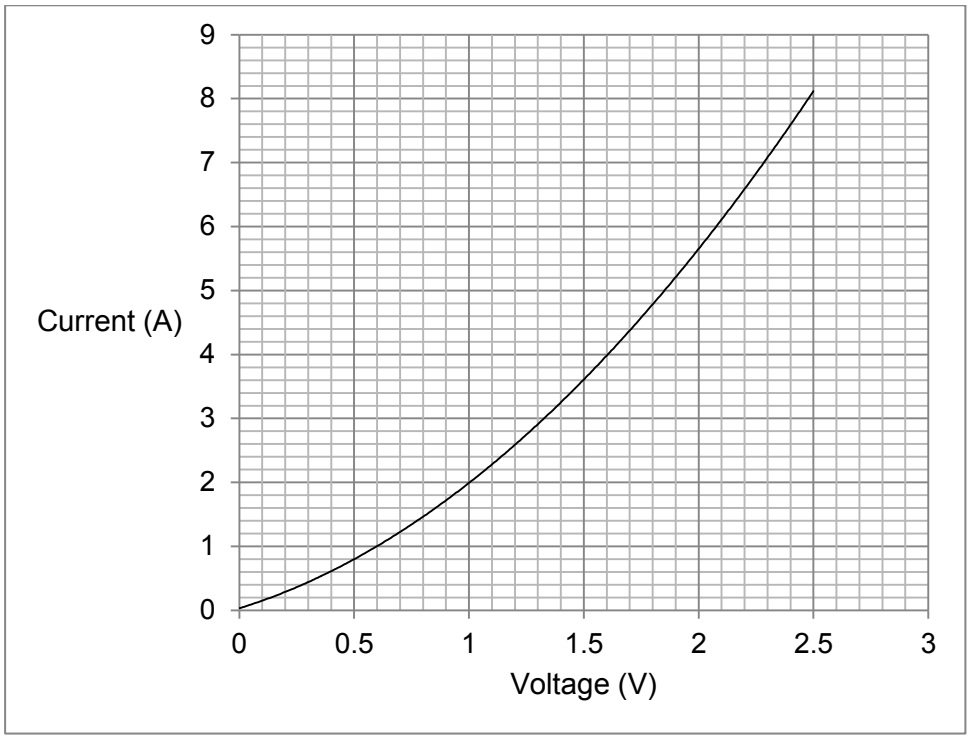
current = ... A

(iii) Calculate the resistance of the resistor. [3]

resistance = ... Ω

(c) **On the grid opposite,** draw a line for a resistor that has a constant resistance of 10 Ω. [2]

(d) The pupils set up a new circuit replacing the resistor with another component. They obtained the following results.



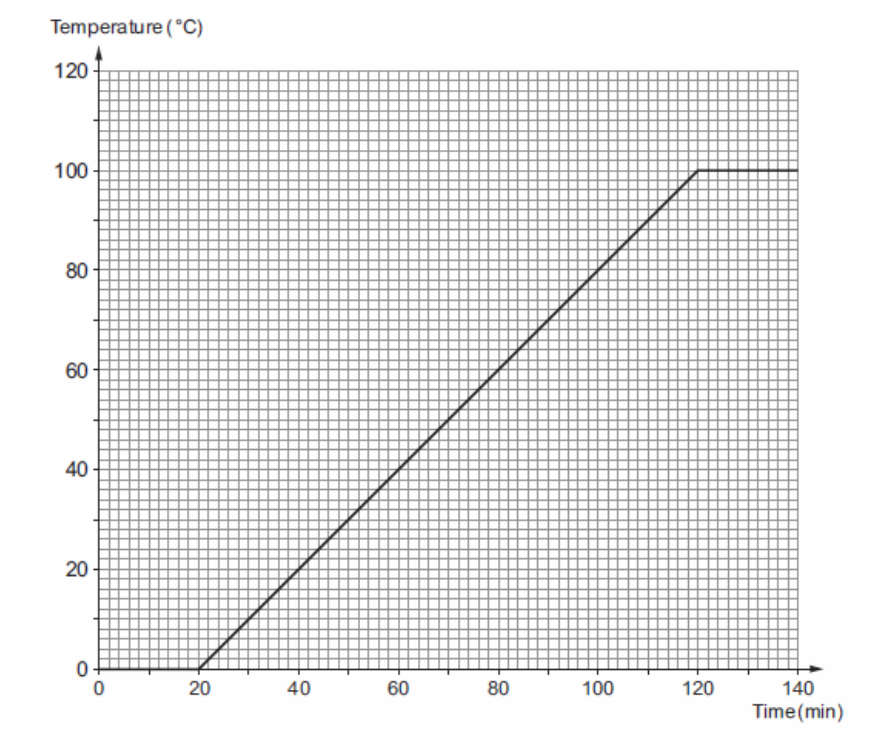
A pupil made this conclusion: "The graph shows that this component obeys Ohm's law". Give **one** reason whether you agree with the conclusion made by the pupil. [1]

……..

……..

11

8. The temperature of a mixture of ice and liquid water is recorded as it is heated over a Bunsen burner during a lesson. Some of the water is boiled away by the end of the lesson. **The starting temperature is 0 °C**.
The following graph is drawn from the results of the experiment.



Describe fully what the graph tells you about water as it is heated. [6 QER]
[Do not refer to the behaviour of particles in your answer.]

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6

9. A group of students wanted to find the time taken to produce 100 cm^3 of gas when dilute hydrochloric acid reacts with marble chips.

(a) Describe a method that they could use in their experiment. You may include a diagram as part of your answer. [3]

……

……

……

(b) The students investigated the effect of temperature on the rate of the reaction. The results they obtained are below.

James used hydrochloric acid at 21°C and recorded a time of 2 minutes 33 seconds.

Syra heated her acid to 40 °C and the reaction took 39 seconds.

Abigail stopped her watch after 1 minute 17 seconds. Her acid had a starting temperature of 30 °C.

Draw a table with labelled columns. Record the students' results in your table with the times given in **seconds**. [3]

(c) Estimate how long the reaction will take at 50°C and explain how you came to this value. [2]

……

……

……

8

SECTION B

Read the article in the resource booklet carefully and answer **all** *the questions that follow.*

10. (a) Methane has a larger GWP than carbon dioxide. It is claimed that methane should be burned rather than released into the atmosphere.

(i) Methane burns in air to produce carbon dioxide and water. Complete the balanced **symbol** equation for this reaction. [2]

$CH_4 + 2O_2 \rightarrow$ ..... + ...

(ii) Burning 100 kg of methane produces 275 kg of carbon dioxide. Use **Equation 1** and the information in **Table 1** to answer the following questions.

I Calculate the greenhouse contribution of 100 kg of methane. [2]

greenhouse contribution = ... kg CO_2eq

II Explain whether or not burning methane has less effect on global warming than just releasing it into the atmosphere. [2]

.....

.....

(b) Use the information in **Table 2** to answer the following questions.

(i) I Jack travels 100 km each day. He is concerned about his carbon footprint. Why would he choose a Voltec car rather than an Amptec car? [1]

.....

II Calculate the mass of CO_2 produced if the Amptec is driven 280 km. [2]

mass = …… g

(ii) Using a charger the Voltec can be charged fully by 32 kWh. When 1 kWh of electricity is used it produces 0.45 kg of carbon dioxide every hour.

Calculate how much carbon dioxide is produced to fully charge the Voltec. [2]

mass = ... kg

(iii) Explain why the data for the Voltec may be misleading. [2]

.....

.....

(c) Suggest **two** reasons why the government gives a grant to purchase electric vehicles. [2]

1. .....

2. .....

15

GCSE COMBINED SCIENCE

COMPONENT 4

Applications in Science

FOUNDATION TIER

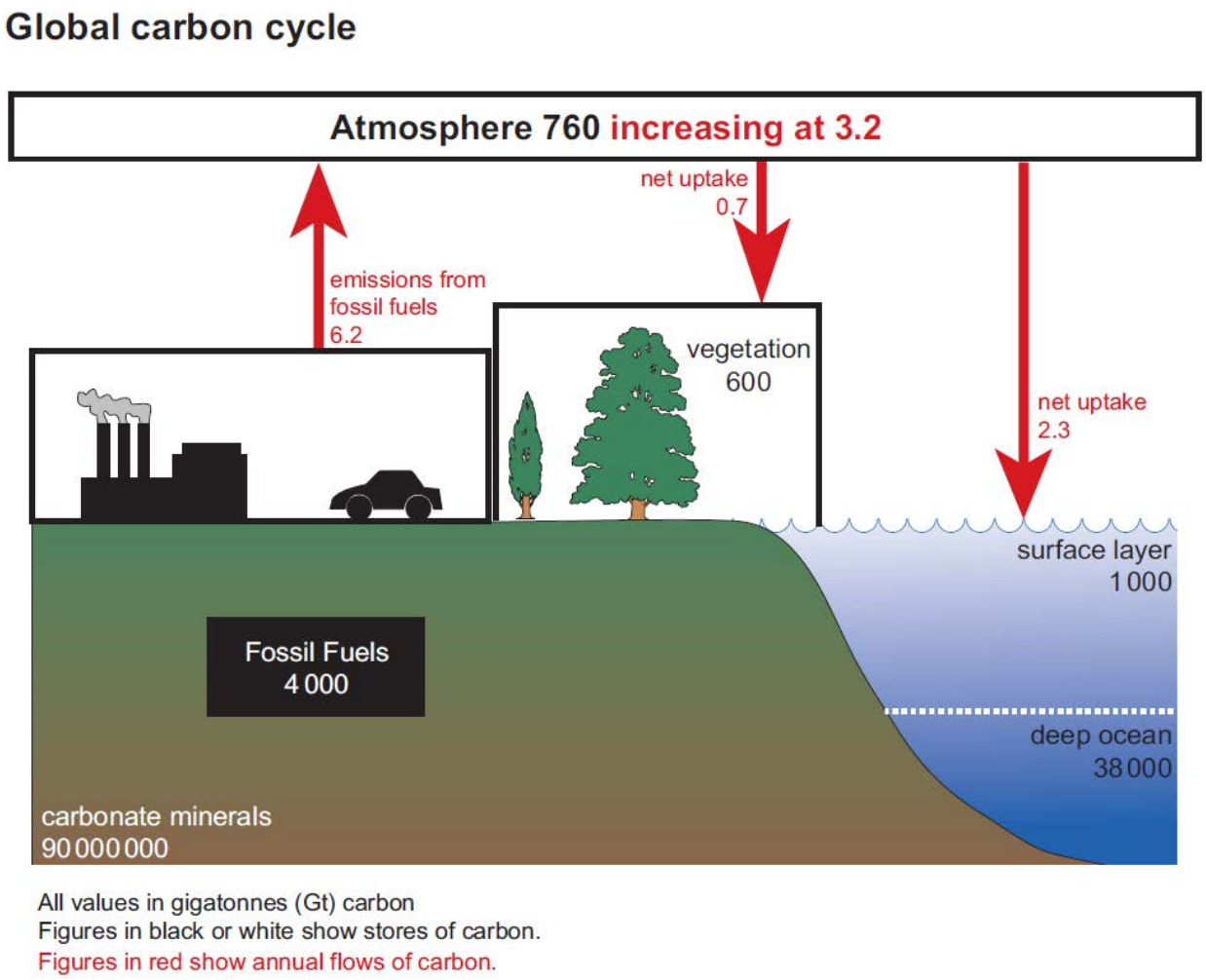
SAMPLE ASSESSMENT MATERIALS

RESOURCE BOOKLET
for use in Section B

EXPLORING THE GREENHOUSE EFFECT

On Earth, carbon is recycled as shown in **Diagram 1** below.

Diagram 1



It is claimed that global warming is caused by humans adding greenhouse gases (GHG) to the atmosphere. Two GHG are carbon dioxide (CO_2) and methane (CH_4).

Greenhouse gases can be compared using their Global Warming Potential (GWP). GWP is the ability of a GHG to trap heat in the atmosphere compared to an equal amount of carbon dioxide. **Table 1** gives the GWP of both GHG.

Table 1

Greenhouse gas	GWP
CO_2	1
CH_4	21

Equation 1

$$\text{greenhouse contribution in kg } CO_2\text{eq} = \text{mass of gas (kg)} \times \text{GWP}$$

The Government gives a grant to buyers of electric vehicles. This is intended to reduce the amount of GHG we produce.

Two such electric vehicles are the Amptec and the Voltec. The Voltec car has an electric motor only. The Amptec car has both an electric motor and a petrol engine. **Table 2** gives information about these electric vehicles and of a petrol engine car.

Table 2

	Typical petrol engine car	Amptec	Voltec
Range per charge (km)	not applicable	80	200
Range on one tank of fuel (km)	700	660	not applicable
Mean fuel used (litres per 100 km)	6.0	1.2	0
Official CO_2 produced (g/km) (Tested over 100 km)	100	27	0