SPECIMEN MATERIAL

# GCSE
# COMBINED SCIENCE: SYNERGY

**H**

Higher Tier Paper 4H

Specimen 2018 Time allowed: 1 hour 45 minutes

**Materials**

For this paper you must have:
- a ruler
- a calculator
- the periodic table (enclosed)
- the Physics equation sheet (enclosed).

**Instructions**
- Answer all questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want to be marked.

**Information**
- There are 100 marks available on this paper.
- 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.
- When answering questions 03.6, 06.1 and 10 you need to make sure that your answer:
  - is clear, logical, sensibly structured
  - fully meets the requirements of the question
  - shows that each separate point or step supports the overall answer.

**Advice**
- In all calculations, show clearly how you work out your answer.

Please write clearly, in block capitals.

Centre number ☐☐☐☐☐ Candidate number ☐☐☐☐

Surname

Forename(s)

Candidate signature _____

**0 1** A student investigates a potassium salt, **X**.

She finds that salt **X**:

- has a high melting point
- does not conduct electricity when it is solid
- dissolves in water and the solution does conduct electricity.

**0 1 . 1** What is the type of bonding in salt **X**?

**[1 mark]**

Tick **one** box.

Covalent ☐

Giant molecular ☐

Ionic ☐

Metallic ☐

**0 1 . 2** What is the name given to solutions that conduct electricity?

**[1 mark]**

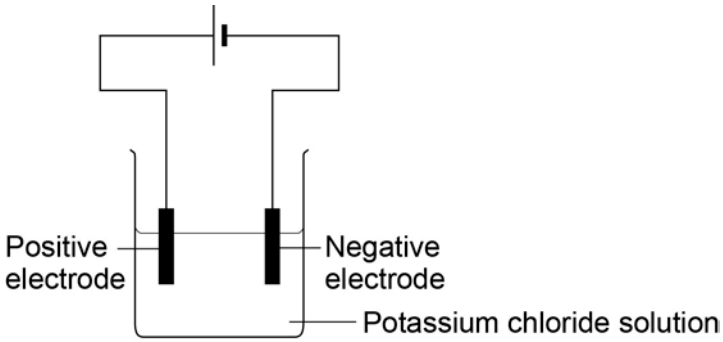
**0 1 . 3** Why does a solution of salt **X** in water conduct electricity?

**[1 mark]**

**0 1 . 4** The student electrolyses a solution of potassium chloride.

**Figure 1** shows the apparatus she uses.

**Figure 1**




When the current is switched on, bubbles of hydrogen gas are given off at the negative electrode.

Explain why hydrogen is produced and **not** potassium.

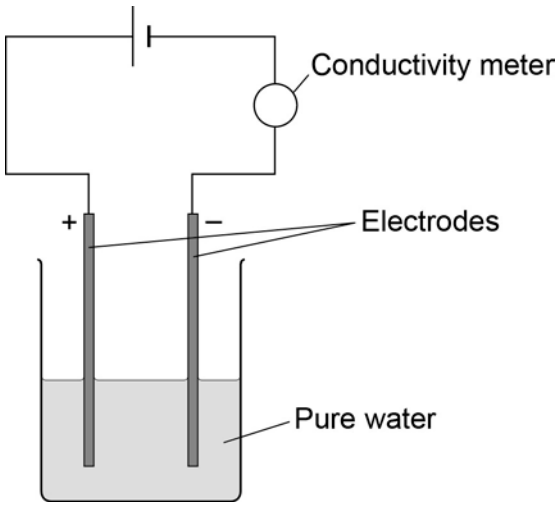
**[2 marks]**

**Question 1 continues on the next page**

The student then compares the relative conductivity of different concentrations of potassium chloride.

**Figure 2** shows the apparatus she uses.

**Figure 2**




This is the method used.

1. Add potassium chloride solution to the water one drop at a time.
2. Stir the mixture.
3. Record the reading on the conductivity meter.

**Table 1** shows the student's results.

**Table 1**

| Number of drops of potassium chloride solution | Relative conductivity of solution |
|---|---|
| 0 | 0 |
| 1 | 90 |
| 2 | 180 |
| 3 | 270 |
| 4 | 360 |
| 5 | 450 |
| 6 | 540 |

**0 1 . 5** When there is no potassium chloride in the beaker no electrical charge flows.

Suggest why pure water does **not** conduct electricity.

**[2 marks]**

**0 1 . 6** Describe the relationship shown in **Table 1**.

**[2 marks]**

**Turn over for the next question**

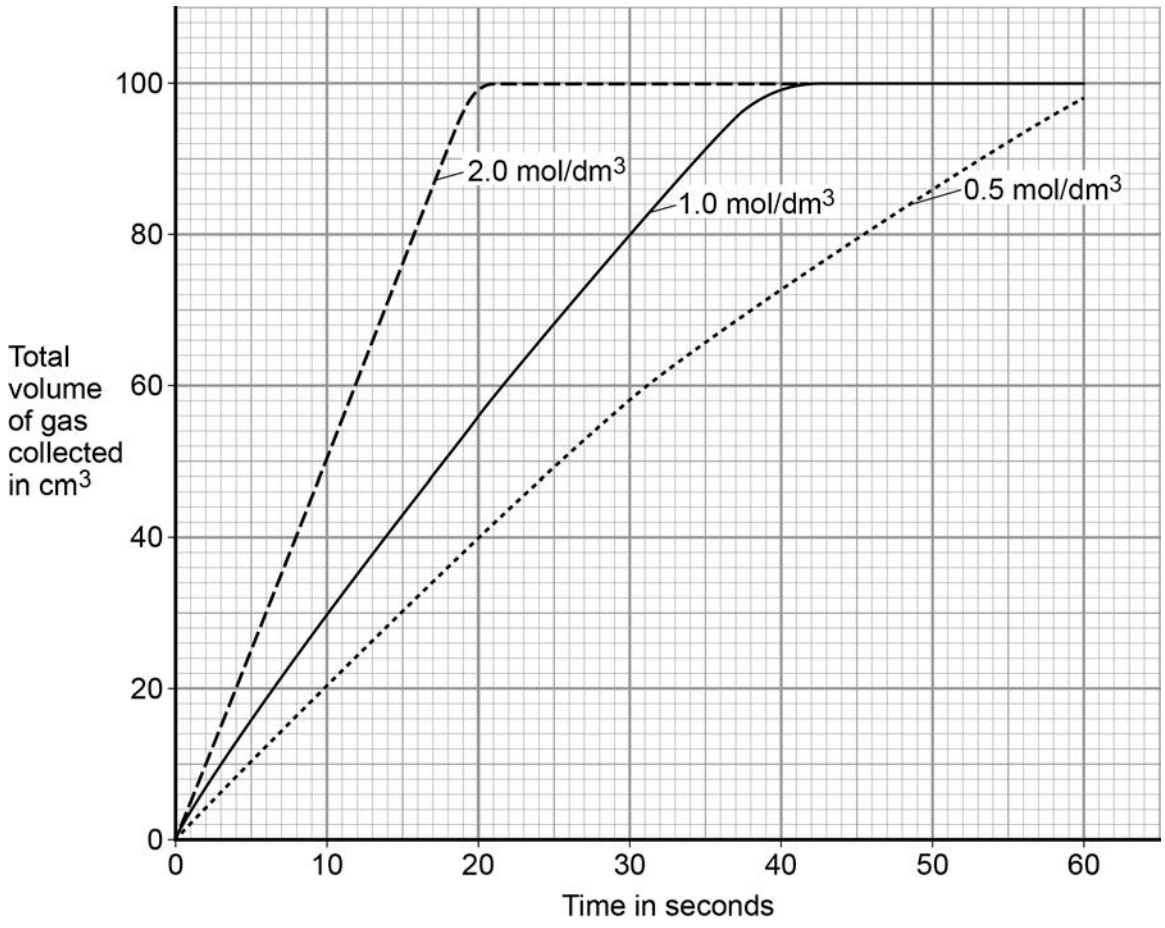
**0 2** A student investigates how the concentration of an acid affects the rate of a reaction.

This is the method used.

1. Put a 3 cm piece of magnesium ribbon into a conical flask.
2. Add 50 $cm^3$ of 0.5 $mol/dm^3$ hydrochloric acid to the flask.
3. Collect and measure the volume of gas produced at 10 second intervals.
4. Repeat with different concentrations of hydrochloric acid using the same length of magnesium ribbon and volume of acid.

The student's results are shown in **Figure 3**.

**Figure 3**



**0 2 . 1** How do the results show that increasing the concentration of acid increases the rate of reaction?

**[2 marks]**

**0 2 . 2** Explain why the rate of reaction changes as the concentration of the acid increases.

You should answer in terms of particles.

**[3 marks]**

**Question 2 continues on the next page**

**0 2 . 3** Student **A** said that the final volume of gas collected was lower for a concentration of 0.5 mol $dm^3$ because the reaction had not finished.

Student **B** said it was because all the acid had reacted.

Describe further experimental work the students could do to find out which student was correct.

**[2 marks]**

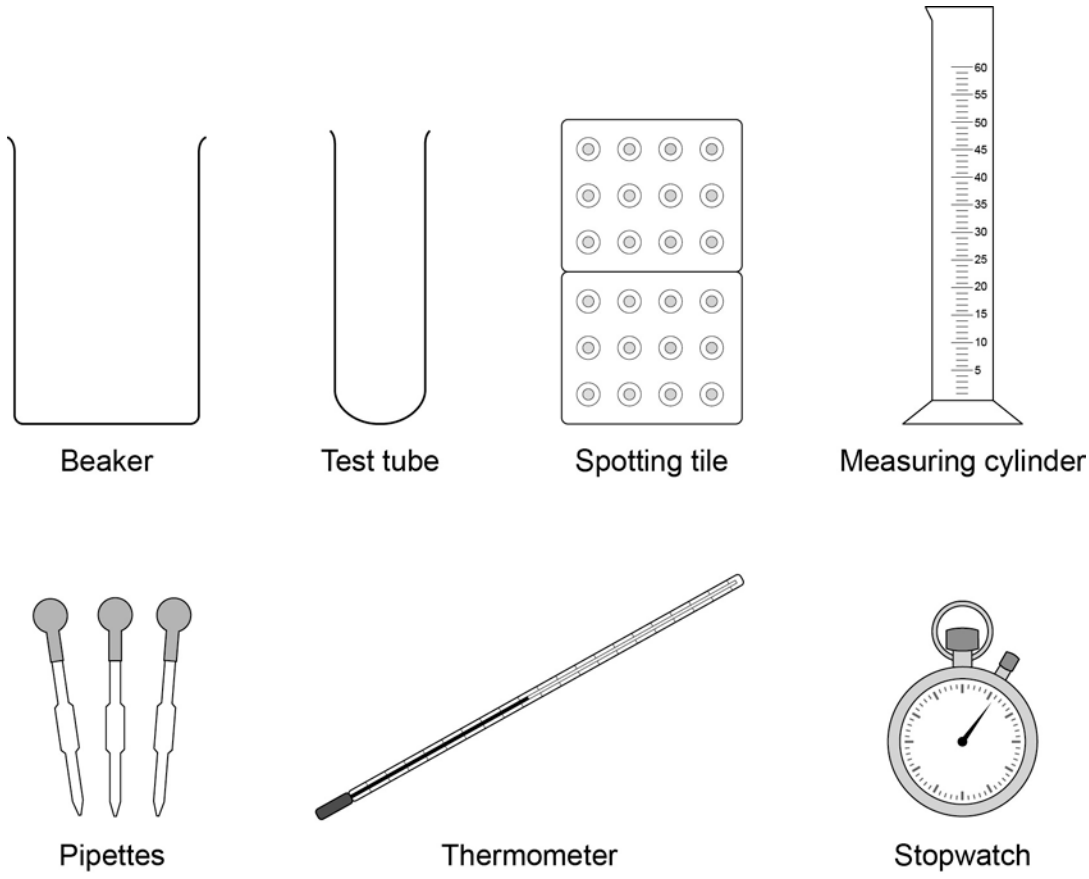
**Turn over for the next question**

**0 3** Amylase catalyses the breakdown of starch into sugars.

A student investigated the effect of amylase on the reaction at different temperatures.

**Figure 4** shows the apparatus the student used.

**Figure 4**




This is the method used.

1. Put starch suspension into a test tube.
2. Add amylase solution.
3. Put the test tube in a beaker of water at 15 °C.
4. Remove a small sample of the mixture every 30 seconds and put in a spotting tile.
5. Test the sample for starch.
6. Time how long it takes to break down all of the starch in the mixture.
7. Repeat steps 1–5 at 20 °C, 25 °C and 30 °C.
8. Repeat for each temperature twice more.

**Table 2** shows the student's results.

**Table 2**

| | Time taken until there was no starch in the sample in minutes | | | |
|---|---|---|---|---|
| **Temperature in °C** | **Test 1** | **Test 2** | **Test 3** | **Mean** |
| 15 | 6.1 | 9.4 | 10.0 | 8.5 |
| 20 | 4.8 | 5.0 | 4.6 | 4.8 |
| 25 | 3.0 | 2.5 | 3.0 | 3.2 |
| 30 | 1.5 | 2.0 | 2.0 | |

**0 3 . 1** One of the results in **Table 2** is anomalous.

Draw a ring around the anomalous result.

**[1 mark]**

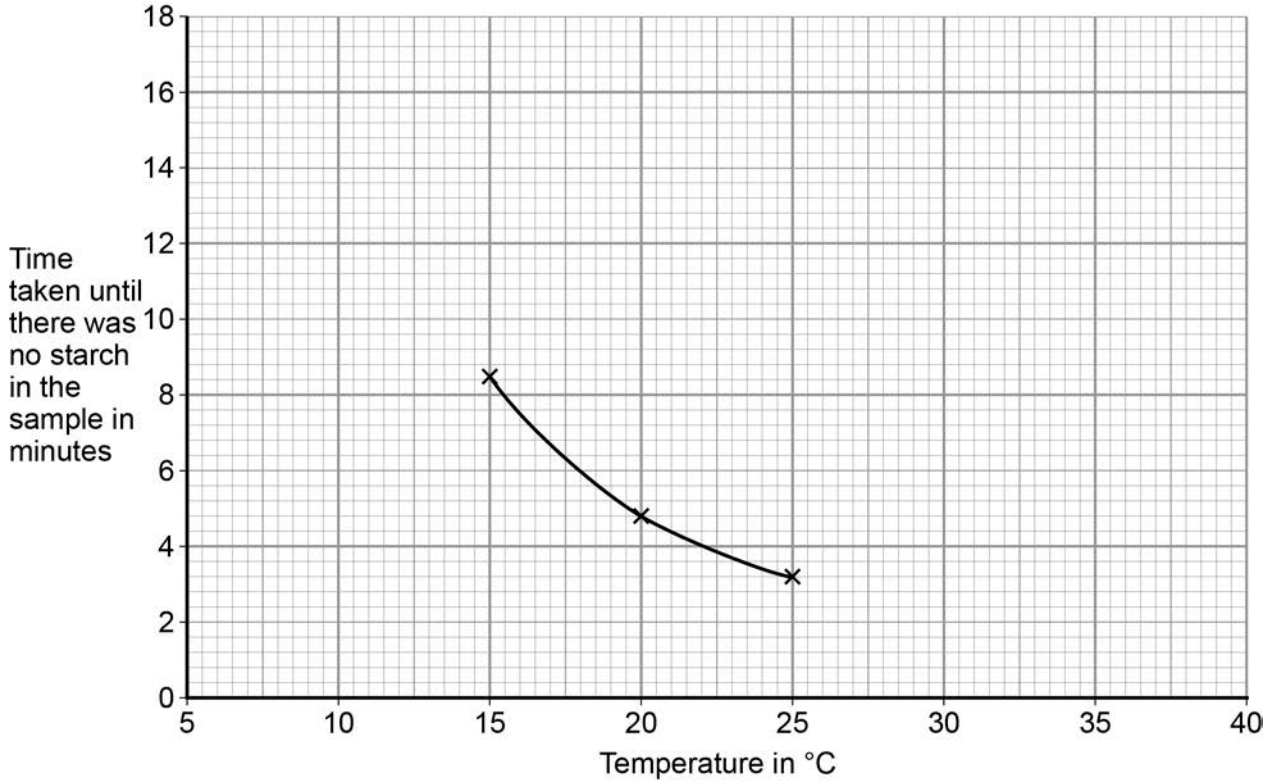
**0 3 . 2** Calculate the mean for 30 °C.

**[1 mark]**

**Question 3 continues on the next page**

**Figure 5** shows a graph of the student's results.

**Figure 5**




**0 3 . 3** Use the graph to predict how long it would take to break down all of the starch at 10 °C.

**[1 mark]**

Time = _____ minutes

**0 3 . 4** The student tested samples of the mixture for starch every 30 seconds.

In each test she added one drop of iodine to the sample in the spotting tile.

Predict the colour of the samples from the 20 °C test at 4.0 minutes and 7.0 minutes.

**[2 marks]**

Colour at 4.0 minutes _____

Colour at 7.0 minutes _____

**0 3 . 5** The student did a fourth test at 30 °C.

In this test the starch did not break down, even after 45 minutes.

Why did the amylase not break down the starch in this test?

**[1 mark]**

Tick **one** box.

- The amylase solution and the starch suspension were mixed before the start of the experiment. ☐
- The amylase solution had been prepared with water at 95 °C. ☐
- The amylase solution had been prepared with water at 20 °C. ☐
- The amylase solution had been stored in the fridge. ☐

**Question 3 continues on the next page**

**0 3 . 6** The student made the following conclusion about the optimum temperature for amylase to work at.

'Amylase works fastest at 40 °C'

Her teacher said that this is **not** a valid conclusion from her results.

Describe how the student could change her method to give results that would improve the validity of her conclusion.

**[6 marks]**

**0 4** This question is about forces, quantities and vectors.

**0 4 . 1** Write down the equation that links gravitational field strength, mass and weight.

**[1 mark]**

**0 4 . 2** A small ball weighs 1.4 N.

gravitational field strength, $g$ = 9.8 N/kg

Calculate the mass of the ball.

**[3 marks]**

Mass = _____ kg

**Question 4 continues on the next page**

**0 4 . 3** A white ball with mass 143 g is moving at a velocity of 7.9 m/s.

It collides with a red ball with mass of 150 g.

The red ball is stationary before the collision. The white ball stops after the collision.

Calculate the velocity of the red ball after the collision.

Give your answer to two significant figures.

**[4 marks]**

Velocity of red ball = _____ m/s

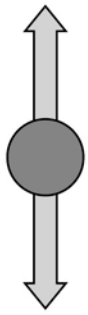
**0 4 . 4** The white ball is thrown high into the air.

After it is released the ball moves up and then back down in a vertical line.

The free body force diagram in **Figure 6** shows the forces on the ball at one point in its flight.

The force arrows are drawn to scale.

**Figure 6**



Explain what is happening to the ball at this point in its flight.

**[4 marks]**

**Turn over for the next question**

**0 5** The elements in Group 1 of the periodic table are metals.

**0 5 . 1** The elements in Group 1 are called the alkali metals.

Why are they called the alkali metals?

**[2 marks]**

**0 5 . 2** Explain the increase in reactivity of elements further down the group.

**[4 marks]**

**0 5 . 3** Lithium oxide is an ionic compound.

Draw a dot and cross diagram to show how lithium and oxygen combine to form lithium oxide.

Only show the electrons in the outer shell of each atom.

Give the charges on the ions formed.

**[4 marks]**

**Turn over for the next question**

**0 6** The salt copper sulfate can be made by reacting copper carbonate with dilute sulfuric acid.

$$CuCO_3(s) + H_2SO_4(aq) \longrightarrow CuSO_4(aq) + H_2O(l) + CO_2(g)$$

**0 6 . 1** Write a method that a student could use to prepare a pure, dry sample of copper

You do **not** need to write a risk assessment or include safety points.

**[6 marks]**

**0 6 . 2** Calculate the **number of molecules** in 14 g of carbon dioxide.

Give your answer in standard form.

Relative atomic masses ($A_r$): C = 14; O = 16

**[4 marks]**

Answer = _____ molecules

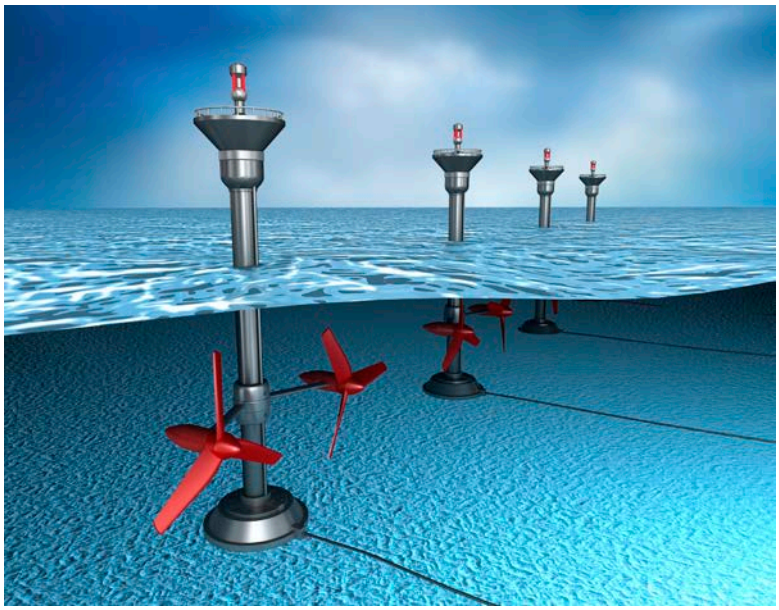
**Turn over for the next question**

**0 7** Electricity in the UK is generated in many ways.

**Figure 7** shows an undersea turbine.

The undersea turbine uses tidal energy to generate electricity.

**Figure 7**



**0 7 . 1** What is the original source of energy for tidal power schemes?

**[1 mark]**

**0 7 . 2** Explain **two** advantages of using undersea tidal turbines to generate electricity rather than burning fossil fuels.

**[4 marks]**

**Question 7 continues on the next page**

**0 7 . 3** Some power stations burn wood instead of fossil fuels to generate electricity.

A coal-burning power station burns 6 million tonnes of coal per year.

Coal has an average energy value of 29.25 MJ per kg.

Wood chip from willow trees has an energy value of 13 MJ per kg.

A hectare of agricultural land can produce 9 tonnes of dry willow wood per year.

If this power station burned dry willow wood instead of coal, how much agricultural land would be needed to grow the willow?

**[3 marks]**

Amount of land needed = hectares

**0 7 . 4** **Table 3** shows the carbon dioxide emissions of four fuels used to generate electricity.

**Table 3**

| Fuel | Direct $CO_2$ emissions in kg per MWh | Lifecycle $CO_2$ emissions in kg per MWh |
|---|---|---|
| Coal | 460 | 540 |
| Natural gas | 185 | 215 |
| Oil | 264 | 313 |
| Wood | 2 100 | 58 |

**Direct $CO_2$ emissions** are the amounts of carbon dioxide released when the fuel is burned.

**Lifecycle $CO_2$ emissions** is the total amount of carbon dioxide released during all stages from fuel extraction to when the fuel has been used.

Use the data from **Table 3** to explain why wood is considered to be a low carbon dioxide emitting fuel.

**[2 marks]**

**There are no questions printed on this page**

**0 8** A student is investigating some electrical components.

**0 8 . 1** Describe how the student could set up a circuit to find the resistance of a lamp.

You should include a circuit diagram in your answer.

**[4 marks]**

**Question 8 continues on the next page**

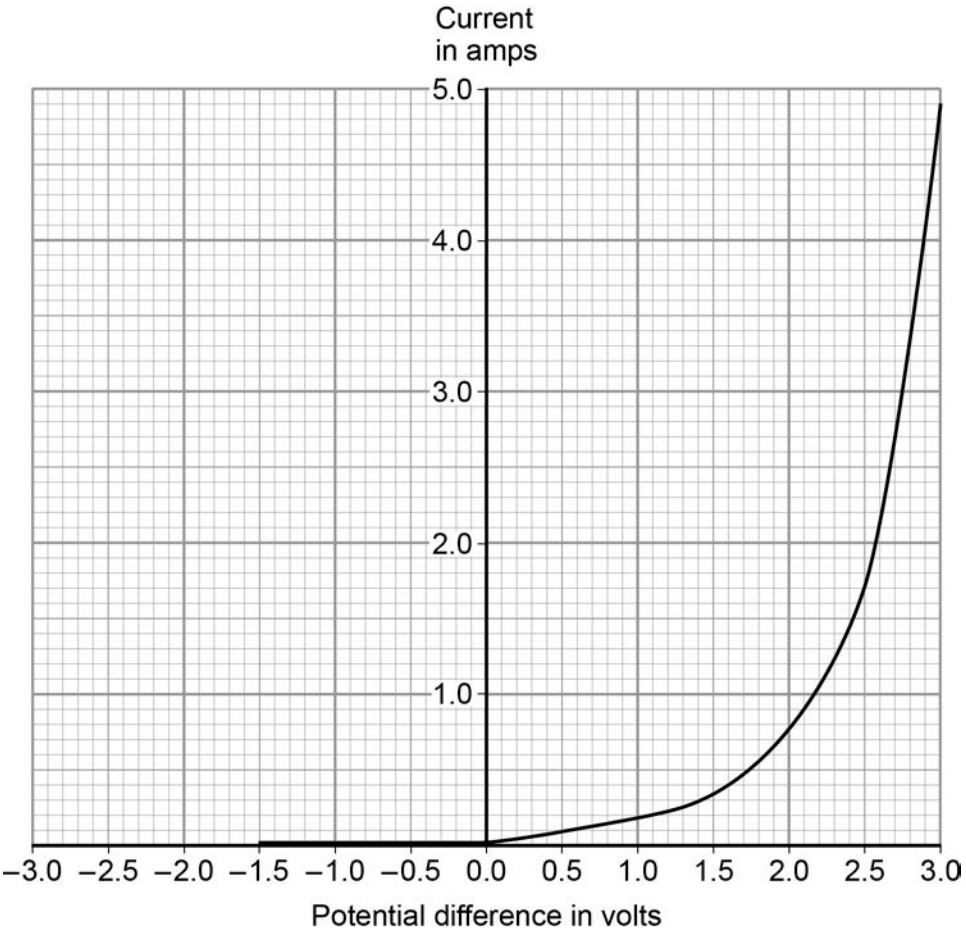
The student is given an electrical component in a sealed box.

She has to find out what the electrical component is by experiment.

The student records the current and the potential difference for the component.

Her results are shown in **Figure 6**.

**Figure 6**




**0 8 . 2** Explain how the student could know that the electrical component in the sealed box is **not** an ohmic conductor.

**[2 marks]**

**0 8 . 3** What is the electrical component in the sealed box?

Explain your answer.

**[3 marks]**

Component _____

Explanation _____

**0 8 . 4** Use the graph to determine the resistance of the component at 2.3 V.

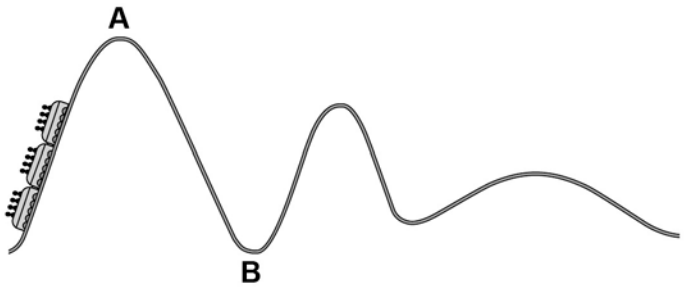
**[4 marks]**

Resistance = _____ Ω

**Turn over for the next question**

**0 9** **Figure 7** shows a rollercoaster.

**Figure 7**




The rollercoaster car is raised a vertical distance of 35 m to point **A** by a motor in 45 seconds.

The mass of the rollercoaster is 600 kg.

The motor has a power rating of 8 000 W.

**0 9 . 1** Calculate the percentage efficiency of the motor.

Gravitational field strength = 9.8 N/kg.

**[5 marks]**

Efficiency = _____ %

**0 9 . 2** The rollercoaster rolls from point **A** to point **B**, a drop of 35 m.

Calculate the speed of the roller coaster at point **B**.

Assume that the decrease in potential energy store is equal to the increase in kinetic energy store.

**[6 marks]**

Speed at point **B** = _____ m/s

**Turn over for the next question**

**There are no questions printed on this page**

**1 0** Read the information about production of copper.

- World demand for copper in 2014 was about 22 million tonnes.
- World reserves of copper are about 700 million tonnes.
- Most of the copper today is obtained from copper ores. The ores are mined.
- Copper ore is heated in a furnace to produce copper sulfide. The furnace is heated by burning fossil fuels. Air is blown through the hot copper sulfide to produce copper and sulfur dioxide.
- Some copper is extracted from low-grade ores by phytomining. Phytomining uses plants to absorb copper compounds. The plants are burned and copper is extracted from the ashes.

A scientist stated:

'more copper should be extracted by phytomining.'

Use the information to justify the scientist's statement.

**[6 marks]**

**END OF QUESTIONS**

**There are no questions printed on this page**

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Figure 7: Tidal energy generator ©alex-mit/iStock