AQA

Please write clearly in block capitals.

Centre number						Candidate number				

Surname ______________________________

Forename(s) ______________________________

Candidate signature ______________________________

I declare this is my own work.

GCSE
COMBINED SCIENCE: SYNERGY

H

Higher Tier Paper 4 Physical Sciences

Wednesday 10 June 2020 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. Pencil should only be used for drawing.
- 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.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- 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.

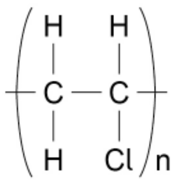
Information
- The maximum mark for this paper is 100.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

0 1 This question is about polymers and plastics.

Figure 1 shows the displayed formula for poly(chloroethene).

Figure 1



0 1 . 1 What does 'n' represent in the displayed formula for poly(chloroethene)?

[1 mark]

0 1 . 2 The representation of poly(chloroethene) in **Figure 1** does **not** show the actual structure of the molecule.

Give **one** reason why.

[1 mark]

Poly(chloroethene) is commonly known as PVC.

PVC does not decompose in the ground.

Many polymer plastics like PVC become pollutant waste in the oceans.

In the oceans, PVC can break into smaller pieces.

The smaller pieces are called PVC nanoplastic.

Do not write outside the box

0 1 . 3 A piece of PVC nanoplastic has a thickness of 50 nm

Calculate the thickness of the PVC nanoplastic in metres.

Give your answer in standard form.

1 nm = 0.000 000 001 m

[2 marks]

Thickness (in standard form) = ____________________ m

0 1 . 4 Suggest **two** reasons why PVC nanoplastic can be harmful to marine life.

[2 marks]

1 ____________________

2 ____________________

0 1 . 5 Suggest **two** ways to reduce plastic waste.

[2 marks]

1 ____________________

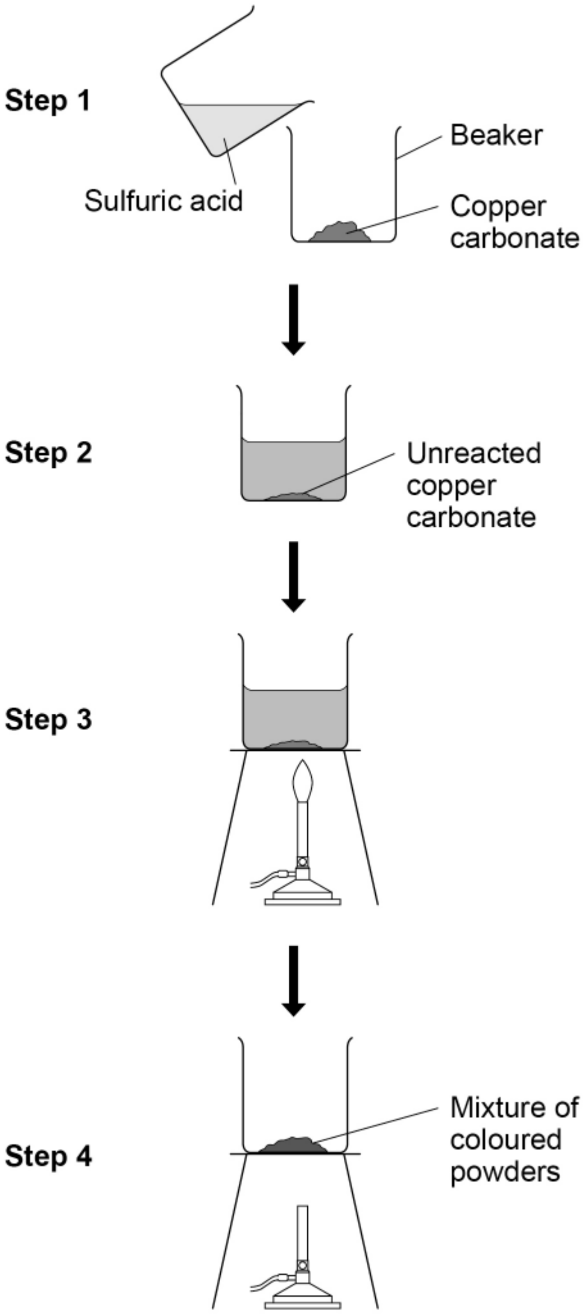
2 ____________________

8

0 2 A student wanted to make blue copper sulfate crystals from green copper carbonate powder and sulfuric acid.

Figure 2 shows the method the student used.

Figure 2



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The student obtained a mixture of coloured powders **not** blue crystals.

Describe how the method could be improved so that blue copper sulfate crystals are produced.

[6 marks]

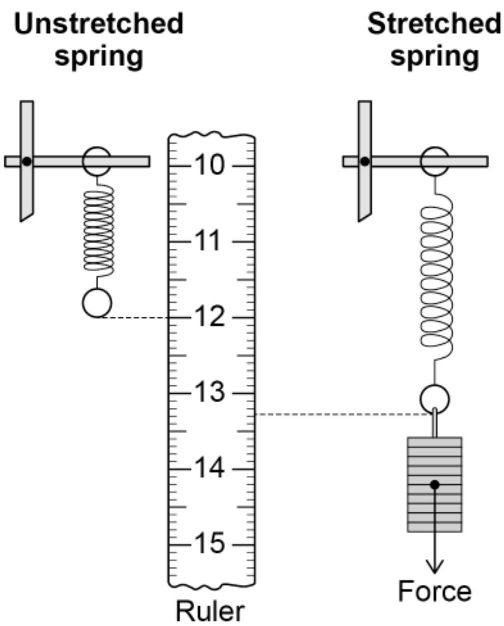
6

Turn over for the next question

0 3 A student investigated how the extension of a spring varied with the force acting on the spring.

Figure 3 shows the equipment the student used and a ruler scale between 10 cm and 15 cm

Figure 3



0 3 . 1 Describe how the student should determine the extension of the spring.

[2 marks]

0 3 . 2 Write down the equation which links extension (e), force (F) and spring constant (k).

[1 mark]

0 3 . 3 The extension of the spring was 0.12 m when the force was 3.0 N

Calculate the spring constant of the spring.

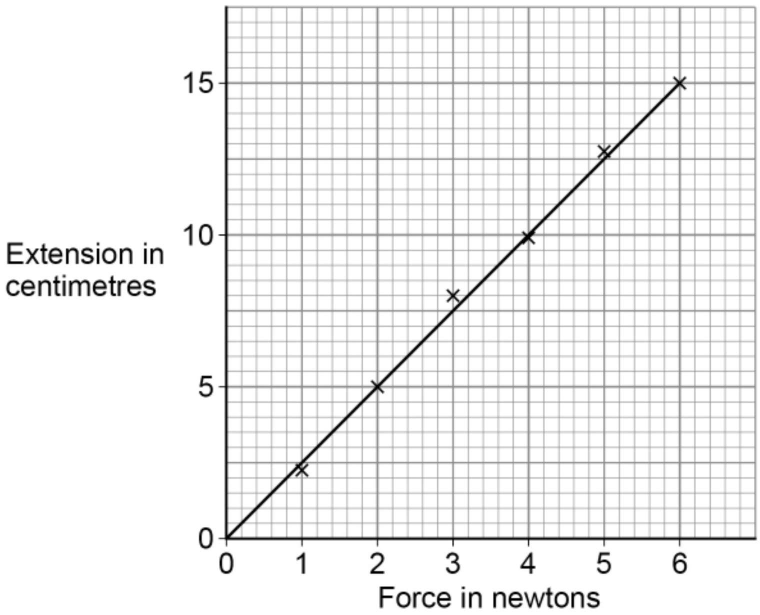
[3 marks]

Spring constant = ____________________ N/m

Question 3 continues on the next page

0 3 . 4 **Figure 4** shows the results of the same investigation using a different spring.

Figure 4



The spring constant of the spring was 40 N/m

Determine the energy stored by the spring when the force was 3.6 N

Use the Physics Equations Sheet.

[4 marks]

____

Energy stored = ____________________ J

10

Do not write outside the box

Turn over for the next question

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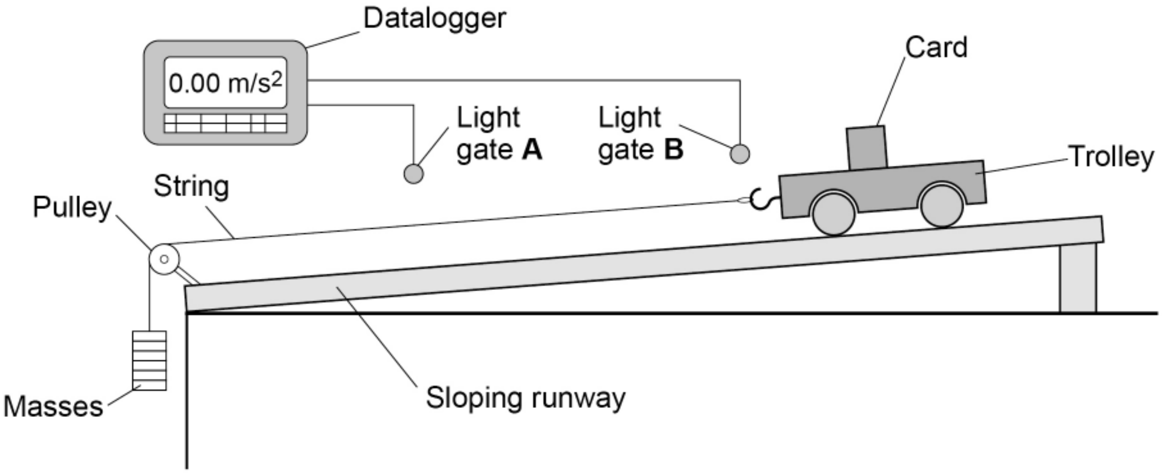
ANSWER IN THE SPACES PROVIDED

0 4 A student investigated how the acceleration of a trolley varied with the resultant force on the trolley.

The force on the trolley was provided by the masses on the string.

Figure 5 shows how the student set up the equipment.

Figure 5



This is the method used.

1. Release the trolley from the top of the runway.

2. As the card passes each light gate a timer turns on and off.

3. The datalogger calculates the velocity of the trolley at light gate **A** and at light gate **B**.

4. The datalogger calculates the acceleration using the two velocities.

5. Repeat steps **1** to **4** using different masses.

Do not write outside the box

0 4 . 1 Which **two** measurements are needed to determine the velocity of the trolley at each light gate?

[2 marks]

Tick (✓) **two** boxes.

Angle of sloping runway ☐

Distance between light gates ☐

Length of card ☐

Resultant force causing the acceleration ☐

Time that light gates are blocked by the card ☐

0 4 . 2 Why was a sloping runway used instead of a flat runway?

[1 mark]

Tick (✓) **one** box.

To compensate for the effect of friction ☐

To increase the effect of air resistance on the trolley ☐

To make the trolley accelerate ☐

Question 4 continues on the next page

Do not write outside the box

0 4 . 3 What are **two** advantages of using a datalogger and light gates instead of a stopclock in this investigation?

[2 marks]

Tick (✓) **two** boxes.

Ensures readings are repeatable ☐

Ensures readings are reproducible ☐

No reaction time error ☐

No systematic errors ☐

Performs calculations automatically ☐

0 4 . 4 Write down the equation which links acceleration (*a*), mass (*m*) and resultant force (*F*).

[1 mark]

___

0 4 . 5 The acceleration of the trolley was 2.4 m/s^2

The resultant force on the trolley was 1.2 N

Calculate the mass of the trolley.

[3 marks]

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___

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Mass = ______________ kg

9

Turn over for the next question

Turn over ►

Do not write outside the box

0 5 This question is about the reactions of metals.

0 5 . 1 A student investigated the temperature change when a metal was added to 25 cm^3 of dilute sulfuric acid.

The student repeated the investigation with different metals.

The student kept all other variables constant.

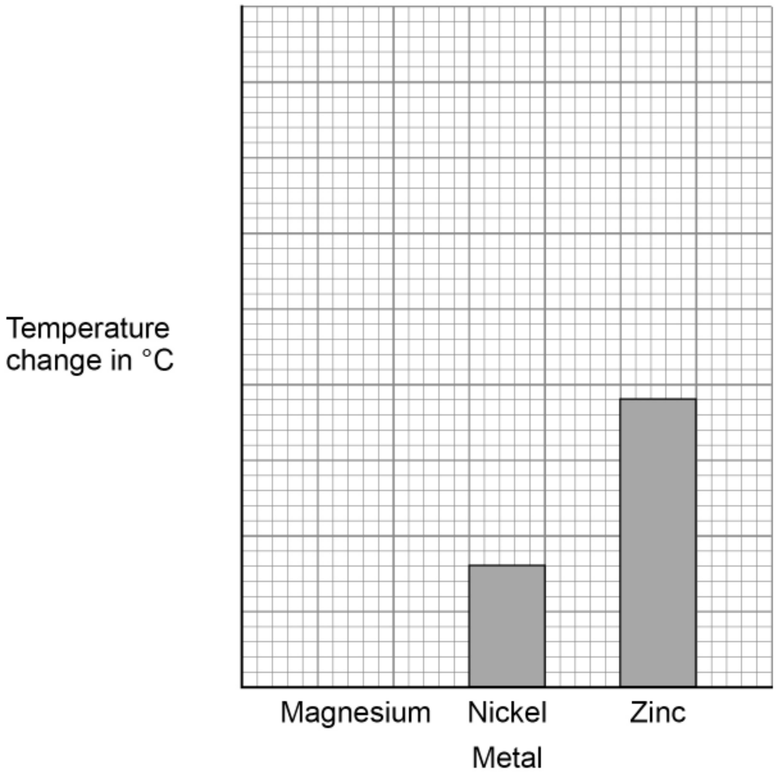
Table 1 shows the results.

Table 1

Metal	**Initial temperature in °C**	**Maximum temperature in °C**
Magnesium	18.0	37.5
Nickel	18.0	22.0
Zinc	18.0	27.5

Figure 6 shows an incomplete bar chart for the data in **Table 1**.

Figure 6



Complete **Figure 6**.

You should:

- write the correct scale on the y-axis
- plot the bar for magnesium.

[2 marks]

Question 5 continues on the next page

Do not write outside the box

Another student investigated displacement reactions of metals.

The student added magnesium, nickel and zinc to different metal sulfate solutions and recorded when a reaction occurred.

0 5 . 2 Predict which metals will react with each metal sulfate solution.

Complete **Table 2**.

You should:

- use a tick (✓) to show where a reaction will occur
- use a cross (×) to show where **no** reaction will occur.

Table 1 is repeated here to help you.

[3 marks]

Table 1

Metal	**Initial temperature in °C**	**Maximum temperature in °C**
Magnesium	18.0	37.5
Nickel	18.0	22.0
Zinc	18.0	27.5

Table 2

	Metal sulfate solution		
Metal	Magnesium sulfate	Nickel sulfate	Zinc sulfate
Magnesium			
Nickel			
Zinc			

Do not write outside the box

0 5 . 3 The student dissolved 0.0025 moles of nickel sulfate in water to make 5 cm^3 of nickel sulfate solution.

Calculate the concentration of the nickel sulfate solution in g/dm^3

Relative formula mass (M_r) of nickel sulfate = 155

[3 marks]

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____

____

____

____

Concentration = ______________________ g/dm^3

8

Turn over for the next question

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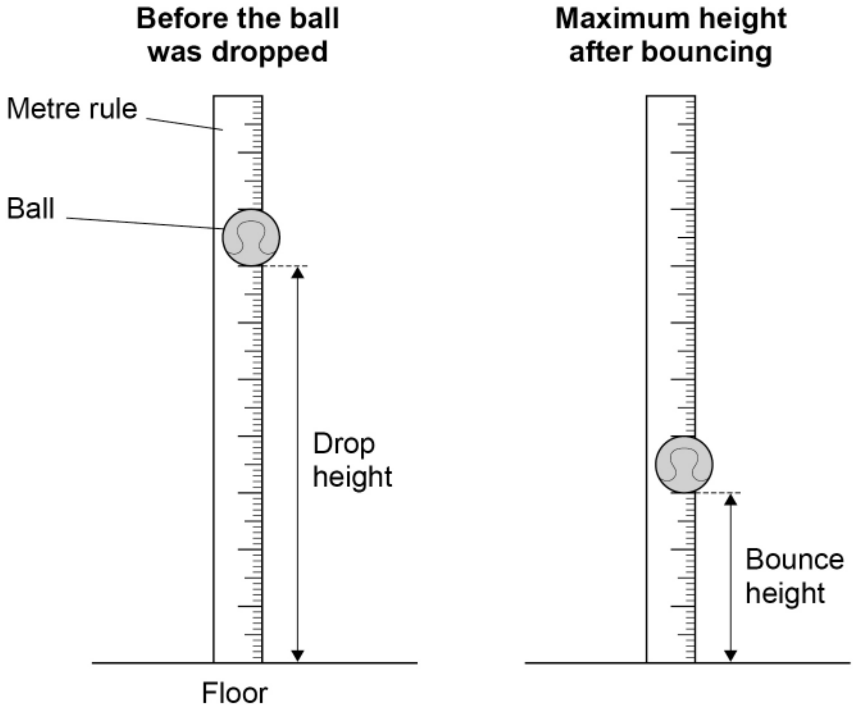
0 6 A student investigated how the bounce height of a ball varied with drop height.

Figure 7 shows the ball before and after bouncing.

Figure 7



This is the method used.

1. Hold the ball at eye level and record the drop height using the metre rule.
2. Drop the ball and measure the bounce height using the metre rule.
3. Take repeat readings and calculate a mean.
4. Repeat steps **1** to **3** for different drop heights.

Table 3 shows the results.

Table 3

Drop height in centimetres	**Bounce height in centimetres**			
	Test 1	**Test 2**	**Test 3**	**Mean**
20.0	9.5	10.0	10.5	10.0
40.0	22.5	23.5	21.0	22.3
60.0	40.5	29.5	31.5	**X**
80.0	43.0	45.5	42.5	43.7
100.0	56.5	55.5	55.5	55.833

0 6 . 1 Calculate value **X** in **Table 3**.

[2 marks]

____

____

____

X = ______________________ cm

0 6 . 2 The mean value of 55.833 has **not** been recorded correctly in **Table 3**.

Give the value that should have been recorded.

[1 mark]

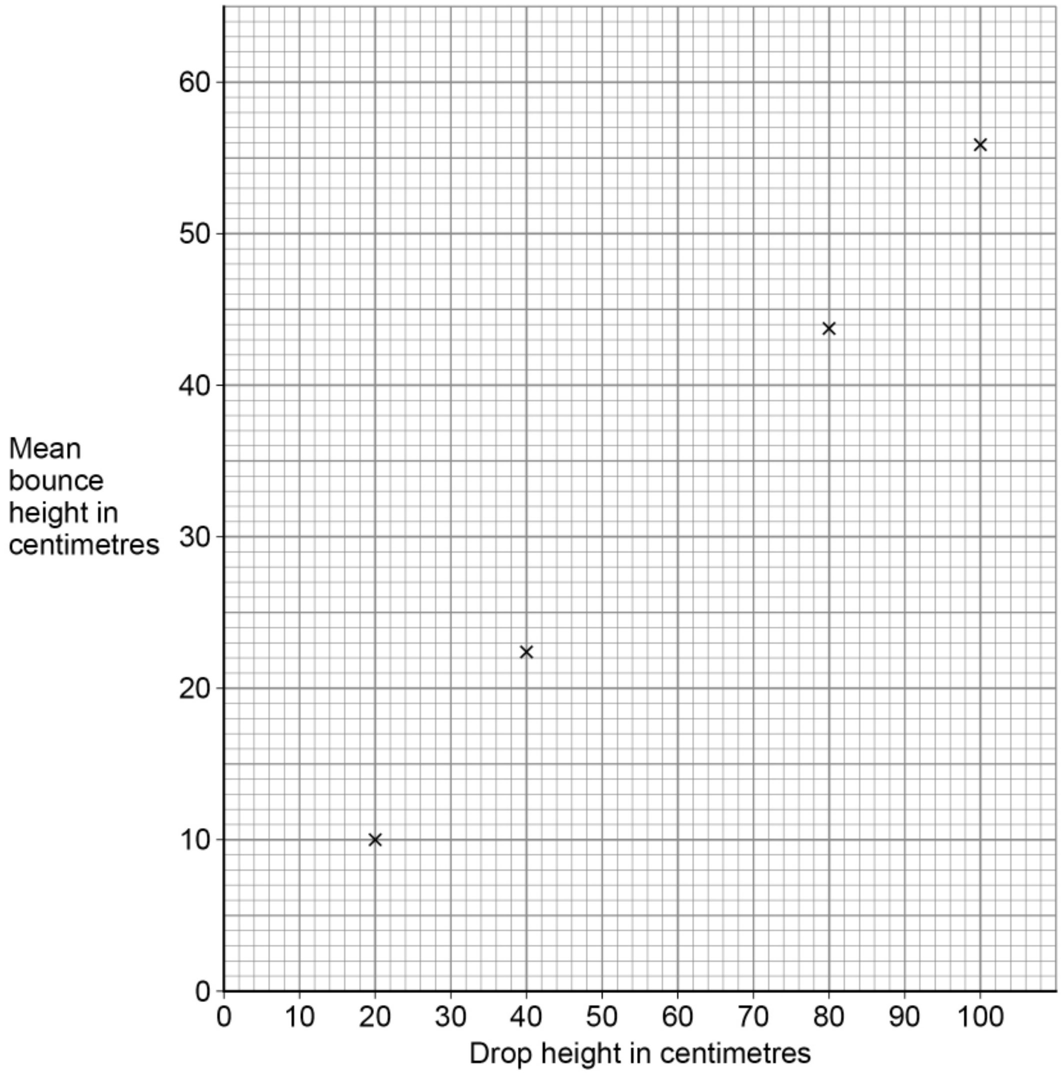
Value = ______________________ cm

Question 6 continues on the next page

Turn over ►

0 6 . 3 **Figure 8** shows some of the results.

Figure 8



What is the relationship between mean bounce height and drop height?

[1 mark]

Do not write outside the box

0 6 . 4 **Table 4** shows some of the results.

Table 4

Drop height in centimetres	**Bounce height in centimetres**			
	Test 1	**Test 2**	**Test 3**	**Mean**
20.0	9.5	10.0	10.5	10.0

Calculate the uncertainty in the student's results when the drop height was 20.0 cm

[2 marks]

Uncertainty = ± ______________ cm

0 6 . 5 The investigation was repeated using a video camera to record the motion of the ball.

Explain why using a video camera could reduce the uncertainty in the results for bounce height.

[2 marks]

8

Turn over for the next question

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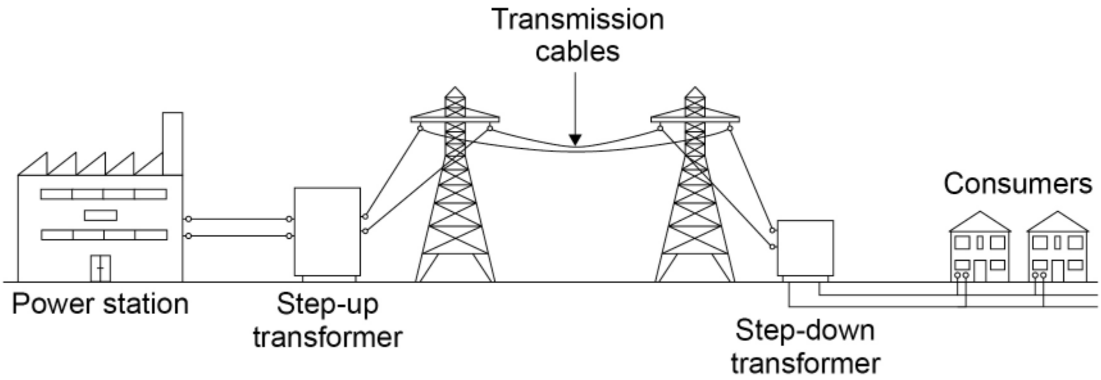
0 7 **Figure 9** shows how the National Grid connects power stations to consumers.

Figure 9



0 7 . 1 Explain how transformers are used in the National Grid.

[5 marks]

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0 7 . 2 A gas-fired power station has a power output of 50 MW

Calculate the energy transferred during 24 hours.

[4 marks]

Energy transferred = ____________________ J

Question 7 continues on the next page

Do not write outside the box

0 7 . 3 **Table 5** shows some of the waste products produced by three different types of power station.

Table 5

Type of power station	Carbon dioxide produced in kg/MJ	Other waste products
Coal	0.08	sulfur dioxide
Geothermal	0.03	none
Nuclear	0.00	radioactive waste

Evaluate the environmental impact of the power stations in **Table 5**.

[4 marks]

13

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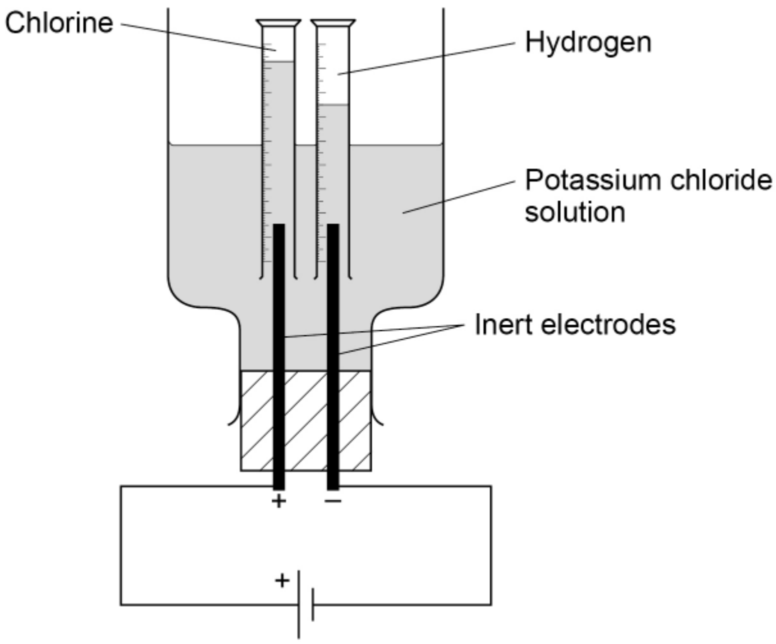
0 8 A student investigated the electrolysis of potassium chloride solution.

Figure 10 shows the apparatus used.

Figure 10



0 8 . 1 Why are inert electrodes used?

[1 mark]

____

____

Question 8 continues on the next page

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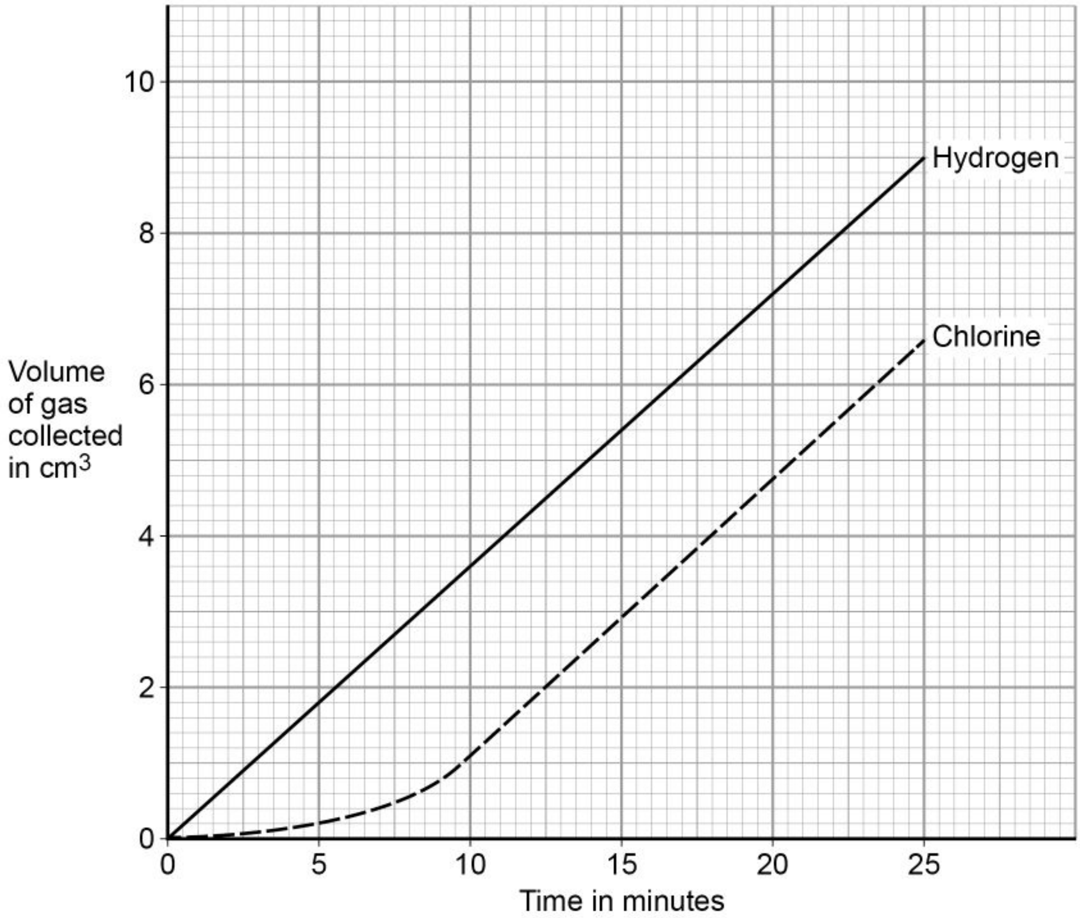
The student measured the volume of gas collected at each electrode for 25 minutes.

Figure 11 shows the results.

Figure 11



0 8 . 2 Compare the **rate** of collection of hydrogen and of chlorine.

Give **one** similarity and **one** difference in the **rate** of collection of the gases.

[2 marks]

Similarity ____

____

Difference ____

____

Do not write outside the box

0 8 . 3 The rate of production of hydrogen and of chlorine at the electrodes is the same.

Explain how the graph on **Figure 11** shows that chlorine is more soluble than hydrogen.

[2 marks]

0 8 . 4 Explain why hydrogen gas is produced at the negative electrode in the electrolysis of potassium chloride solution.

[4 marks]

0 8 . 5 Write the half equation for the production of chlorine gas at the positive electrode.

[2 marks]

______ → ______ + ______

11

Do not write outside the box

0 9 Hydrogen peroxide (H_2O_2) decomposes to produce oxygen gas and water.

0 9 . 1 Balance the equation for the reaction.

[1 mark]

$$\_\_\_\_\_\_ \ H_2O_2 \rightarrow \_\_\_\_\_\_ \ H_2O + O_2$$

Two catalysts that can be used in the reaction are raw potato and manganese dioxide.

0 9 . 2 A student compared the rate of decomposition of hydrogen peroxide using:

- a cube of raw potato as the catalyst
- crushed raw potato as the catalyst.

The student kept all other variables constant.

The hydrogen peroxide decomposed at a different rate when using a cube of raw potato compared with using crushed raw potato.

Explain why.

[3 marks]

0 9 . 3 The student repeated the investigation using boiled potato instead of raw potato.

When boiled potato is added to hydrogen peroxide no bubbles of oxygen are observed.

Explain why.

[2 marks]

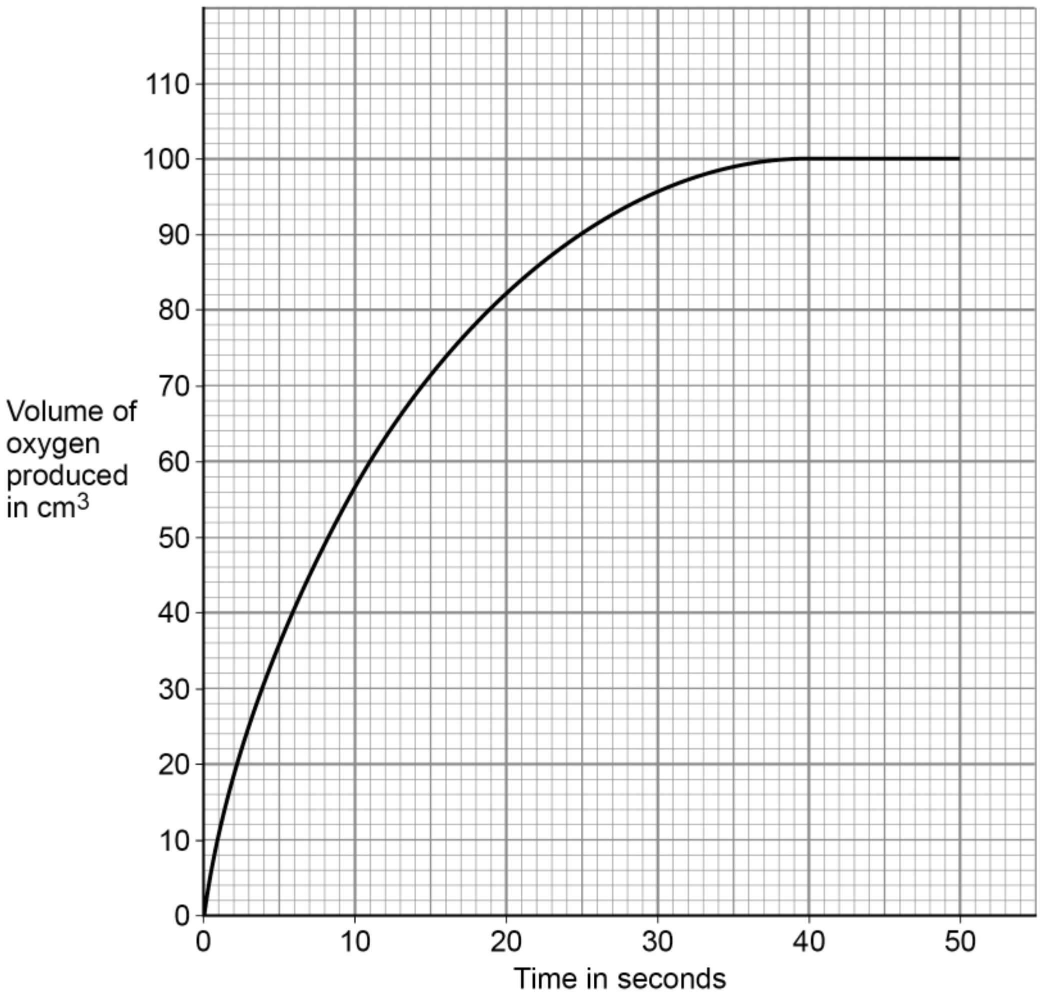
Question 9 continues on the next page

0 9 . 4 The student then investigated the rate of decomposition of hydrogen peroxide using manganese dioxide as the catalyst.

The student measured the volume of oxygen produced every 5 seconds for 50 seconds.

Figure 12 shows the results.

Figure 12



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Determine the rate of reaction at 15 s

[4 marks]

Rate = ______________________ cm^3/s

10

Turn over for the next question

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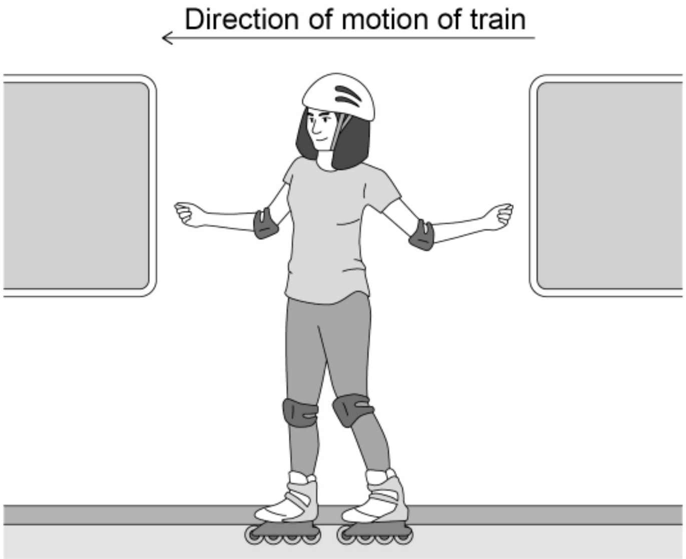
1 0 **Figure 13** shows a girl inside a train. The girl is wearing inline skates.

The train is moving at a constant velocity. The girl is stationary relative to the train.

Figure 13



1 0 . 1 The girl is not touching the train walls.

The train suddenly decelerates.

Explain what will happen to the movement of the girl as the train suddenly decelerates.

[3 marks]

____

____

____

____

____

____

Question 10 continues on the next page

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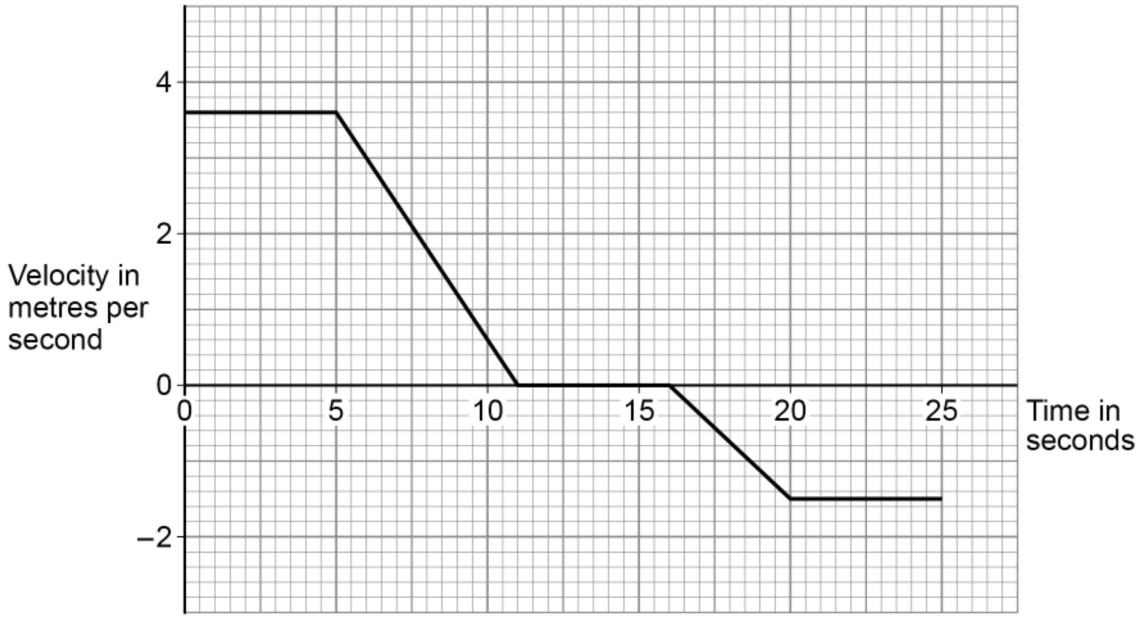
Figure 14 shows a velocity-time graph for the train for part of its journey.

Figure 14



1 0 . 2 Write down the equation which links acceleration (a), change in velocity (Δv) and time taken (t).

[1 mark]

____

1 0 . 3 Determine the acceleration of the train between 5 seconds and 11 seconds.

[2 marks]

____

____

____

Acceleration = ____________________ m/s^2

1 0 . 4 Determine the total displacement of the train between 0 seconds and 25 seconds.

[5 marks]

Displacement = ____________________ m

1 0 . 5 At a different point in the journey the train decelerates from a velocity of 40 m/s to a velocity of 15 m/s

The deceleration is 2.0 m/s^2

Calculate the distance the train travels while decelerating.

[3 marks]

Distance = ____________________ m

Question 10 continues on the next page

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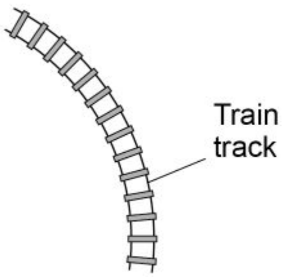
10.6 **Figure 15** shows part of the track for the train's journey.

The train moves at a constant speed along this part of the track.

The train is accelerating.

Figure 15



Explain how the train can be accelerating while travelling at a constant speed.
[3 marks]

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17

END OF QUESTIONS

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