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

F

Foundation Tier Paper 3 Physical Sciences

Friday 9 June 2023 Afternoon 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.

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

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.

Do not write outside the box

0 1 This question is about acids and alkalis.

Universal indicator is used to measure the pH of solutions.

0 1 . 1 Which is a pH value of an alkaline solution?

[1 mark]

Tick (✓) **one** box.

5 ☐ 7 ☐ 9 ☐

0 1 . 2 Which is a colour of universal indicator in an alkaline solution?

[1 mark]

Tick (✓) **one** box.

Blue ☐

Red ☐

Yellow ☐

0 1 . 3 What piece of equipment measures the pH of a solution more accurately than universal indicator?

[1 mark]

_____

Do not write outside the box

0 1 . 4 Which ion do all acids produce in aqueous solution?

[1 mark]

Tick (✓) **one** box.

H^+ ☐ OH^- ☐ O^{2-} ☐

0 1 . 5 The reaction between an acid and an alkali produces water.

What is the name of this type of reaction?

[1 mark]

Tick (✓) **one** box.

Combustion ☐

Decomposition ☐

Neutralisation ☐

Question 1 continues on the next page

Do not write outside the box

0 1 . 6 Sulfuric acid has the formula H_2SO_4

What is the total number of atoms in the formula H_2SO_4?

[1 mark]

Tick (✓) **one** box.

3 ☐ 6 ☐ 7 ☐ 10 ☐

0 1 . 7 0.5 dm^3 of a solution of sulfuric acid contains 9.8 g of sulfuric acid.

Calculate the concentration of the solution of sulfuric acid.

Use the equation:

$$\text{concentration} = \frac{\text{mass of sulfuric acid}}{\text{volume of solution}}$$

[2 marks]

_____

_____

_____

Concentration = _____ g/dm^3

8

Do not write outside the box

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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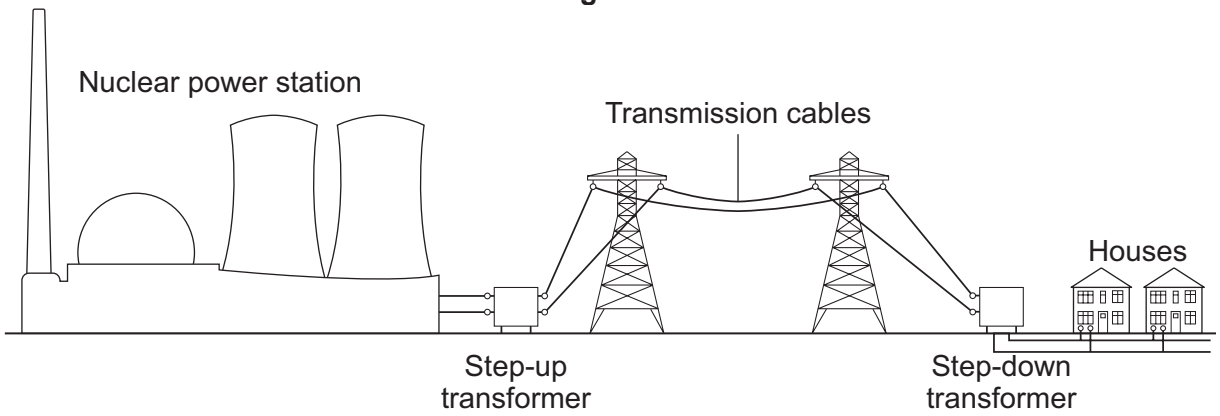
0 2 **Figure 1** shows how the National Grid connects a nuclear power station to houses.

Figure 1



0 2 . 1 What is **one** advantage of generating electricity using nuclear power?

[1 mark]

Tick (✓) **one** box.

Generating electricity using nuclear power is reliable. ☐

Generating electricity using nuclear power produces radioactive waste. ☐

Nuclear fuel is non-renewable. ☐

Do not write outside the box

The step-up transformer **increases** the efficiency of power transmission.

0 2 . 2 How does the step-up transformer affect the potential difference across the transmission cables?

[1 mark]

Tick (✓) **one** box.

The potential difference decreases. ☐

The potential difference stays the same. ☐

The potential difference increases. ☐

0 2 . 3 How does the step-up transformer affect the current in the transmission cables?

[1 mark]

Tick (✓) **one** box.

The current decreases. ☐

The current stays the same. ☐

The current increases. ☐

0 2 . 4 How does the step-up transformer affect the energy transferred from the transmission cables to the surroundings?

[1 mark]

Tick (✓) **one** box.

The energy transferred to the surroundings decreases. ☐

The energy transferred to the surroundings stays the same. ☐

The energy transferred to the surroundings increases. ☐

Question 2 continues on the next page

Do not write outside the box

0 2 . 5 The total power input from the nuclear power station to the National Grid is 2400 MW.

efficiency of power transmission = 0.90

Calculate the useful power output in MW.

Use the equation:

useful power output = efficiency × total power input

[2 marks]

Useful power output = _____ MW

Do not write outside the box

0 2 . 6 **Table 1** shows the percentage (%) of electricity generated by all the energy resources in the UK on one day in 2022.

Table 1

Energy resource	Percentage (%)
Coal	2
Natural gas	36
Nuclear	**X**
Renewables	45

Calculate percentage **X** in **Table 1**.

[2 marks]

_____

_____

_____

_____

Percentage **X** = _____ %

8

Turn over for the next question

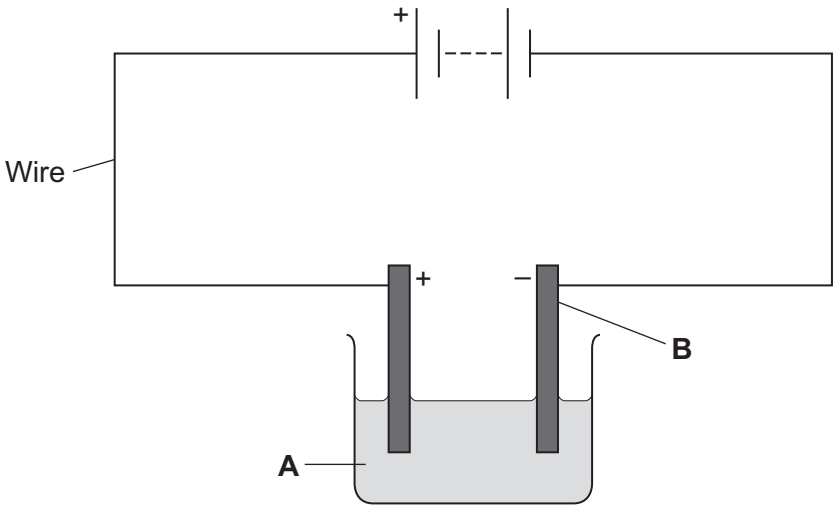
Do not write outside the box

0 3 This question is about the electrolysis of copper sulfate solution.

A student investigated the electrolysis of copper sulfate solution.

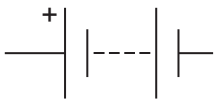
Figure 2 shows the apparatus.

Figure 2



0 3 . 1 What is the name of the component represented by the circuit symbol below?

[1 mark]



_____

Do not write outside the box

0 3 . 2 Identify **A** and **B** in **Figure 2**.

[2 marks]

A _____

B _____

0 3 . 3 Which particles in the copper sulfate solution carry the charge during electrolysis?

[1 mark]

Tick (✓) **one** box.

Atoms ☐

Ions ☐

Molecules ☐

Question 3 continues on the next page

The student measured the mass of copper deposited in 20 minutes.

The student did the test three times.

Table 2 shows the results.

Table 2

Test	Mass of copper deposited in 20 minutes in grams
1	0.52
2	0.45
3	0.50

0 3 . 4 Calculate the mass of copper deposited in **one** minute for **Test 1**.

Use **Table 2**.

[2 marks]

Mass = _____ g

0 3 . 5 Calculate the mean mass of copper deposited in 20 minutes.

Use **Table 2**.

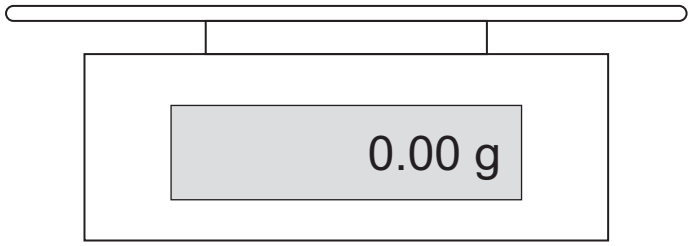
[2 marks]

Mean mass = _____ g

Do not write outside the box

0 3 . 6 **Figure 3** shows the balance used to make the measurements in **Table 2**.

Figure 3



What is the smallest change in mass that can be measured using this balance?

[1 mark]

Tick (✓) **one** box.

0.001 g ☐

0.01 g ☐

0.1 g ☐

9

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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0 4 This question is about carbon and hydrocarbons.

0 4 . 1 Which is a form of carbon?

[1 mark]

Tick (✓) **one** box.

Diamond ☐ Gold ☐ Silicon ☐

0 4 . 2 Graphite is a form of carbon.

Which is a property of graphite?

[1 mark]

Tick (✓) **one** box.

Conducts electricity ☐

Has a low melting point ☐

Is very hard ☐

0 4 . 3 Buckminsterfullerene is a carbon molecule.

What is the formula of buckminsterfullerene?

[1 mark]

Tick (✓) **one** box.

C_6 ☐ C_{12} ☐ C_{60} ☐ C_{72} ☐

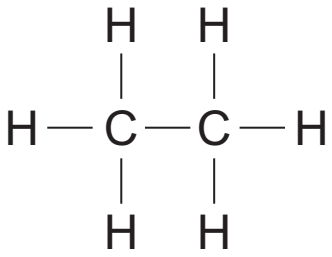
Question 4 continues on the next page

Hydrocarbons are molecules made up of hydrogen atoms and carbon atoms only.

Ethane is a hydrocarbon.

Figure 4 represents an ethane molecule.

Figure 4



0 4 . 4 Complete the formula of an ethane molecule.

[1 mark]

C ___ H ___

Do not write outside the box

0 4 . 5 **Figure 5** represents a bond between a carbon atom and a hydrogen atom in ethane.

Figure 5

Which **two** words describe the C–H bond in ethane?

[2 marks]

Tick (✓) **two** boxes.

- Covalent ☐
- Double ☐
- Intermolecular ☐
- Ionic ☐
- Strong ☐

Question 4 continues on the next page

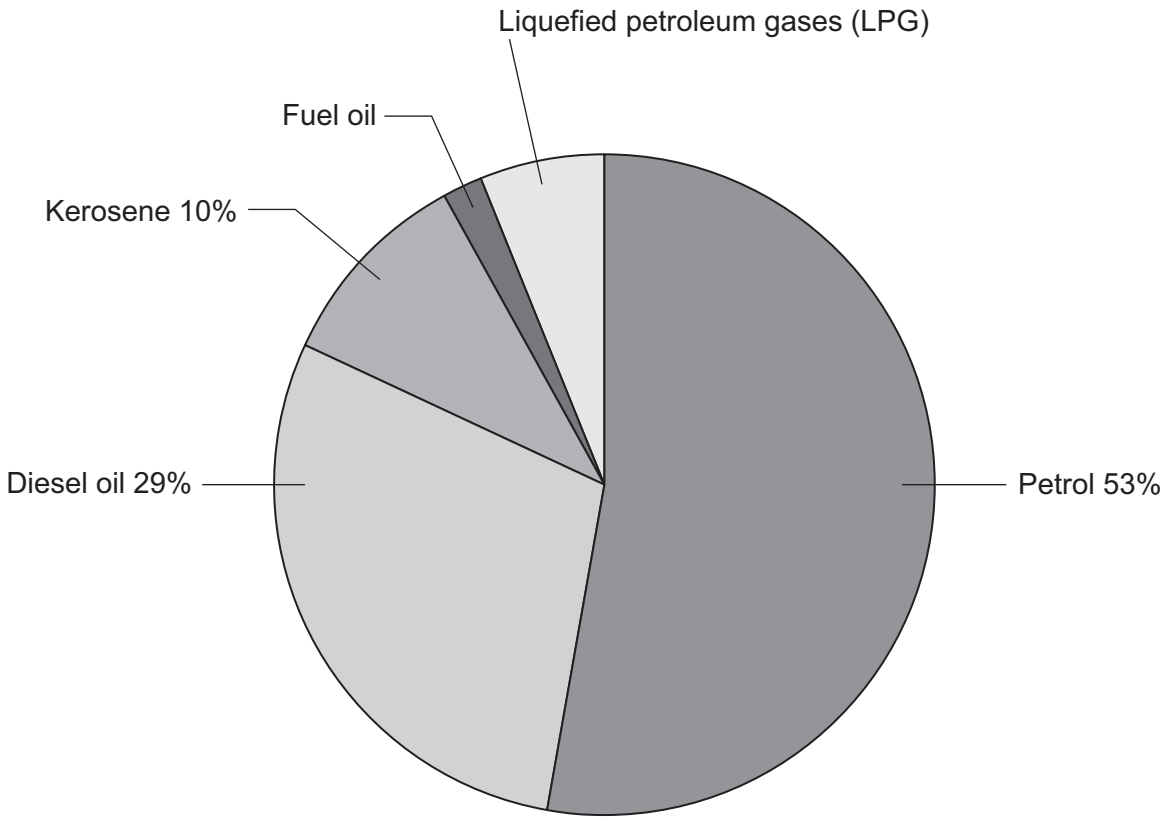
Crude oil is a mixture of compounds.

Most of the compounds in crude oil are hydrocarbons.

Crude oil is separated into hydrocarbon fractions.

0 4 . 6 **Figure 6** shows the percentage (%) of different hydrocarbon fractions in a sample of crude oil.

Figure 6



Do not write outside the box

Determine the percentage of LPG **and** the percentage of fuel oil in this sample of crude oil.

Complete the following steps.

[3 marks]

Calculate the total percentage of petrol, diesel oil and kerosene.

Total percentage of petrol, diesel oil and kerosene = _____ %

Calculate the total percentage of LPG and fuel oil.

Total percentage of LPG and fuel oil = _____ %

Calculate the percentage of LPG **and** the percentage of fuel oil.

Use the ratio:

Percentage of LPG : percentage of fuel oil = 3 : 1

Percentage of LPG = _____ %

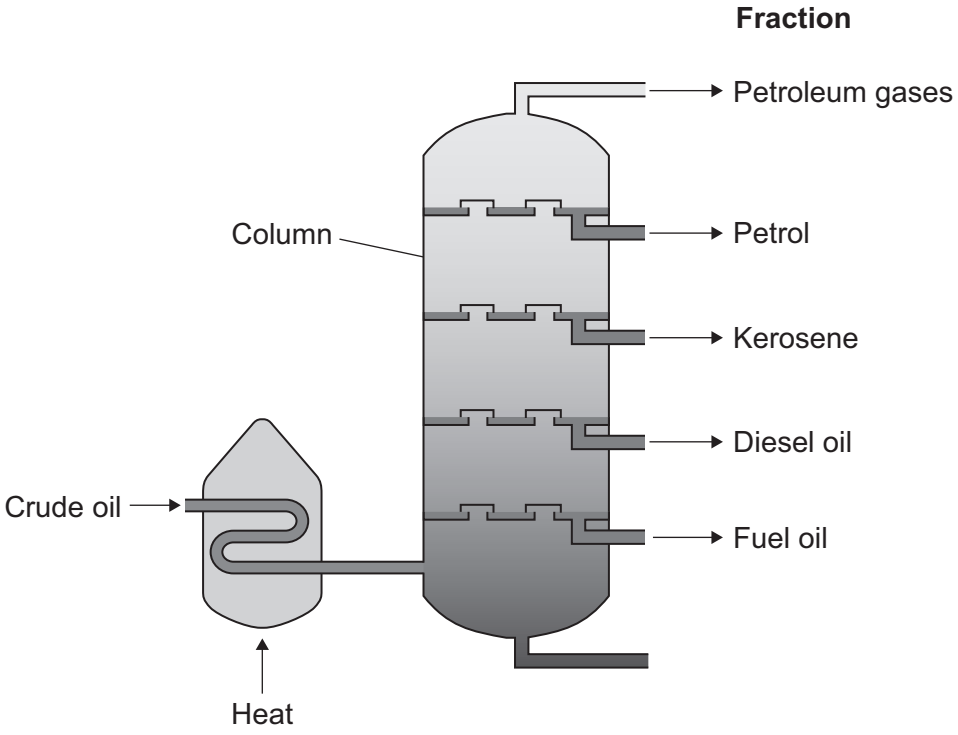
Percentage of fuel oil = _____ %

Question 4 continues on the next page

Fractional distillation is used to separate crude oil into hydrocarbon fractions.

Figure 7 shows a fractional distillation column.

Figure 7



0 4 . 7 Complete the sentences.

Choose answers from the box.

[2 marks]

condense	**freeze**	**melt**	**vaporise**

The liquid crude oil is heated and the hydrocarbons _____ .

The hydrocarbons rise up the column.

The hydrocarbons cool and _____ .

Do not write outside the box

0 4 . 8 Complete the sentence.

Choose the answer from the box.

[1 mark]

boiling point	**flammability**	**viscosity**

The hydrocarbons separate at different temperatures because each hydrocarbon has a different _____.

0 4 . 9 Large hydrocarbon molecules can be broken down into smaller hydrocarbon molecules.

What is the name of this type of reaction?

[1 mark]

Tick (✓) **one** box.

Cracking ☐

Oxidation ☐

Polymerisation ☐

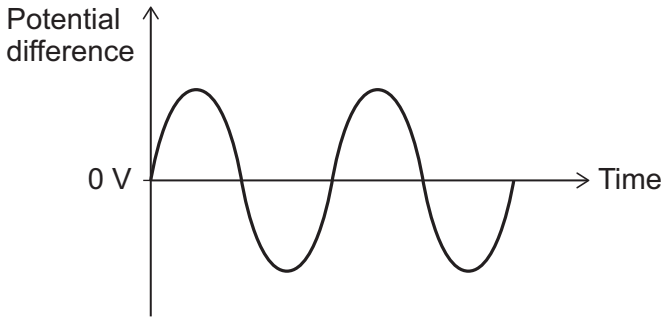
13

Turn over for the next question

Do not write outside the box

0 5 **Figure 8** shows how the potential difference of the mains electricity supply varies with time.

Figure 8



0 5 . 1 How does **Figure 8** show that the potential difference is alternating?

[1 mark]

Tick (✓) **one** box.

The potential difference changes direction. ☐

The potential difference starts at zero volts. ☐

The potential difference varies. ☐

0 5 . 2 What is the potential difference of the mains electricity supply in the UK?

[1 mark]

Tick (✓) **one** box.

0 volts ☐

50 volts ☐

115 volts ☐

230 volts ☐

Figure 9 shows a student using hair straighteners.

The hair straighteners contain heating elements which transfer thermal energy to the hair.

Figure 9

The hair straighteners are connected to the mains electricity supply by a three-core cable.

0 5 . 3 Draw **one** line from the name of each wire to the function of each wire in the cable.

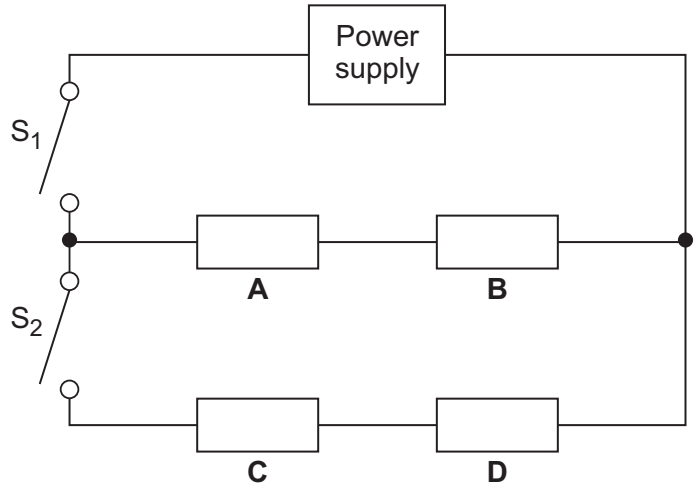
[2 marks]

Wire	Function
Earth	Carries the alternating potential difference
Live	Completes the circuit
Neutral	Safety wire

Question 5 continues on the next page

Figure 10 shows the circuit diagram for the hair straighteners.

Figure 10



The resistors **A**, **B**, **C** and **D** represent four heating elements in the hair straighteners.

0 5 . 4 Complete **Table 3** to show how switches S_1 and S_2 are used to switch the heating elements on or off.

The first row of the table has been completed for you.

[2 marks]

Table 3

Switches	**Heating elements on or off?**	
	A and **B**	**C** and **D**
S_1 open and S_2 open	off	off
S_1 closed and S_2 open		
S_1 closed and S_2 closed		

Do not write outside the box

Use the Physics Equations Sheet to answer Questions **05.5** and **05.6**.

0 5 . 5 Write down the equation which links energy transferred (E), power (P) and time (t).

[1 mark]

_____

0 5 . 6 When the hair straighteners are switched off, the heating elements take 20 minutes to cool to room temperature.

The mean power transfer to the surroundings during this time is 12 W.

Calculate the energy transferred to the surroundings by the heating elements in 20 minutes.

[3 marks]

_____

_____

_____

_____

_____

_____

Energy transferred = _____ J

10

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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0 6 Calcium reacts with hydrochloric acid.

The word equation for the reaction is:

calcium + hydrochloric acid ⟶ calcium chloride + hydrogen

0 6 . 1 Which state symbol is used for the hydrogen produced in this reaction?

[1 mark]

Tick (✓) **one** box.

(aq) ☐ (g) ☐ (l) ☐ (s) ☐

0 6 . 2 What is the result of the test for hydrogen?

[1 mark]

Tick (✓) **one** box.

A burning splint makes a pop sound ☐

A glowing splint relights ☐

Damp blue litmus paper bleaches ☐

0 6 . 3 Calcium is in Group 2 of the periodic table.

What is the symbol for a calcium ion?

[1 mark]

Tick (✓) **one** box.

Ca^{-} ☐ Ca^{2-} ☐ Ca^{+} ☐ Ca^{2+} ☐

Question 6 continues on the next page

Table 4 shows the mass of calcium chloride produced when different masses of calcium react with hydrochloric acid.

Table 4

Mass of calcium reacted in grams	Mass of calcium chloride produced in grams
0.0	0.0
0.5	1.4
1.0	2.8
1.5	4.2
2.0	5.6

0 6 . 4 Complete the sentence.

Use **Table 4**.

[1 mark]

As the mass of calcium reacted increases, the mass of calcium chloride

produced _____ .

0 6 . 5 Complete **Figure 11**.

You should:

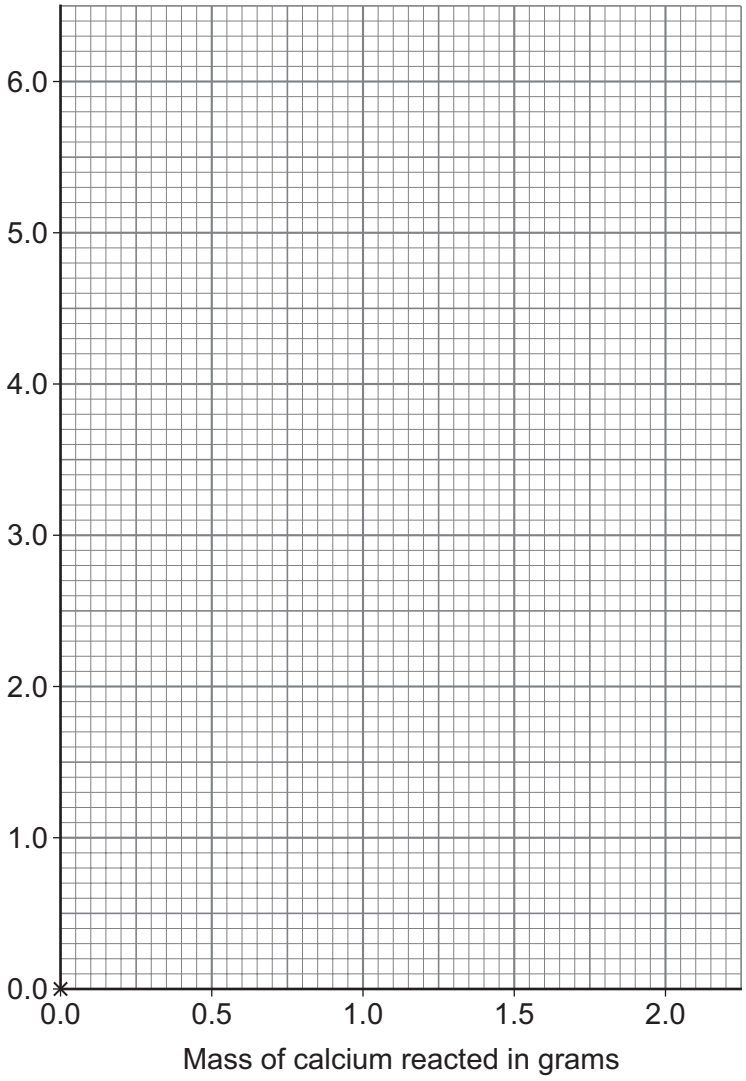
- label the *y*-axis
- plot the data from **Table 4**
- draw a line of best fit.

The point at 0.0, 0.0 has been plotted for you.

[4 marks]

Do not write outside the box

Figure 11



0 6 . 6 Predict the mass of calcium chloride produced when 1.25 g of calcium reacts with hydrochloric acid.

Use **Figure 11**.

[1 mark]

Mass of calcium chloride = _____ g

Question 6 continues on the next page

Turn over ▶

Do not write outside the box

0 6 . 7 The formula of calcium chloride is $CaCl_2$

Calculate the relative formula mass (M_r) of calcium chloride.

Relative atomic masses (A_r): Ca = 40 Cl = 35.5

[2 marks]

_____

_____

_____

M_r = _____

11

Do not write outside the box

0 7 **Figure 12** shows people going on a journey in an electric car.

Figure 12

0 7 . 1 The current in the electric motor of the car is 200 A.

The resistance of the motor is 1.75 Ω.

Calculate the power of the motor.

Use the equation:

$$\text{power} = (\text{current})^2 \times \text{resistance}$$

[2 marks]

Power = _____ W

0 7 . 2 The car travelled at a constant speed of 12.5 m/s for 600 seconds of the journey.

Calculate the distance travelled during this time.

Use the equation:

$$\text{distance travelled} = \text{speed} \times \text{time}$$

[2 marks]

Distance travelled = _____ m

Question 7 continues on the next page

The car travelled from town **P** to town **Q**.

Figure 13 shows the route taken by the car.

Figure 13

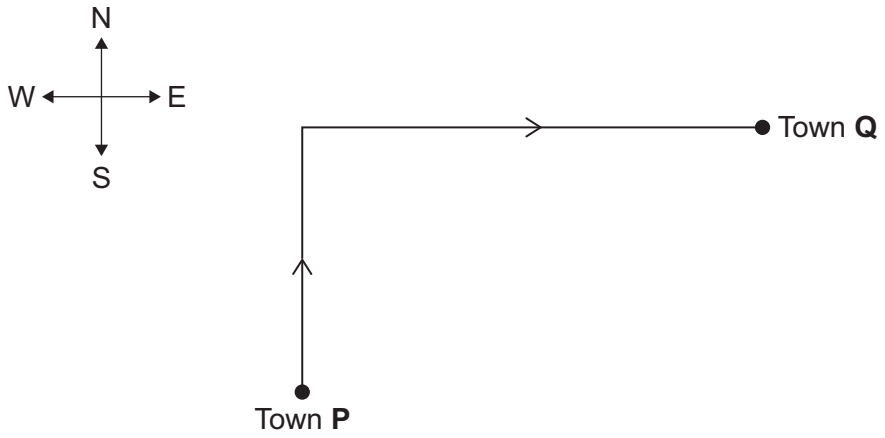


Figure 13 is drawn to a scale of 1 cm = 5 km.

0 7 . 3 Determine the distance in km travelled by the car as it moves from town **P** to town **Q**.

Use **Figure 13**.

[2 marks]

Distance = _____ km

0 7 . 4 The displacement of the car at the end of the journey is the straight-line distance and the direction from town **P** to town **Q**.

What is the angle of the displacement of the car from north at the end of the journey?

[1 mark]

Tick (✓) **one** box.

30º ☐ 60º ☐ 90º ☐

Do not write outside the box

Use the Physics Equations Sheet to answer Questions **07.5** and **07.6**.

0 7 . 5 Write down the equation which links acceleration (a), change in velocity (Δv) and time (t).

[1 mark]

_____

0 7 . 6 At the end of the journey, the car decelerates from a velocity of 24 m/s and stops.

The deceleration of the car was 4.0 m/s^2.

Calculate the time taken for the car to decelerate and stop.

[3 marks]

_____

_____

_____

_____

Time = _____ s

11

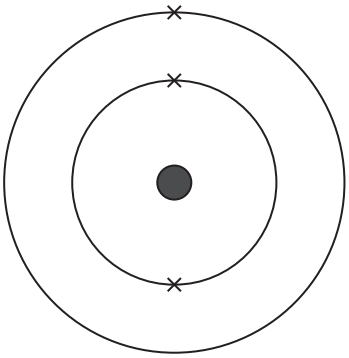
Turn over for the next question

Do not write outside the box

0 8 This question is about metals.

Figure 14 represents the electronic structure of an atom.

Figure 14



0 8 . 1 Identify the metal represented in **Figure 14**.

Use the periodic table.

[1 mark]

0 8 . 2 How does the atom in **Figure 14** form a positive ion?

[1 mark]

Copper is too soft for some uses.

Copper can be mixed with other metals to make a mixture that is harder than copper.

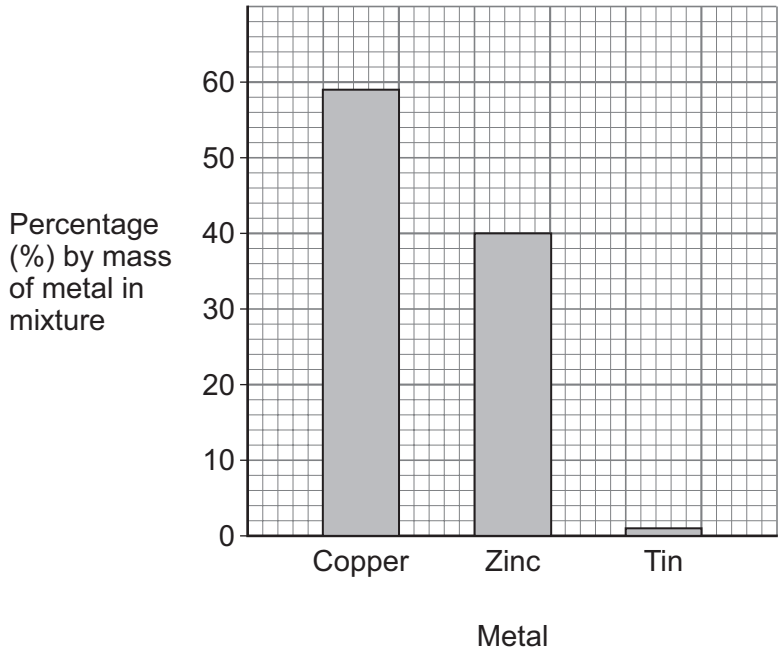
0 8 . 3 Name the type of mixture formed when copper is mixed with other metals.

[1 mark]

_____

0 8 . 4 **Figure 15** shows the percentage (%) by mass of three metals in a mixture.

Figure 15



Determine the mass of copper in 20 g of the mixture.

[3 marks]

_____

_____

_____

_____

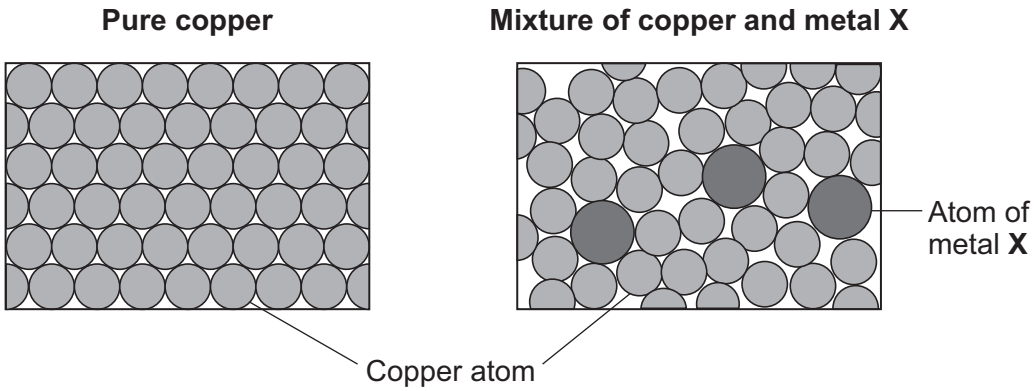
Mass of copper = _____ g

Question 8 continues on the next page

Do not write outside the box

Figure 16 represents pure copper and a mixture of copper and metal **X**.

Figure 16



0 8 . 5 Explain why the mixture of copper and metal **X** is harder than pure copper.

[3 marks]

Do not write outside the box

0 8 . 6 Give **two** reasons why copper has a high melting point.

[2 marks]

1 _____

_____

2 _____

_____

0 8 . 7 Why is copper a good conductor of electricity?

[1 mark]

_____

_____

12

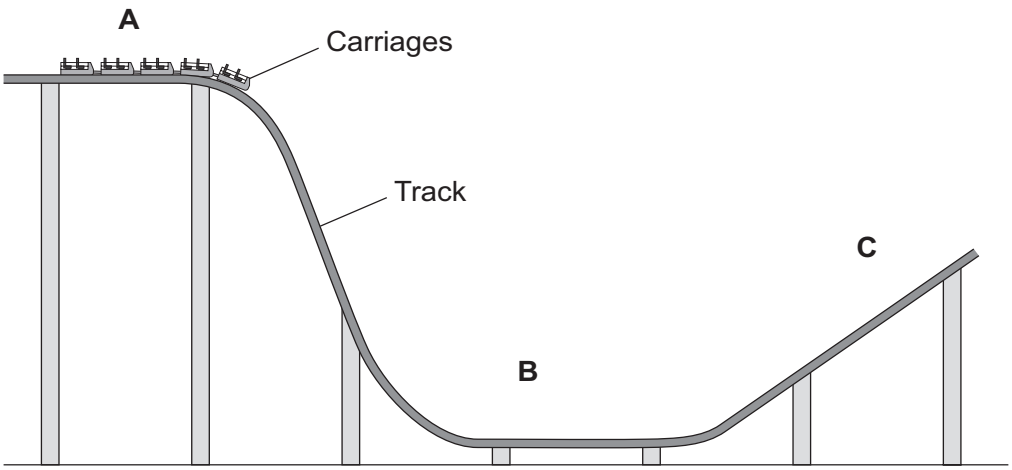
Turn over for the next question

Do not write outside the box

0 9 **Figure 17** shows part of a roller coaster ride in a theme park.

The roller coaster carriages move along the track from position **A** to position **C**.

Figure 17



Use the Physics Equations Sheet to answer Questions **09.1** and **09.2**.

0 9 . 1 Which equation links kinetic energy (E_k), mass (m) and speed (v)?

[1 mark]

Tick (✓) **one** box.

$E_k = mv^2$ ☐

$E_k = \frac{1}{2}mv$ ☐

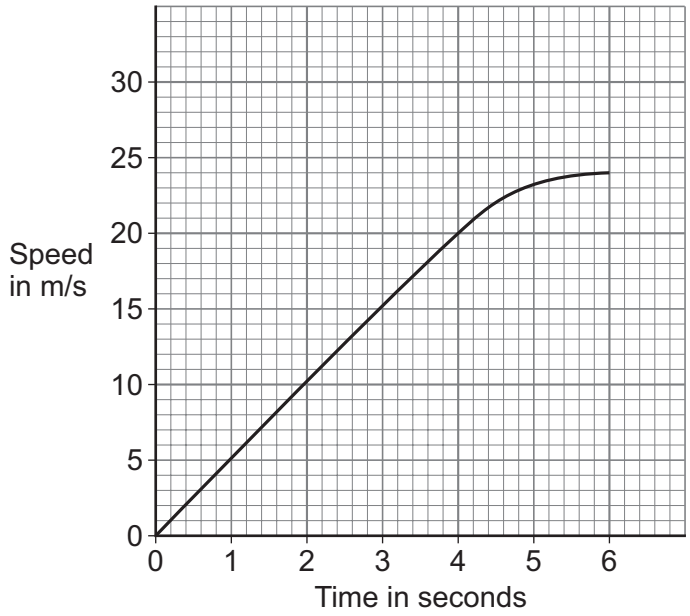
$E_k = \frac{1}{2}mv^2$ ☐

$E_k = \frac{1}{2}m^2v$ ☐

Do not write outside the box

0 9 . 2 **Figure 18** shows how the speed of the carriages changed as the carriages moved along the track from position **A** to position **B**.

Figure 18



The kinetic energy of the carriages at 6.0 seconds was 900 000 J.

Calculate the mass of the carriages.

Use **Figure 18**.

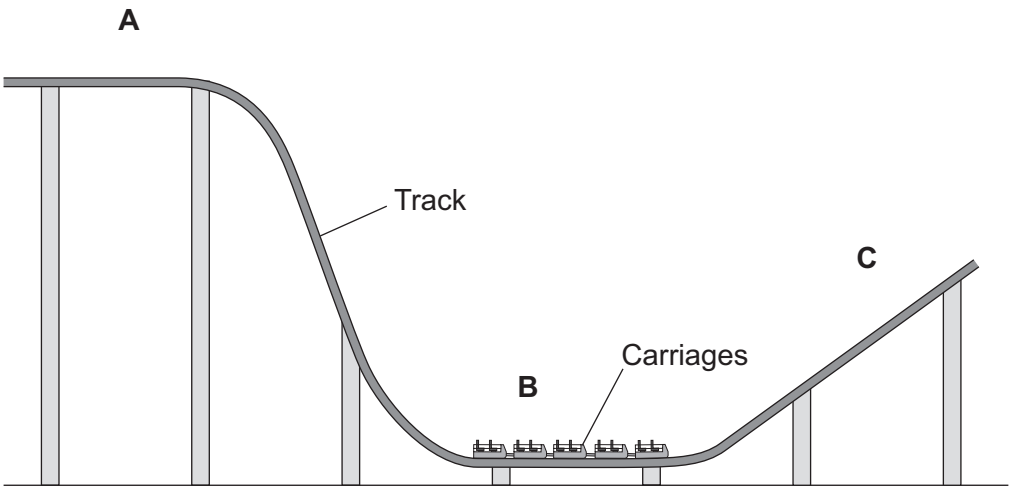
[4 marks]

Mass = _____ kg

Question 9 continues on the next page

Figure 19 shows the carriages at position **B** on the track.

Figure 19



0 9 . 3 Why does the speed of the carriages decrease as they move along the track from position **B** to position **C**?

[1 mark]

Tick (✓) **one** box.

Gravitational potential energy is transferred to kinetic energy. ☐

Kinetic energy is transferred to gravitational potential energy. ☐

Thermal energy is transferred from the surroundings to the carriages. ☐

Do not write outside the box

Brakes are used to stop the carriages at the end of the ride.

0 9 . 4 Explain why water on the brakes affects the distance the carriages travel after the brakes are applied.

[2 marks]

0 9 . 5 The brakes are made of a material with a high thermal conductivity.

Explain what is meant by 'high thermal conductivity'.

[2 marks]

10

Turn over for the next question

Do not write outside the box

1 0 Copper carbonate reacts with hydrochloric acid to produce copper chloride and two other products.

1 0 . 1 Name the **two** other products formed when copper carbonate reacts with hydrochloric acid.

Do **not** refer to copper chloride.

[2 marks]

1 _____

2 _____

1 0 . 2 Describe a method to make pure, dry crystals of copper chloride from copper carbonate and hydrochloric acid.

[6 marks]

_____

_____

_____

_____

_____

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_____

_____

_____

END OF QUESTIONS

8

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ANSWER IN THE SPACES PROVIDED

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Question number	**Additional page, if required.** **Write the question numbers in the left-hand margin.**

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