A

AQA

Surname _____

Forename(s) _____

Centre Number _____

Candidate Number _____

Candidate Signature _____

I declare this is my own work.

GCSE
COMBINED SCIENCE: SYNERGY

F

Foundation Tier Paper 3 Physical Sciences

8465/3F

Friday 9 June 2023 Afternoon

Time allowed: 1 hour 45 minutes

At the top of the page, write your surname and forename(s), your centre number, your candidate number and add your signature.

[Turn over]

JUN238465 3F 01

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.**
- **Answer ALL questions in the spaces provided. Do not write 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.**

DO NOT TURN OVER UNTIL TOLD TO DO SO

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]

_____

_____

0 1 . 4

Which ion do all acids produce in aqueous solution? [1 mark]

Tick (✓) ONE box.

☐ H^+ ☐ OH^- ☐ O^{2-}

[Turn over]

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**

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

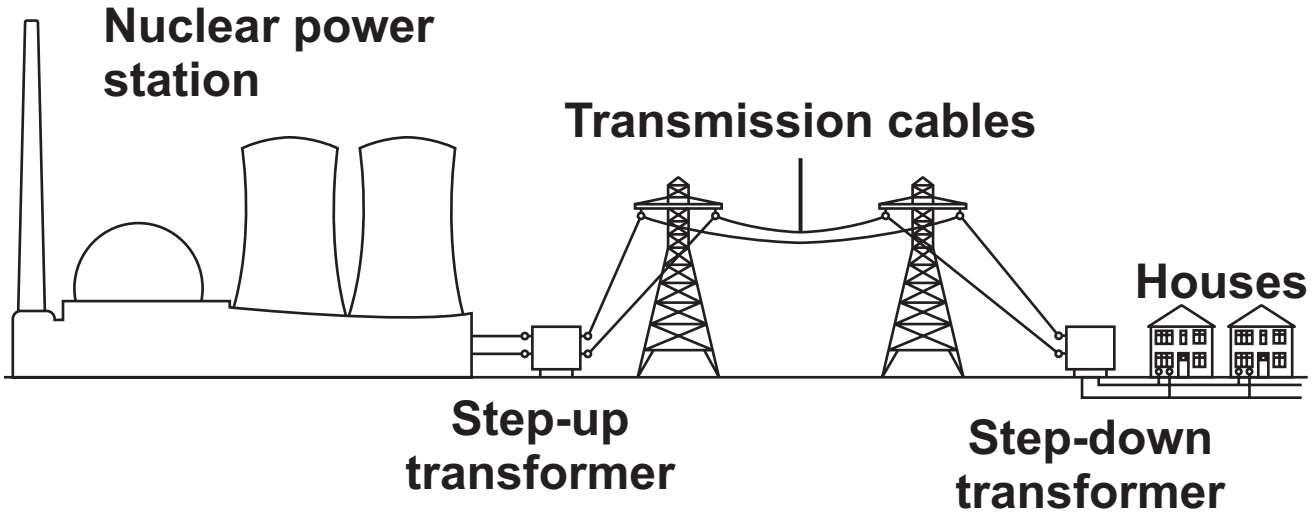
8

[Turn over]

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.**

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.**

[Turn over]

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.**

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

[Turn over]

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

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[Turn over]

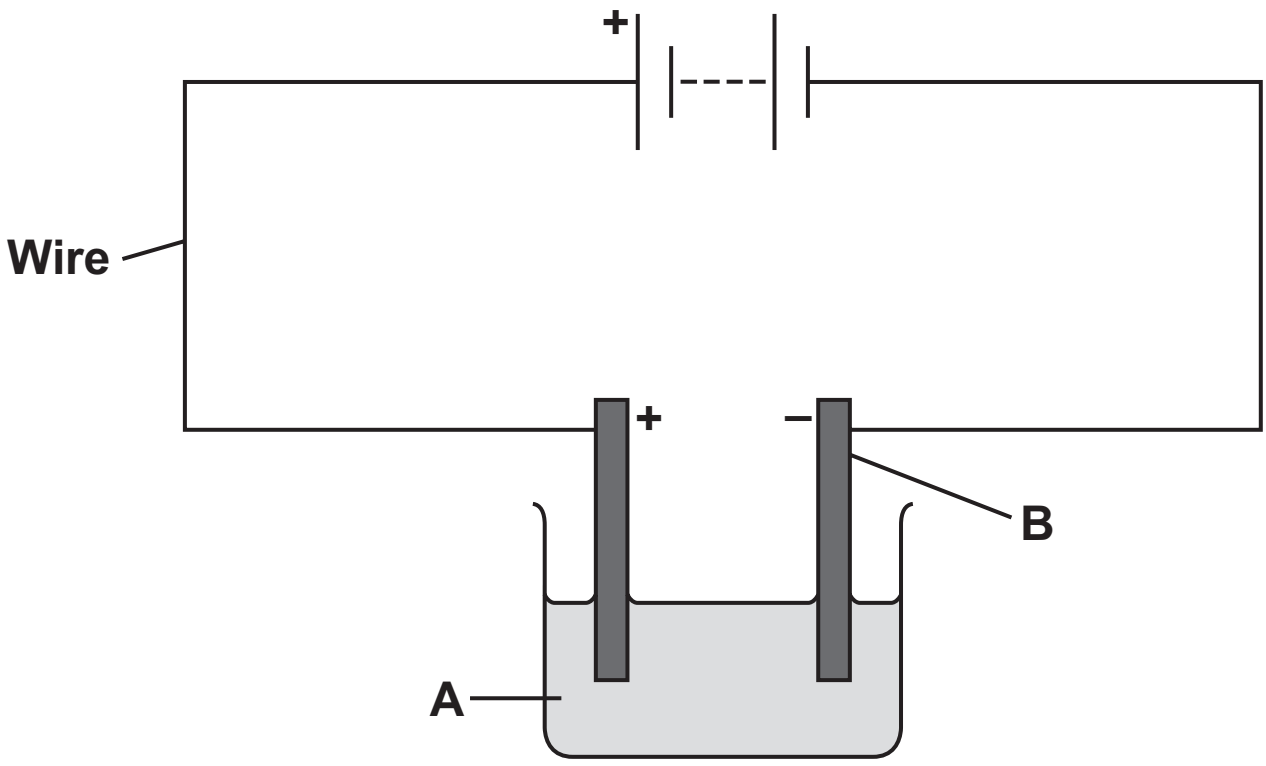
0 3

This question is about the electrolysis of copper sulfate solution.

A student investigated the electrolysis of copper sulfate solution.

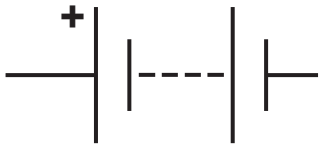
FIGURE 2 shows the apparatus.

FIGURE 2



0 3 . 1

What is the name of the component represented by the circuit symbol below? [1 mark]



_____

_____

0 3 . 2

Identify A and B in FIGURE 2, on the opposite page. [2 marks]

A _____

_____

B _____

_____

[Turn over]

0 3 . 3

Which particles in the copper sulfate solution carry the charge during electrolysis? [1 mark]

Tick (✓) ONE box.

☐ **Atoms**

☐ **Ions**

☐ **Molecules**

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, on the opposite page. [2 marks]

_____

_____

_____

Mass = _____ g

[Turn over]

0 3 . 5

Calculate the mean mass of copper deposited in 20 minutes.

Use TABLE 2, on page 16. [2 marks]

_____

_____

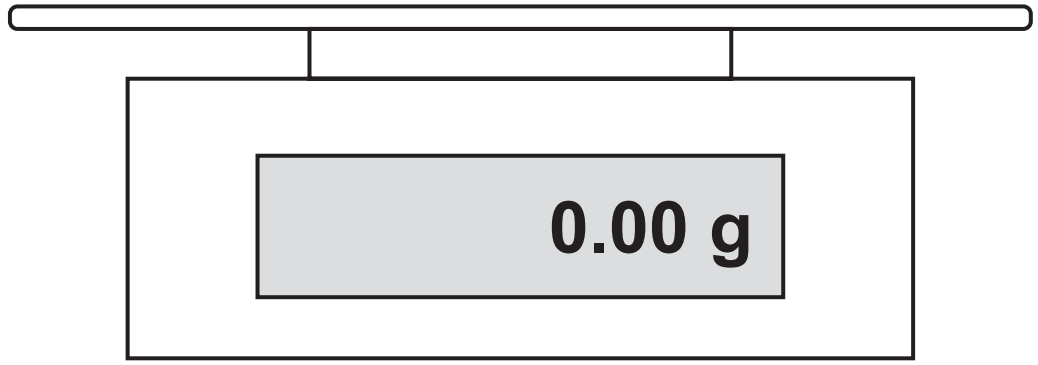
_____

Mean mass = _____ g

0 3 . 6

FIGURE 3 shows the balance used to make the measurements in TABLE 2, on page 16.

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]

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.

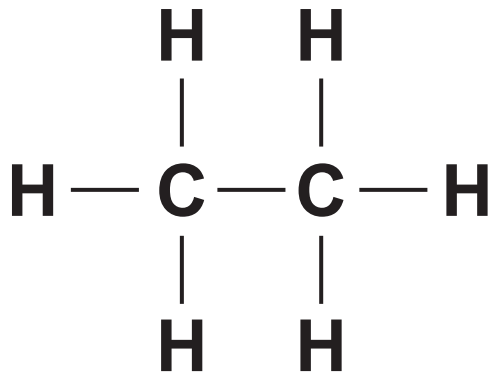
☐ C_6 ☐ C_{12} ☐ C_{60} ☐ C_{72}

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

0 4 . 5

FIGURE 5 represents a bond between a carbon atom and a hydrogen atom in ethane.

FIGURE 5

C — H

Which TWO words describe the C–H bond in ethane?
[2 marks]

Tick (✓) TWO boxes.

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

[Turn over]

Crude oil is a mixture of compounds.

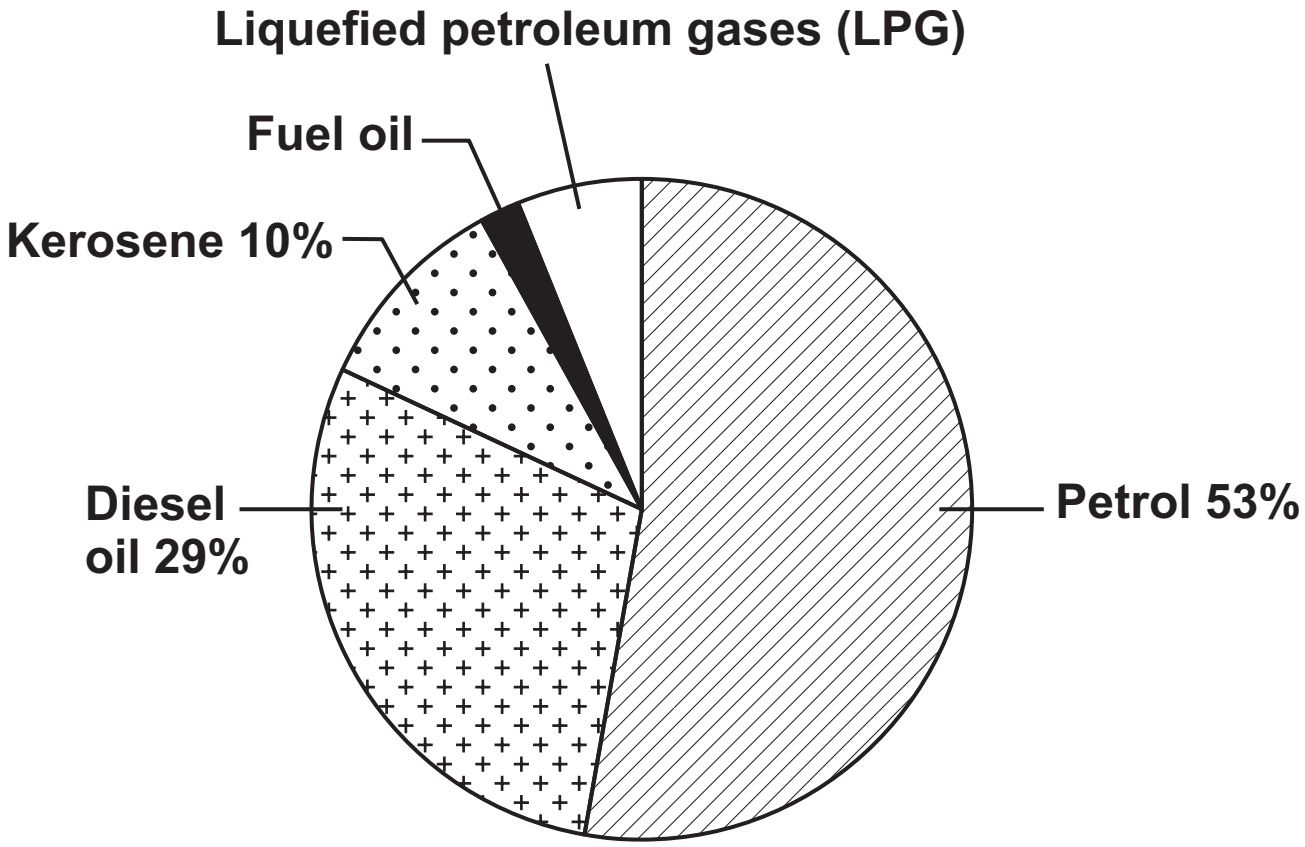
Most of the compounds in crude oil are hydrocarbons.

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



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 = _____ %

[Turn over]

Calculate the percentage of LPG AND the percentage of fuel oil.

Use the ratio:

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

_____

_____

_____

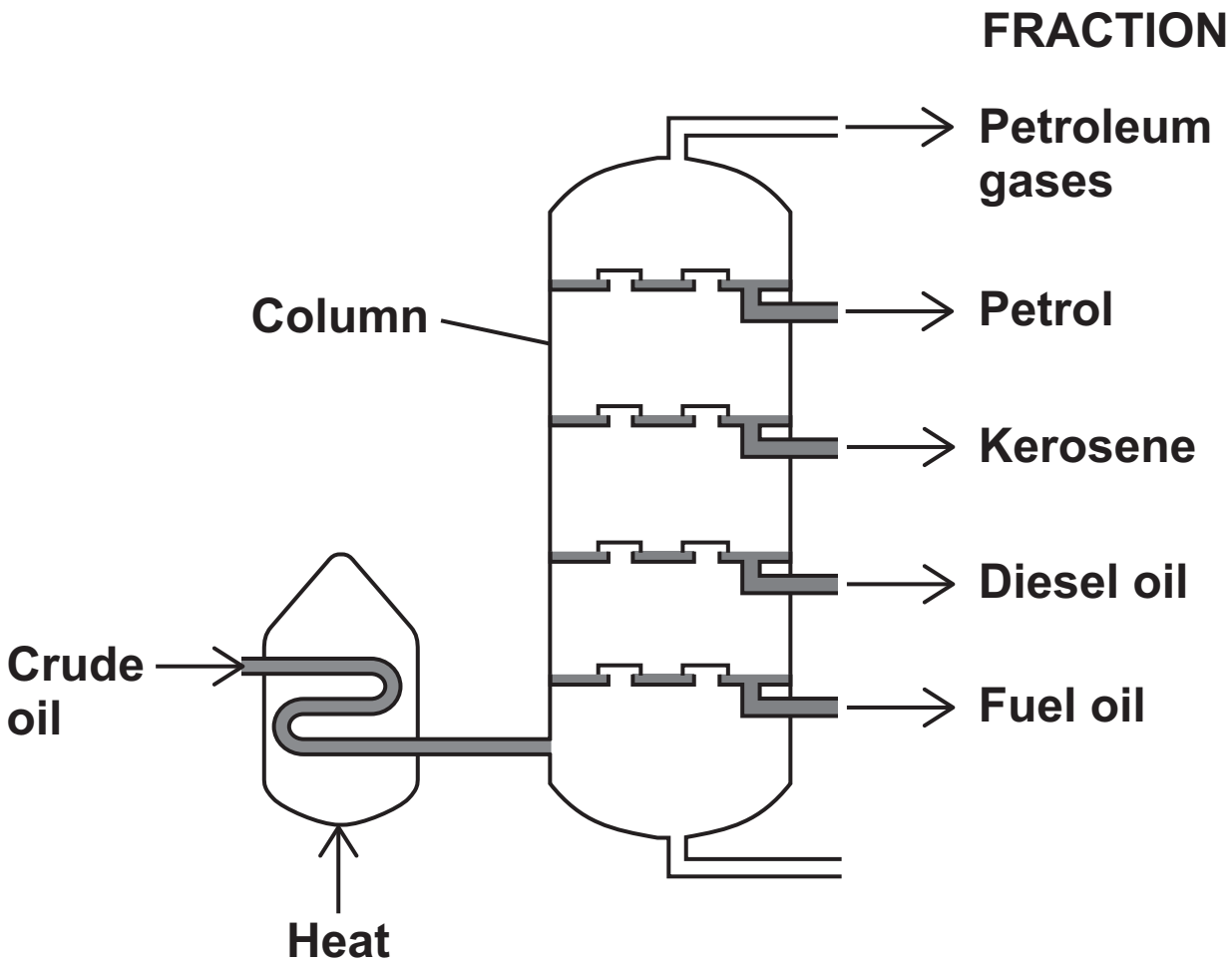
Percentage of LPG = _____ %

Percentage of fuel oil = _____ %

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

FIGURE 7 shows a fractional distillation column.

FIGURE 7



[Turn over]

0 4 . 7

Complete the sentences.

Choose answers from the list below. [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 _____ .

0 4 . 8

Complete the sentence.

Choose the answer from the list below. [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**

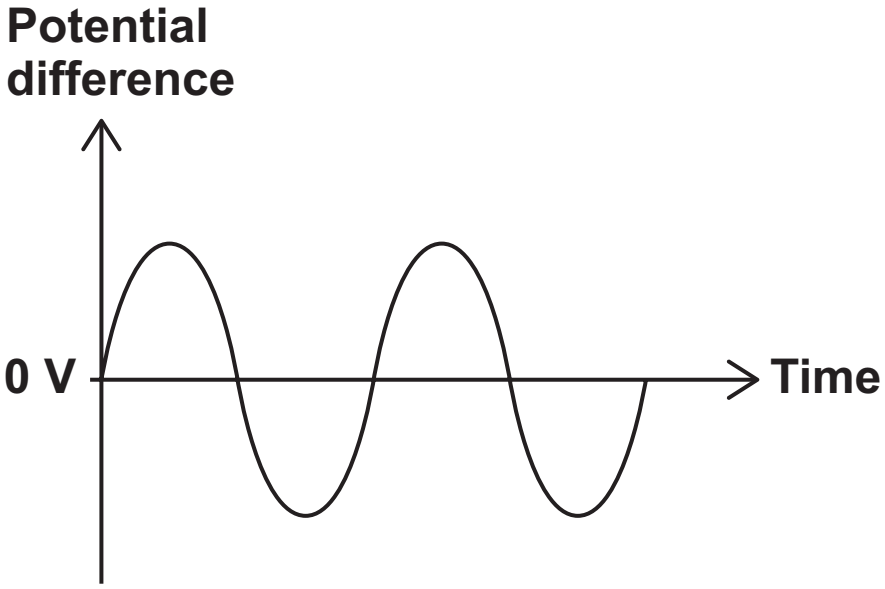
☐ **Polymerisation**

13

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**

[Turn over]

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

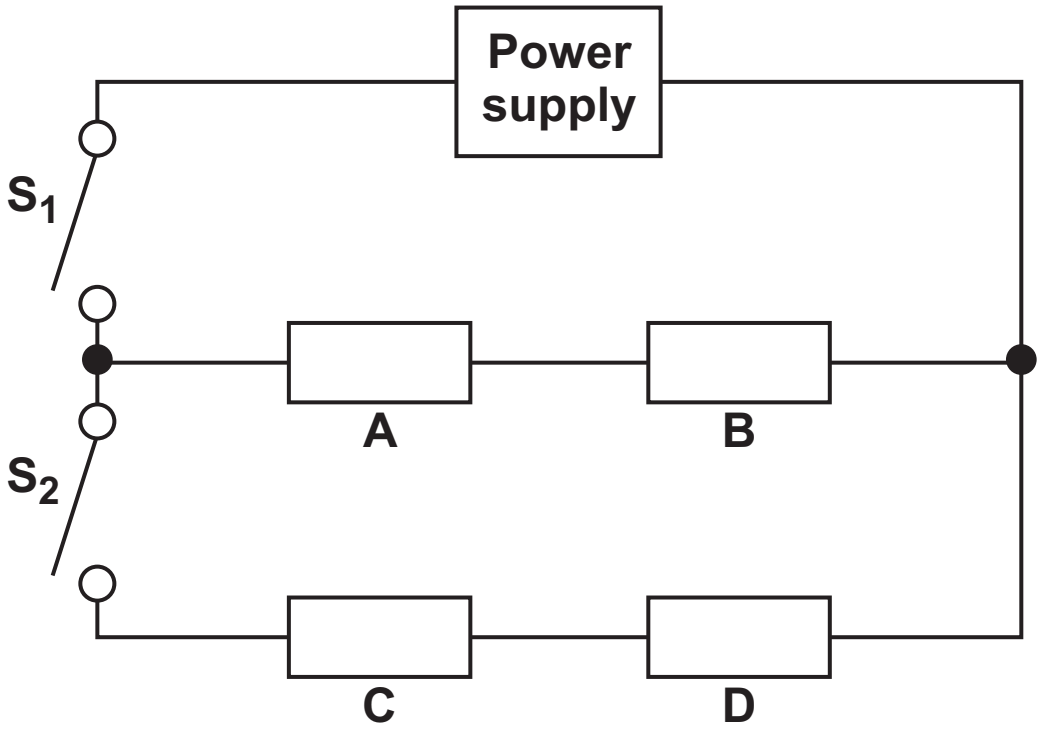
Draw ONE line from the name of each wire to the function of each wire in the cable. [2 marks]

WIRE	FUNCTION
Earth	Carries the alternating potential difference
Live	Completes the circuit
Neutral	Safety wire

[Turn over]

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		

[Turn over]

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]

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+}

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

[Turn over]

0 6 . 4

Complete the sentence.

Use TABLE 4, on page 39. [1 mark]

As the mass of calcium reacted increases, the mass of calcium chloride produced _____ .

0 6 . 5

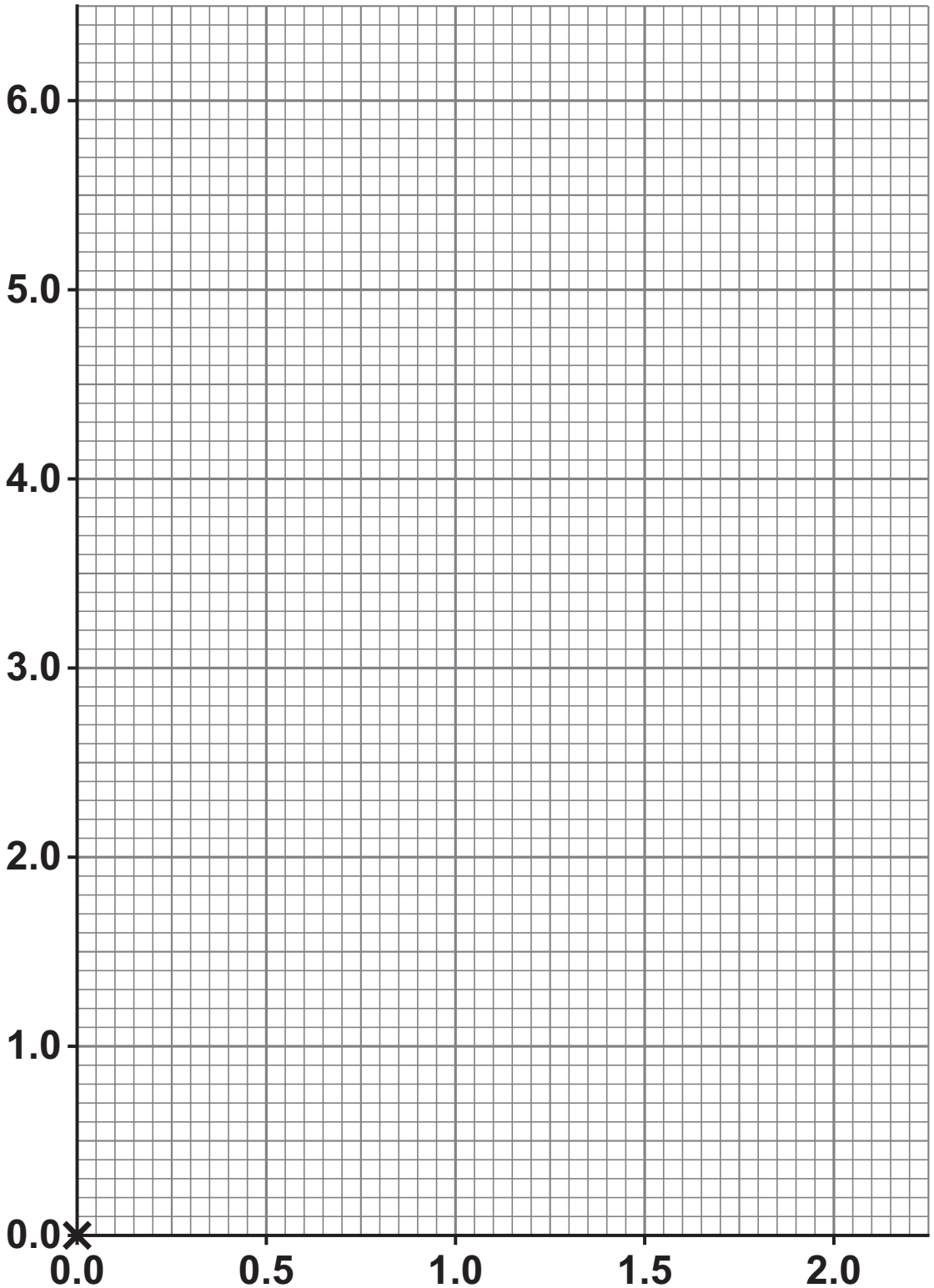
Complete FIGURE 11, on the opposite page.

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]

FIGURE 11


6.0
5.0
4.0
3.0
2.0
1.0
0.0
0.0
0.5
1.0
1.5
2.0
Mass of calcium reacted in grams

0 6 . 6

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

Use FIGURE 11, on page 41. [1 mark]

Mass of calcium chloride = _____ g

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

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[Turn over]

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:

power = (current)^2 × 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:

distance travelled = speed × time [2 marks]

_____

_____

_____

Distance travelled = _____ m

[Turn over]

The car travelled from town P to town Q.

FIGURE 13 shows the route taken by the car.

FIGURE 13

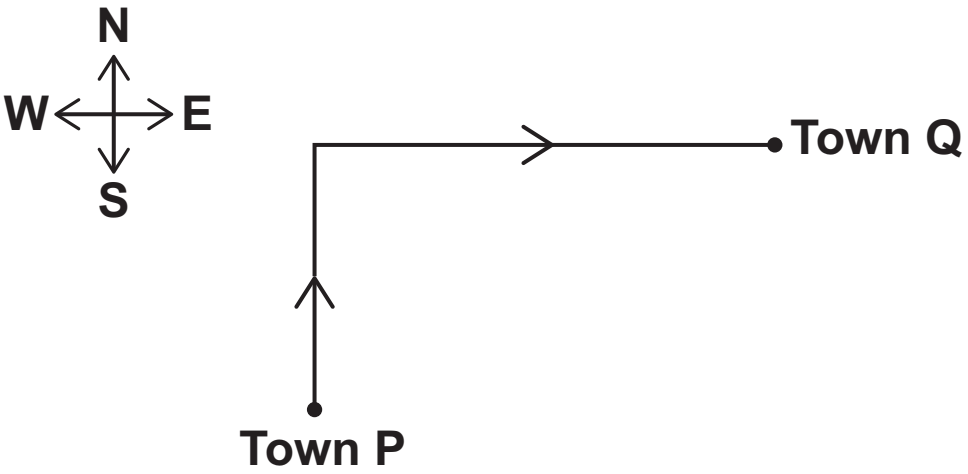


FIGURE 13 is drawn to a scale of 1 cm = 5 km.

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.

☐ **30°** ☐ **60°** ☐ **90°**

[Turn over]

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 (Δ*v*) 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

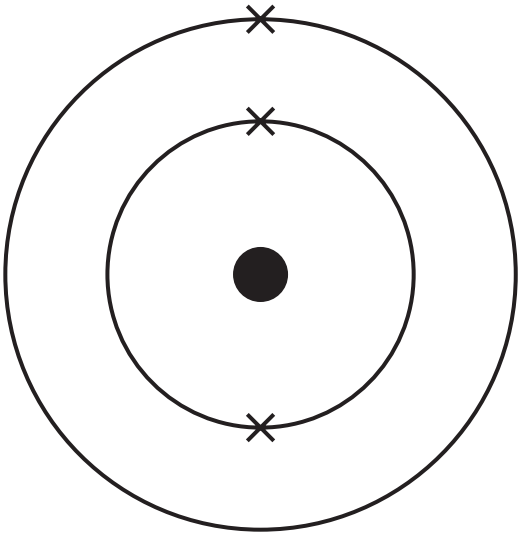
[Turn over]

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, on the opposite page, 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]

_____

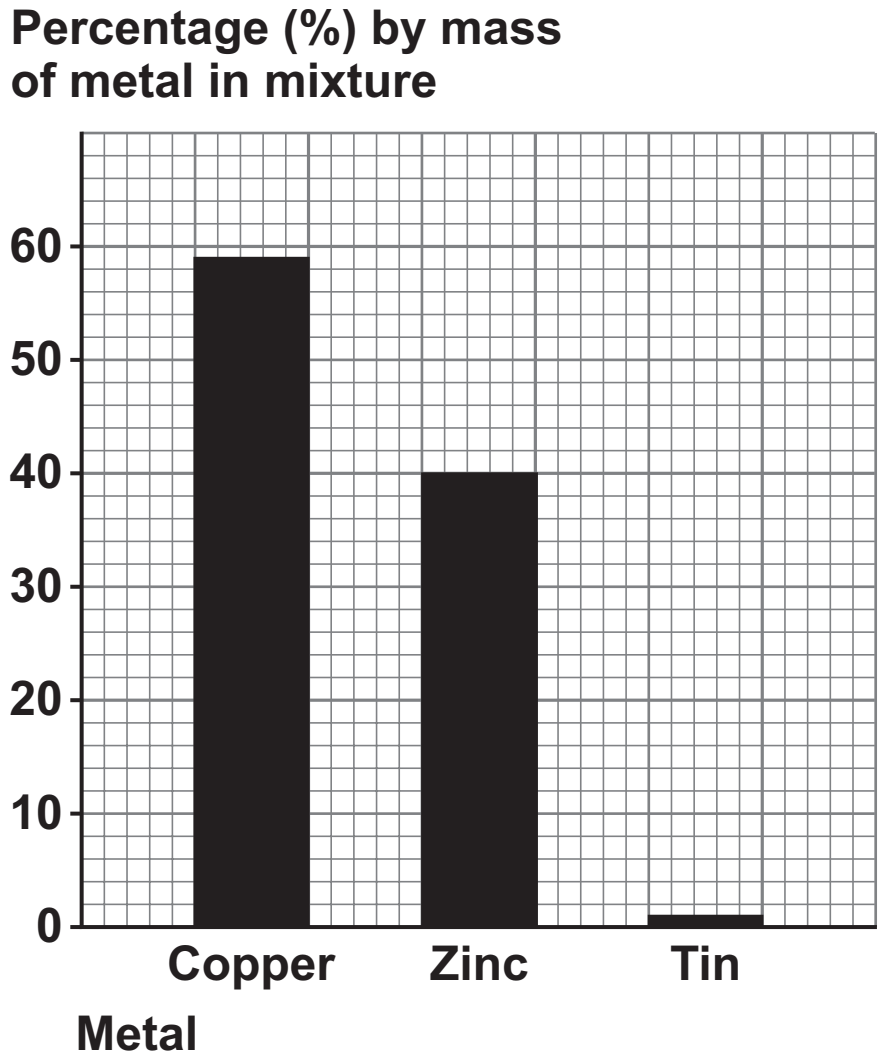
_____

[Turn over]

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]

_____

_____

_____

_____

_____

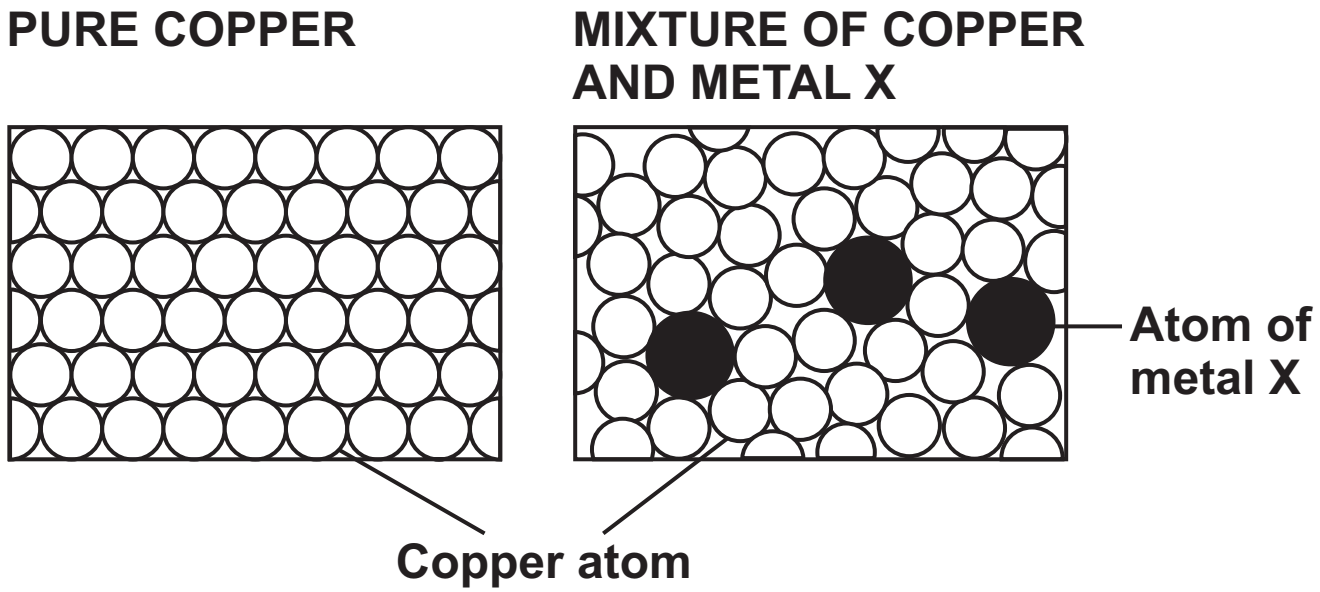
_____

Mass of copper = _____ g

[Turn over]

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]

_____

_____

_____

_____

_____

_____

_____

_____

_____

[Turn over]

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

BLANK PAGE

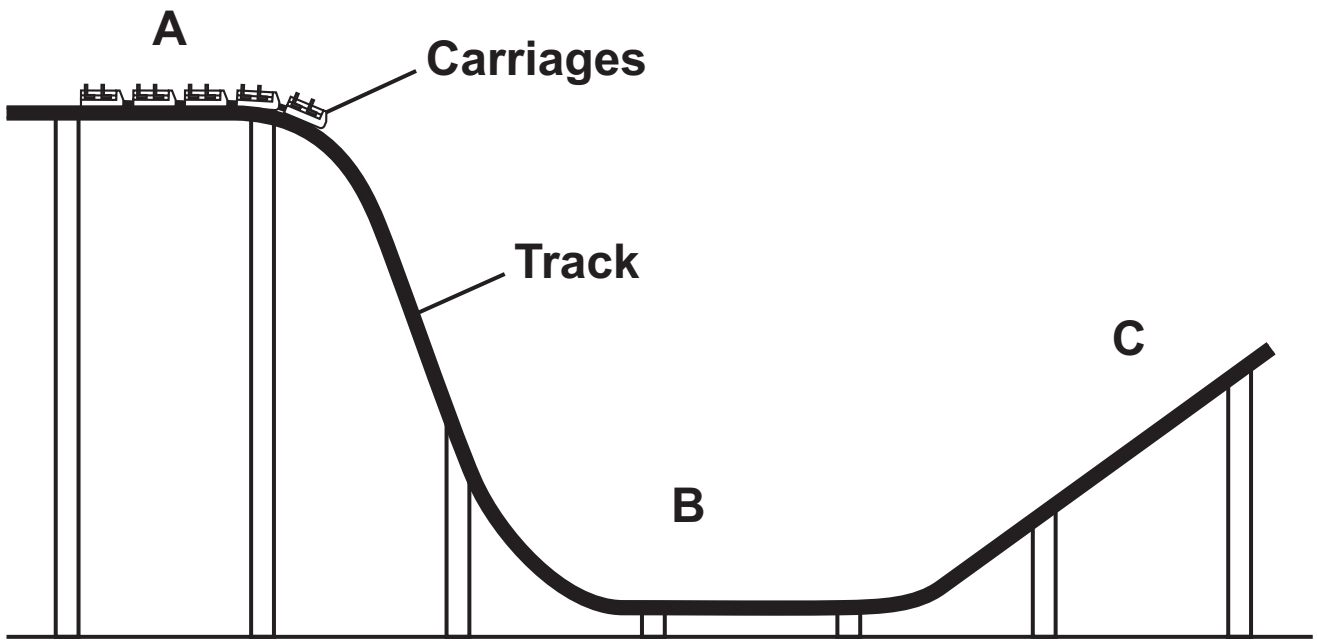
[Turn over]

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.

☐ $E_k = mv^2$

☐ $E_k = \frac{1}{2}mv$

☐ $E_k = \frac{1}{2}mv^2$

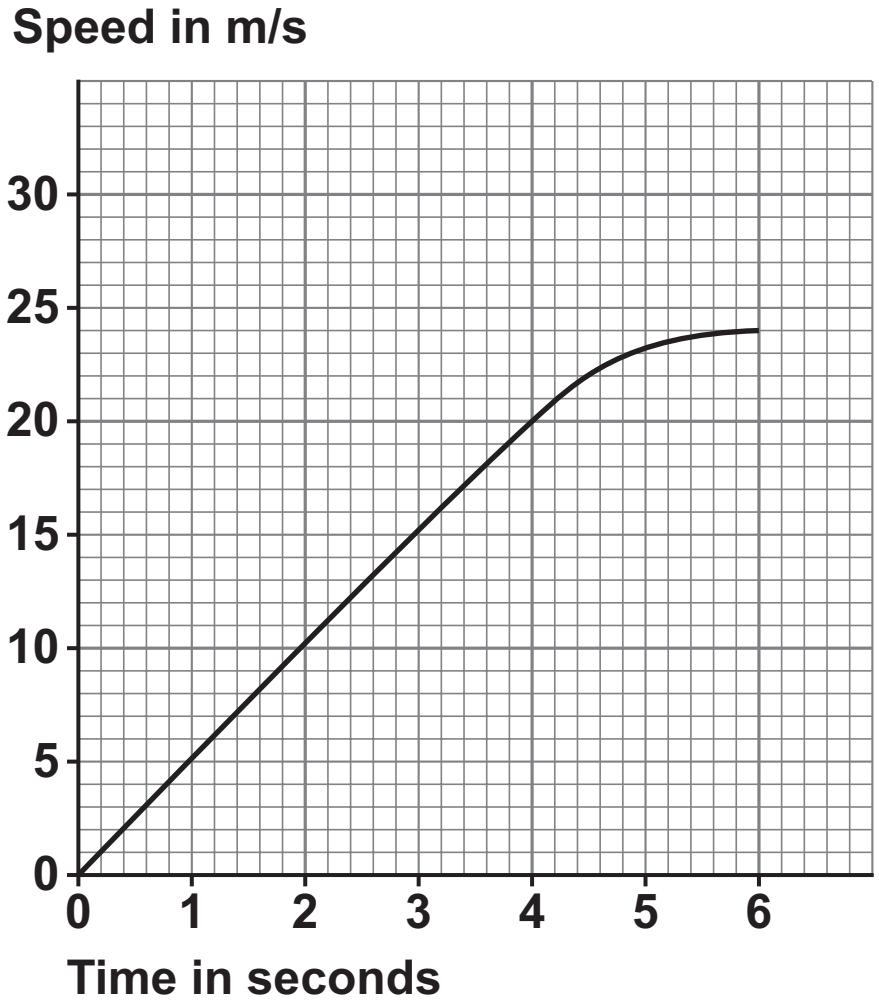
☐ $E_k = \frac{1}{2}m^2v$

[Turn over]

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, on the opposite page. [4 marks]

_____

_____

_____

_____

_____

_____

_____

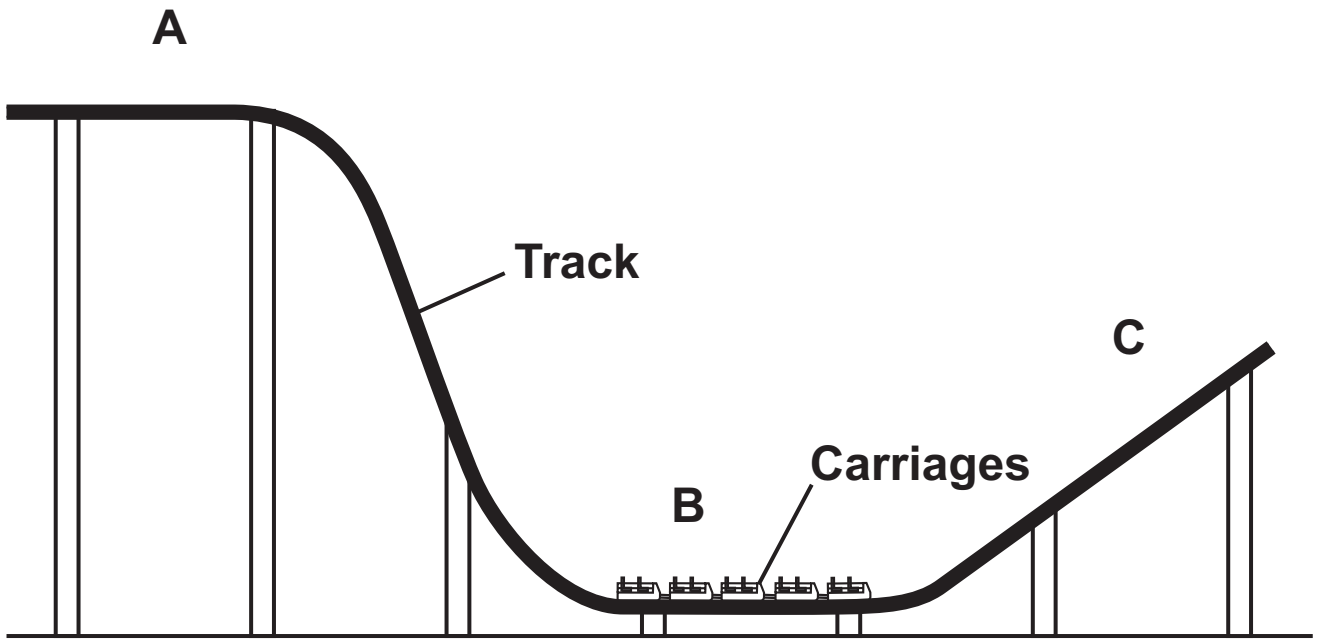
_____

Mass = _____ kg

[Turn over]

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.**

[Turn over]

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]

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]

_____

_____

_____

_____

8

END OF QUESTIONS

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