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]**

JUN2384653F01

**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 = _____ $g/dm^3$**

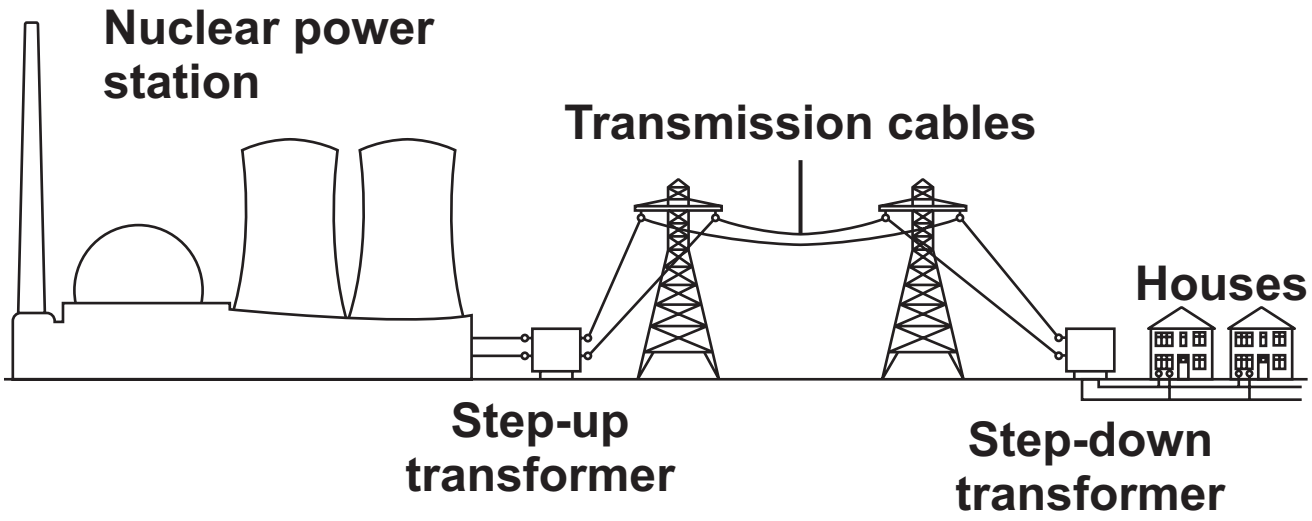
8

**[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

**BLANK PAGE**

**[Turn over]**

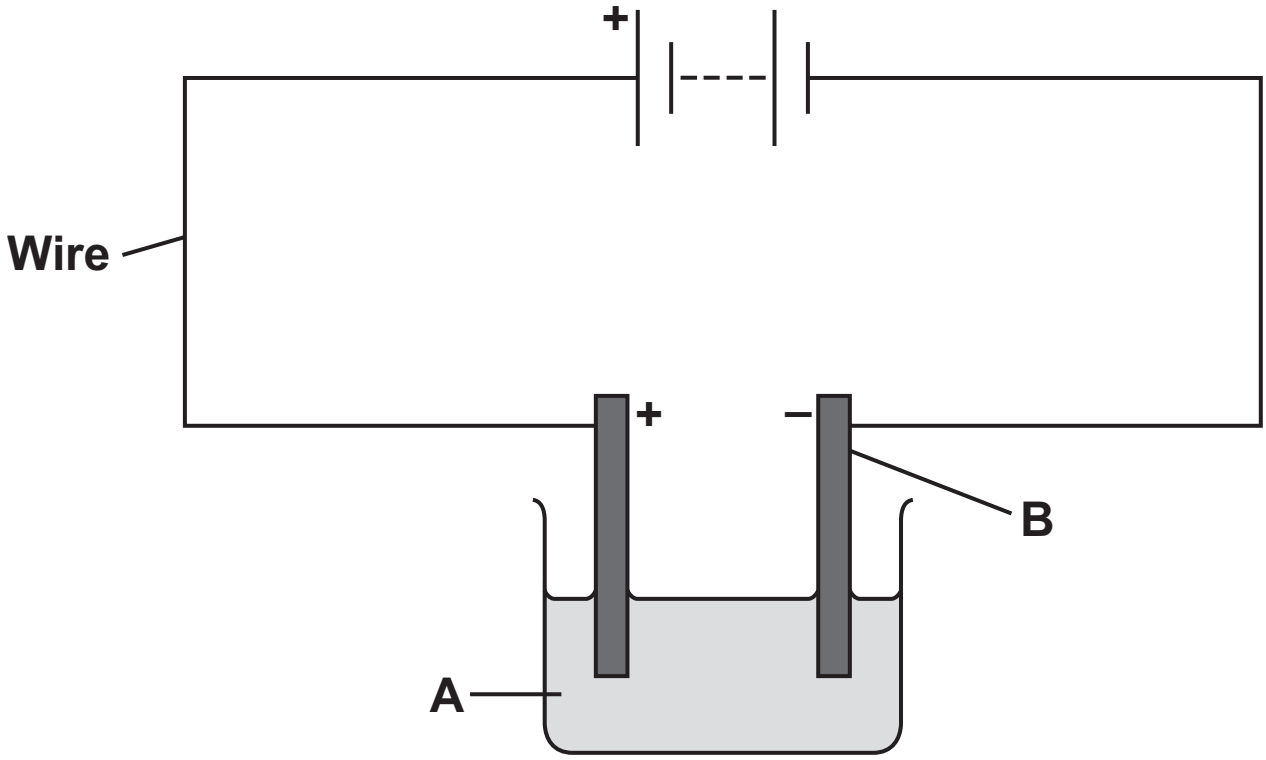
**0 3**

**This question is about the electrolysis of copper sulfate solution.**

**A student investigated the electrolysis of copper sulfate solution.**

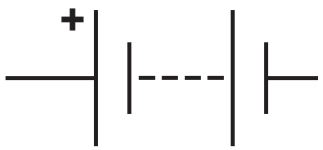
**FIGURE 2 shows the apparatus.**

**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]**

_____

_____

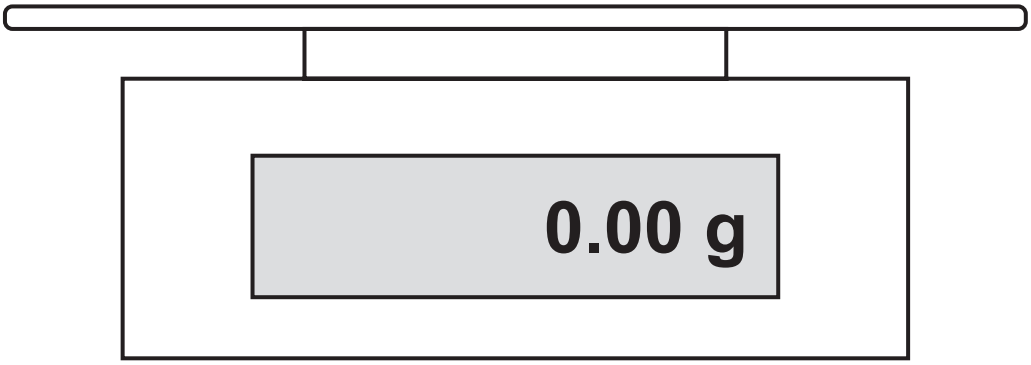
_____

**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.**

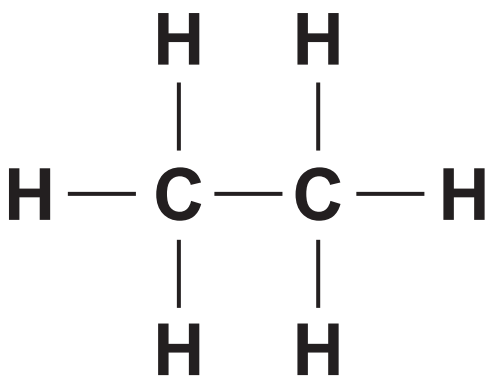
☐ $C_6$ ☐ $C_{12}$ ☐ $C_{60}$ ☐ $C_{72}$

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

**Ethane is a hydrocarbon.**

**FIGURE 4 represents an ethane molecule.**

**FIGURE 4**




**[Turn over]**

**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.**

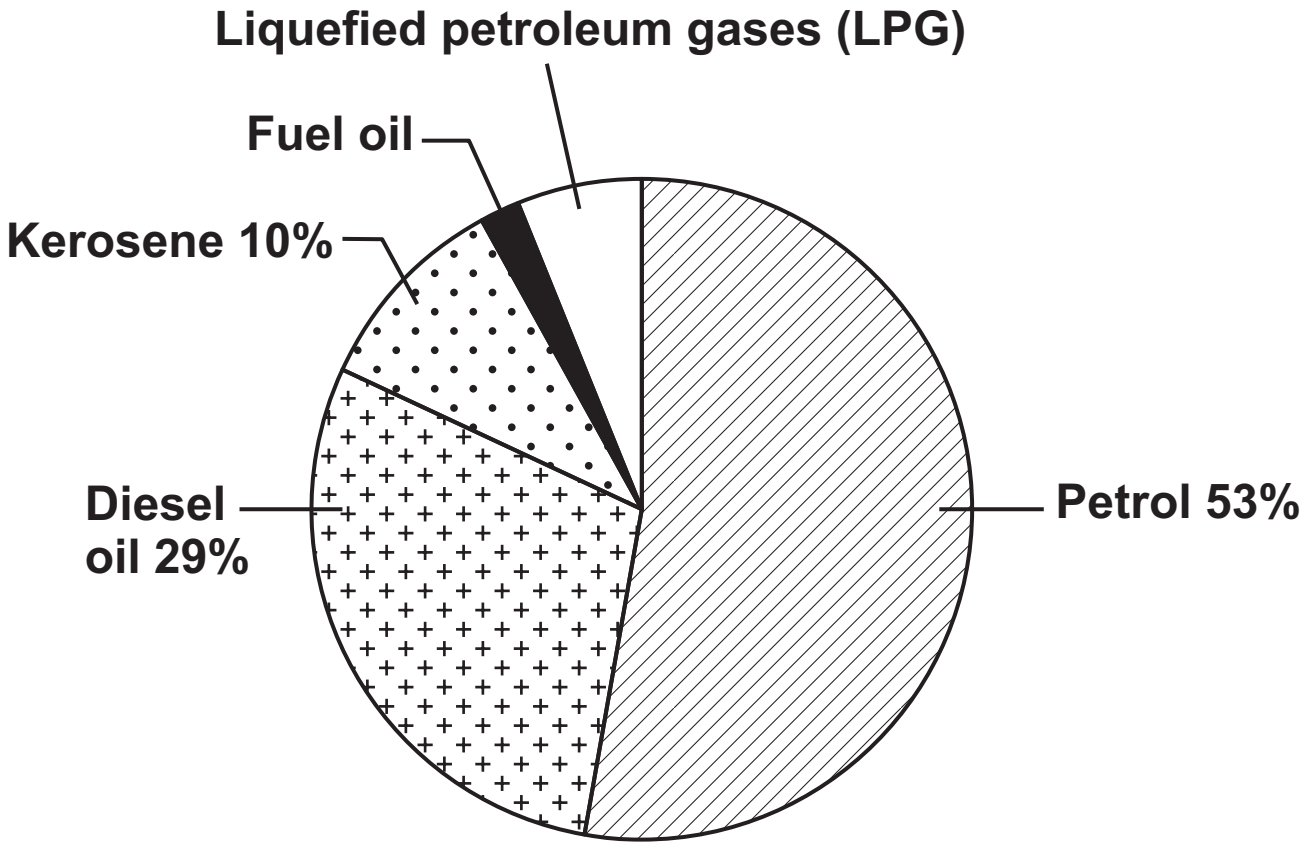
**Most of the compounds in crude oil are hydrocarbons.**

**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**

_____

_____

_____

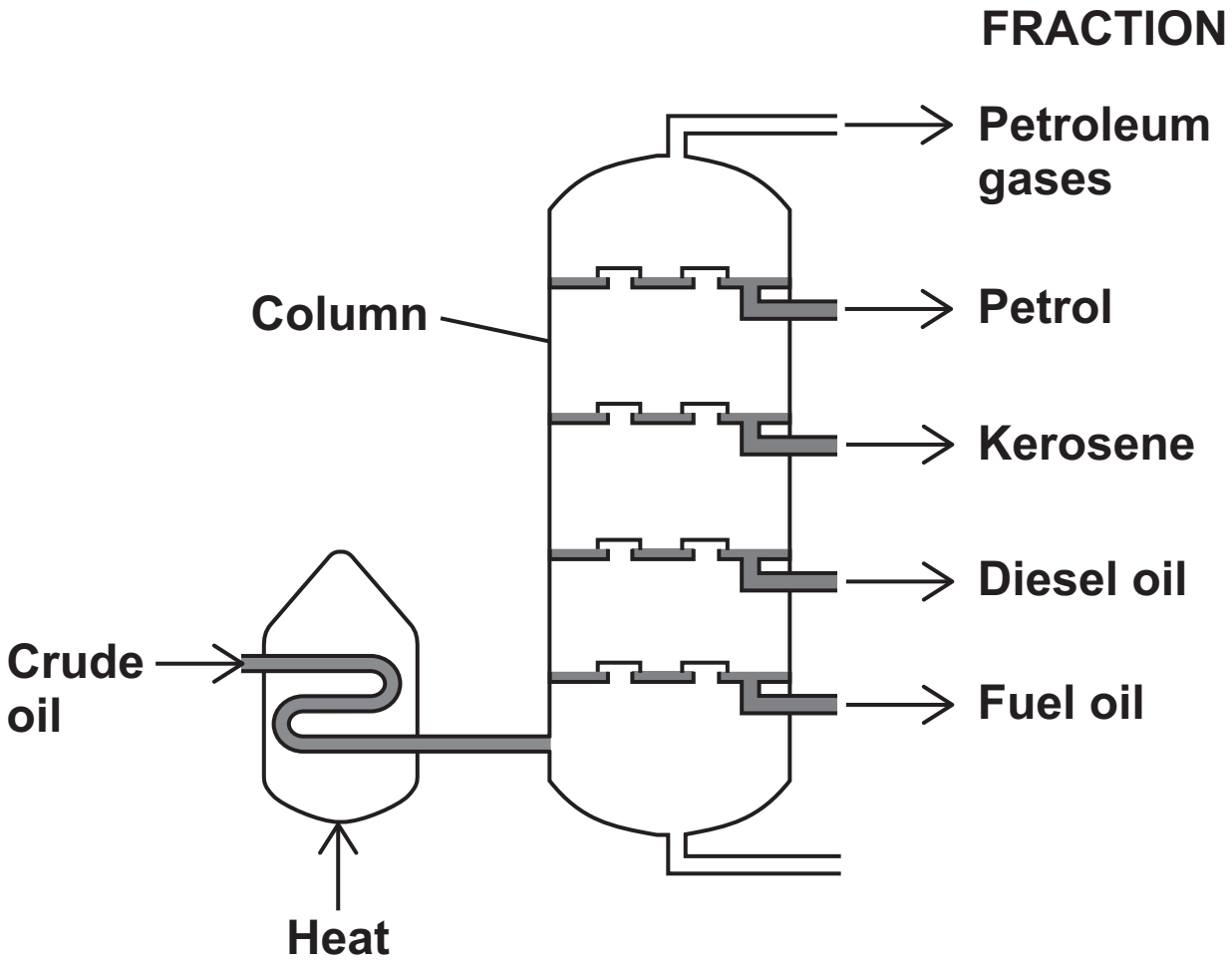
**Percentage of LPG = _____ %**

**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**

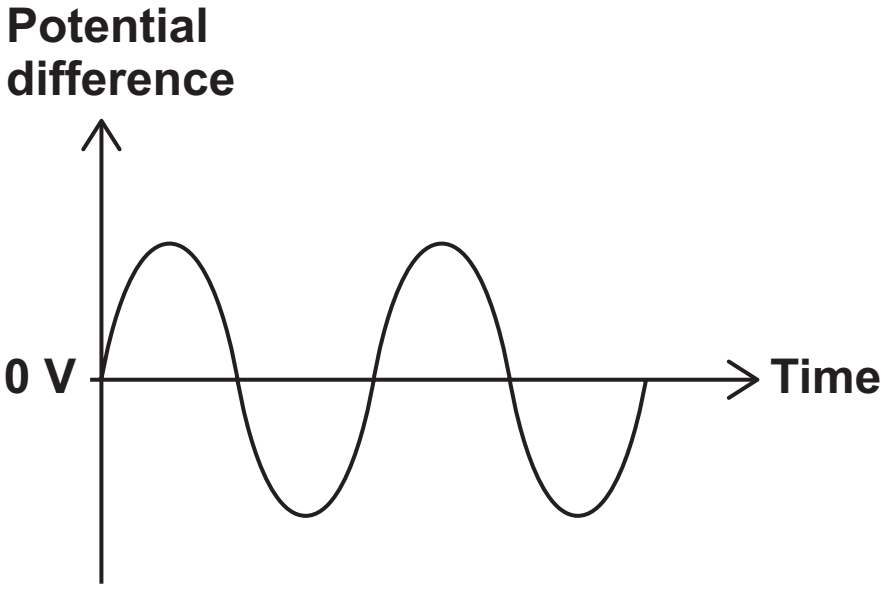
☐ **Polymerisation**

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**

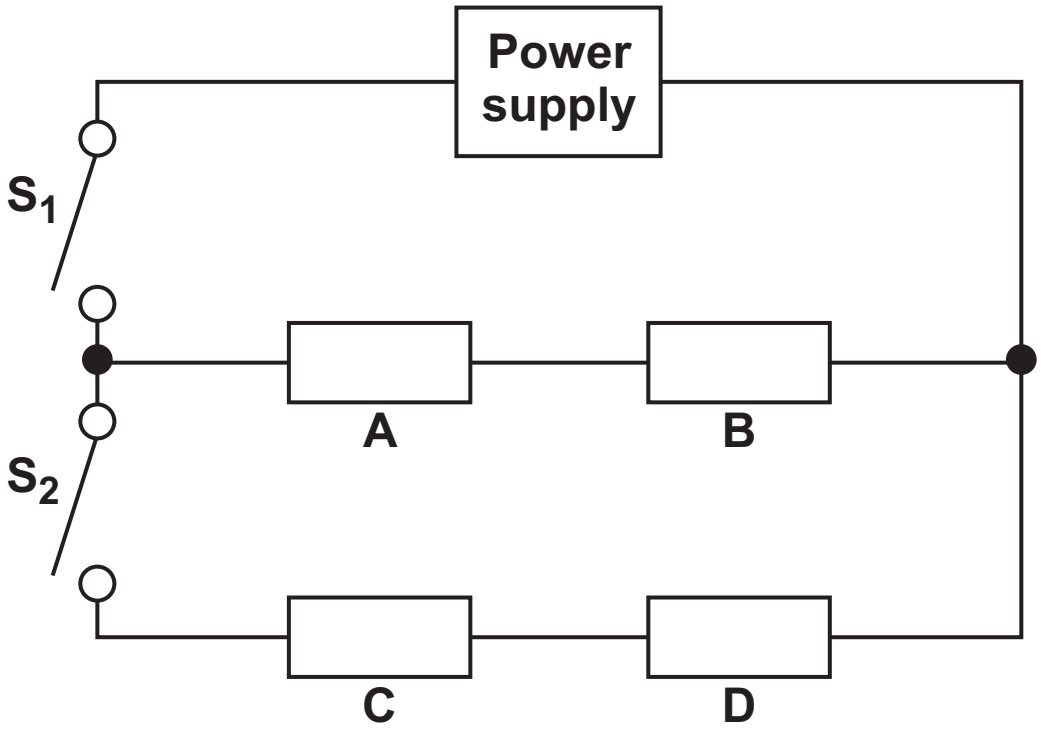
**Draw ONE line from the name of each wire to the function of each wire in the cable. [2 marks]**

| 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**

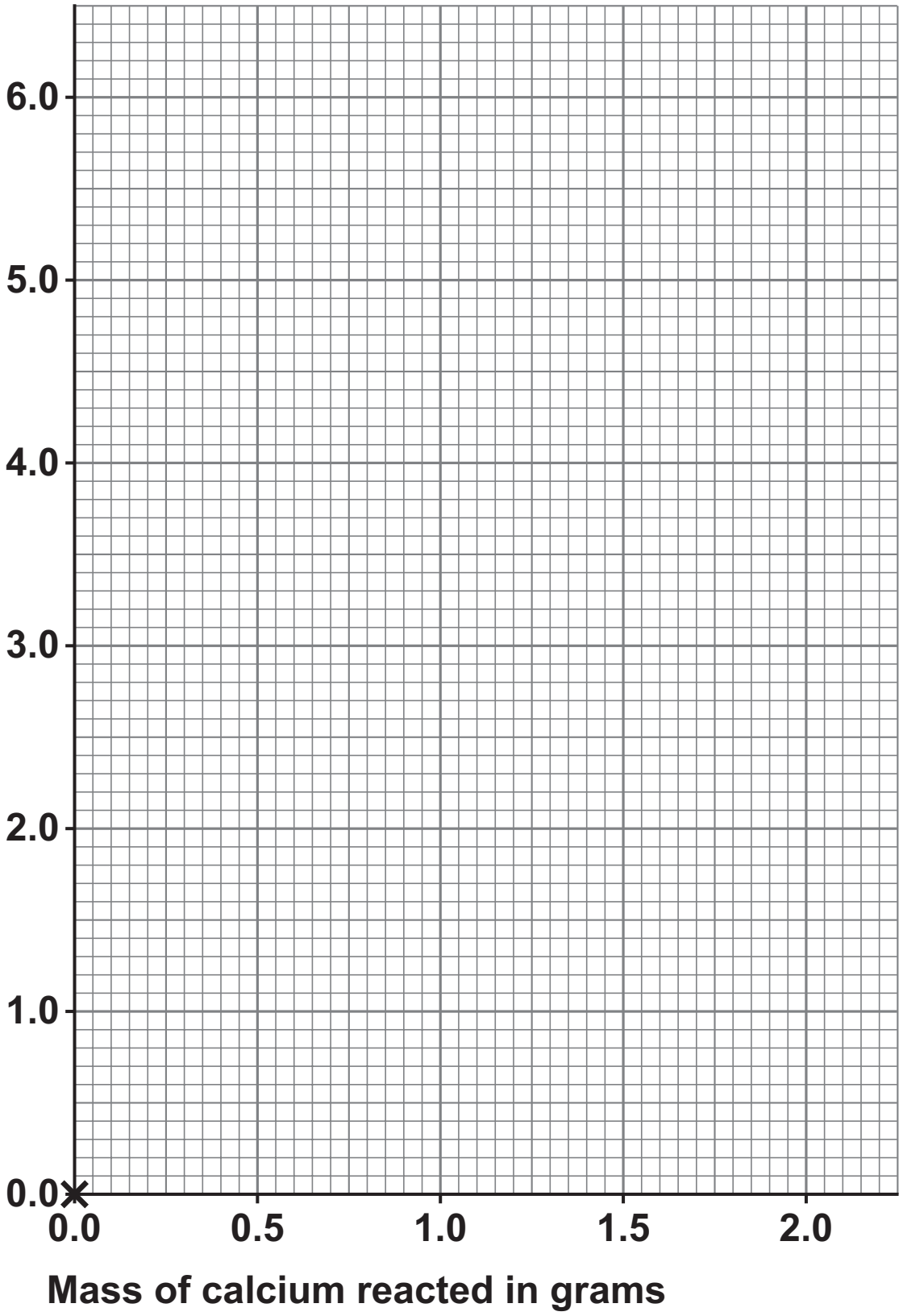
**Complete FIGURE 11, on the opposite page.**

**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

**BLANK PAGE**

**[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**

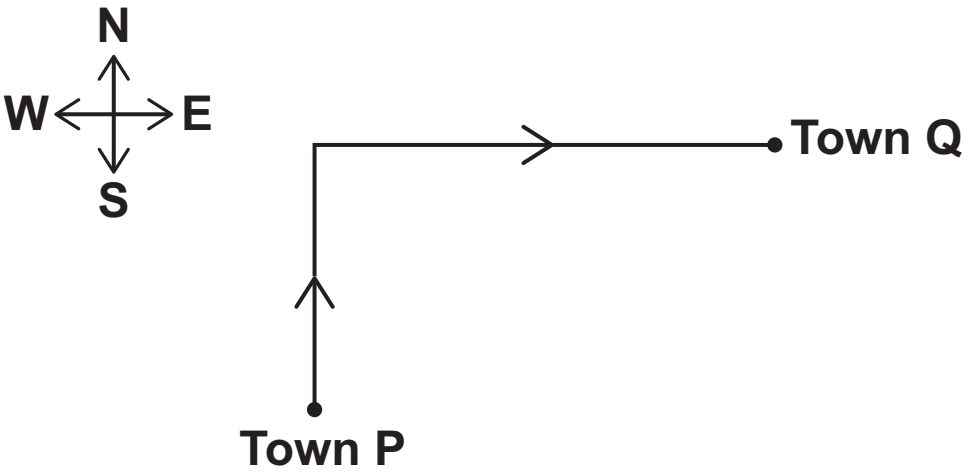



**FIGURE 13 is drawn to a scale of 1 cm = 5 km.**

**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.**

☐ **30º** ☐ **60º** ☐ **90º**

**[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**

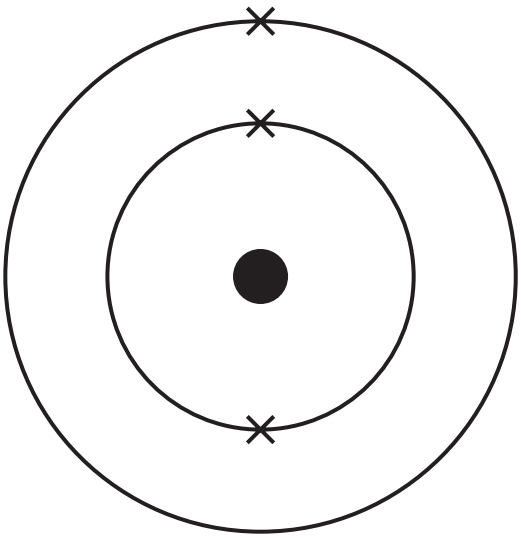
**[Turn over]**

**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**

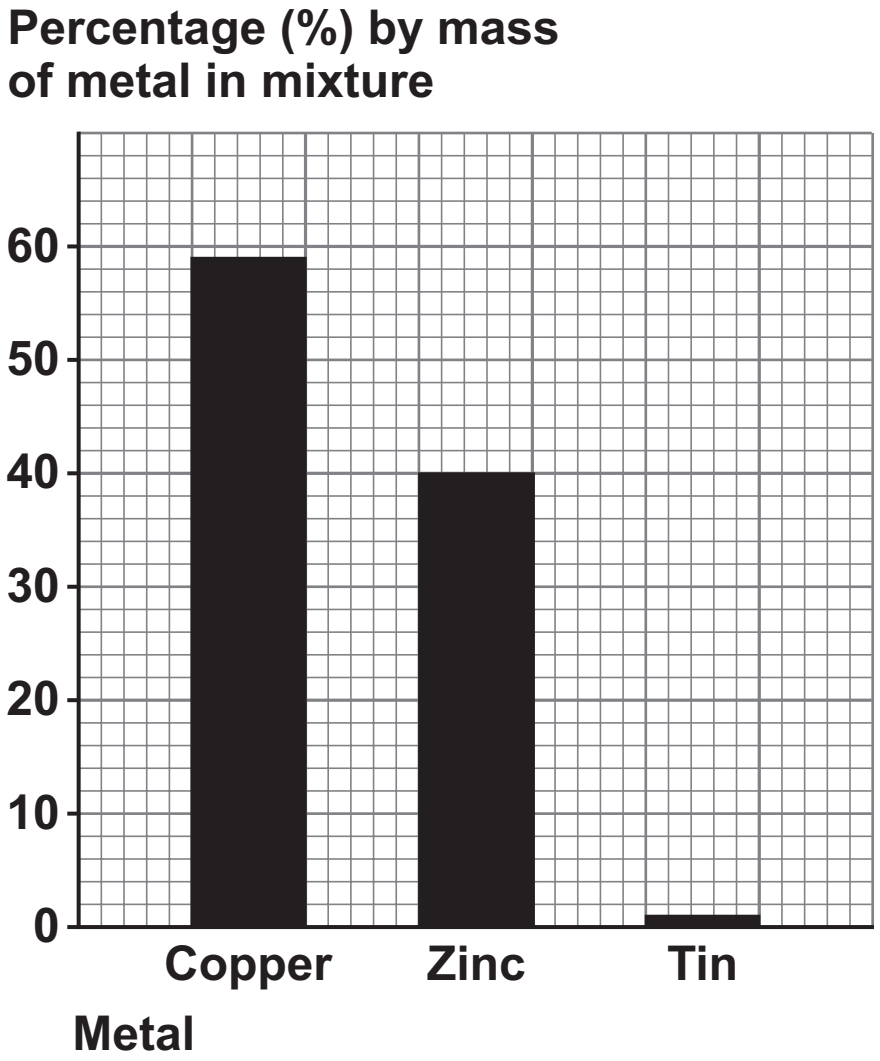
**Name the type of mixture formed when copper is mixed with other metals. [1 mark]**

**[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]**

_____

_____

_____

_____

_____

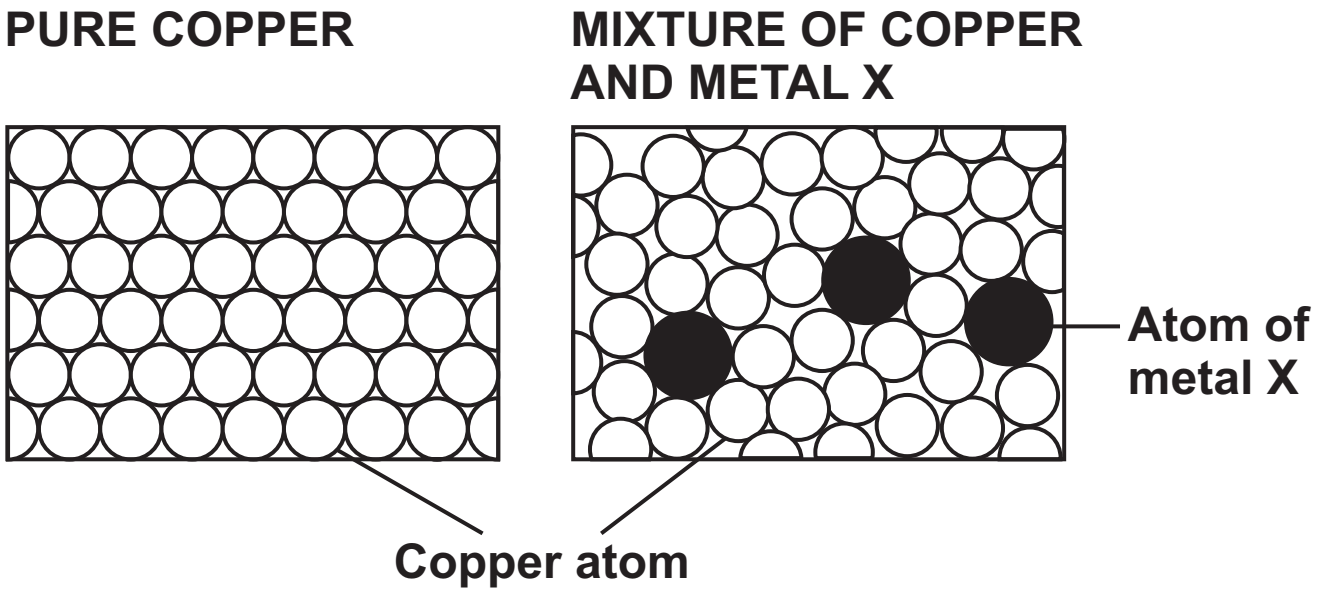
_____

**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**

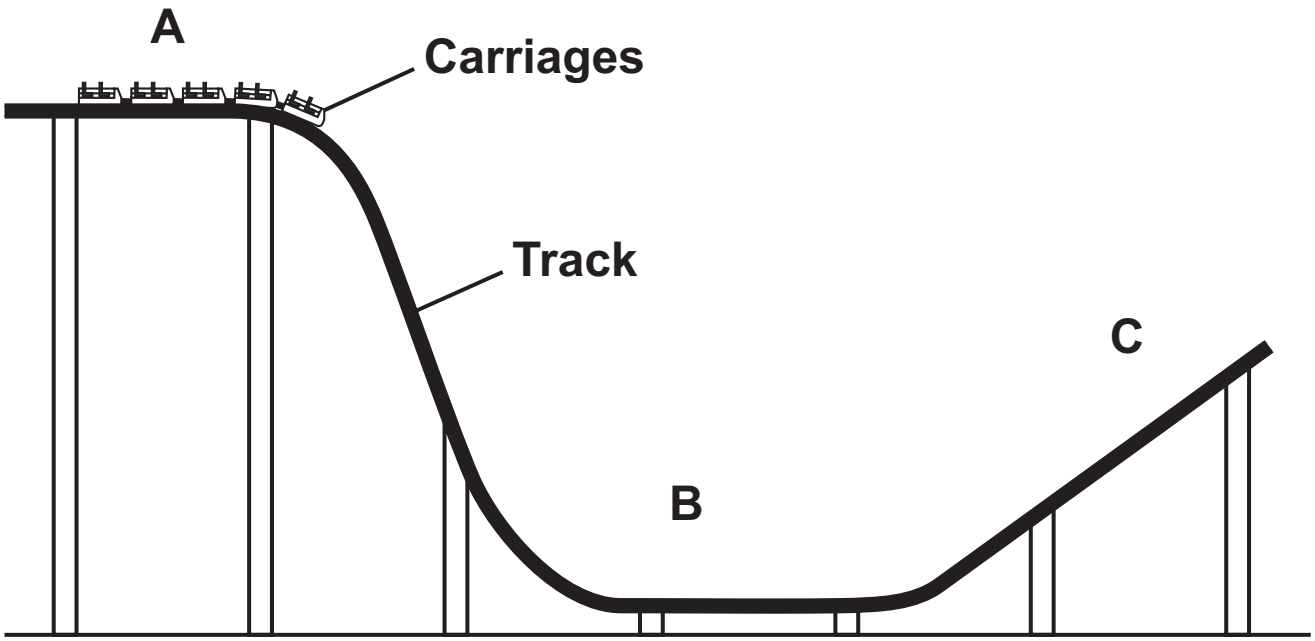
**[Turn over]**

**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.**

☐ $E_k = mv^2$

☐ $E_k = \frac{1}{2}mv$

☐ $E_k = \frac{1}{2}mv^2$

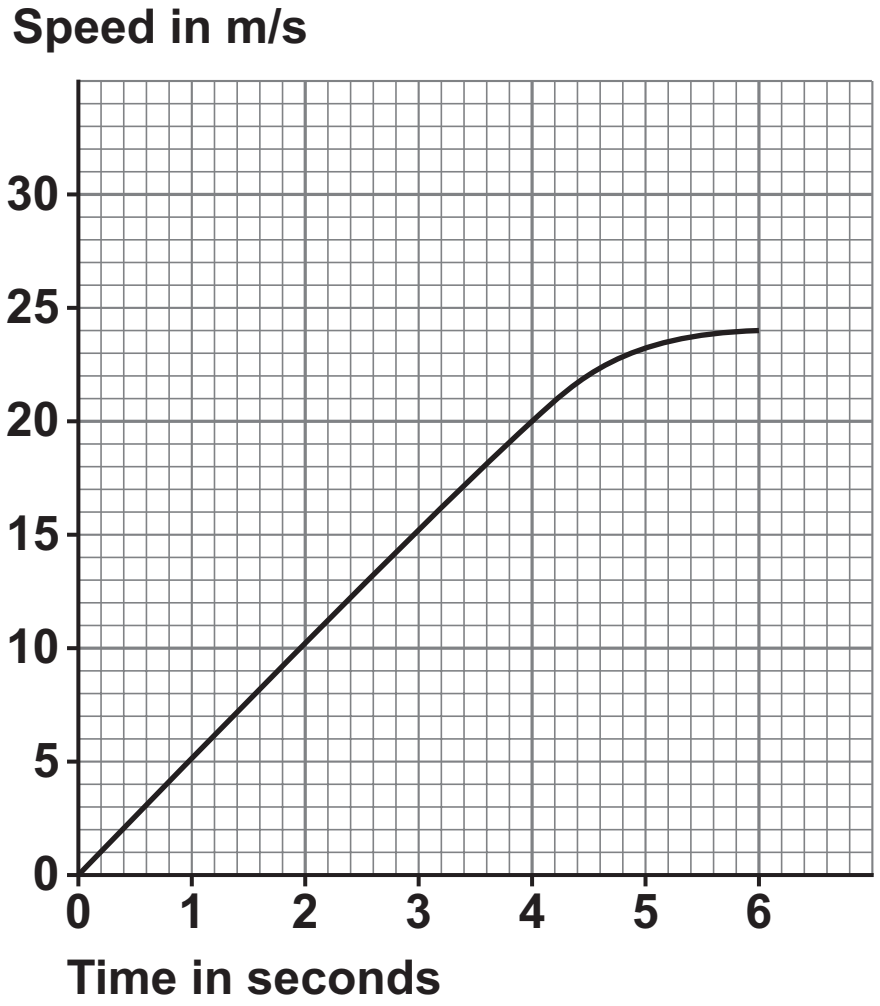
☐ $E_k = \frac{1}{2}m^2v$

**[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]**

_____

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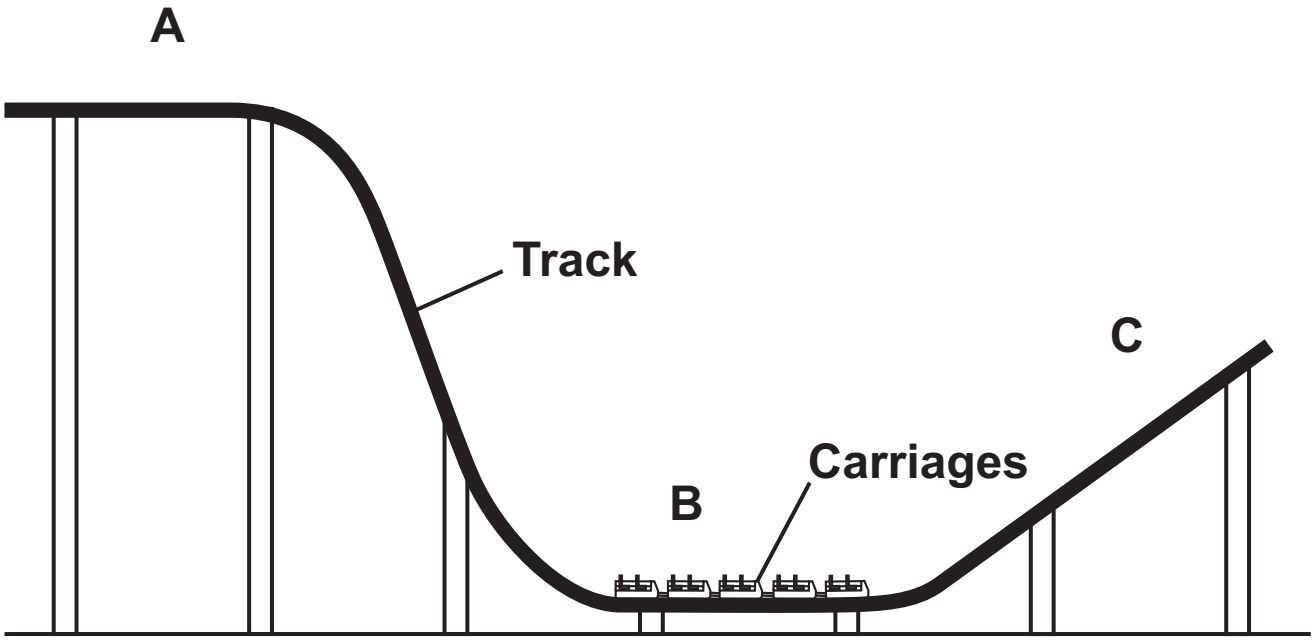
**Mass = _____ kg**

**[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]**

_____

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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**

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

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| 10 | |
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