Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname ____________________

Forename(s) ____________________

Candidate signature ____________________

GCSE
COMBINED SCIENCE: SYNERGY

F

Foundation Tier   Paper 3 Physical sciences

Friday 7 June 2019   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.
- 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.
- 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	
TOTAL	

Do not write outside the box

There are no questions printed on this page

**DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED**

Do not write outside the box

Answer **all** questions in the spaces provided.

0 1 A student investigated the rate of the reaction between magnesium and hydrochloric acid.

The reaction produced a gas.

0 1 . 1 Which gas is produced in the reaction?

[1 mark]

Tick (✓) **one** box.

Carbon dioxide ☐

Chlorine ☐

Hydrogen ☐

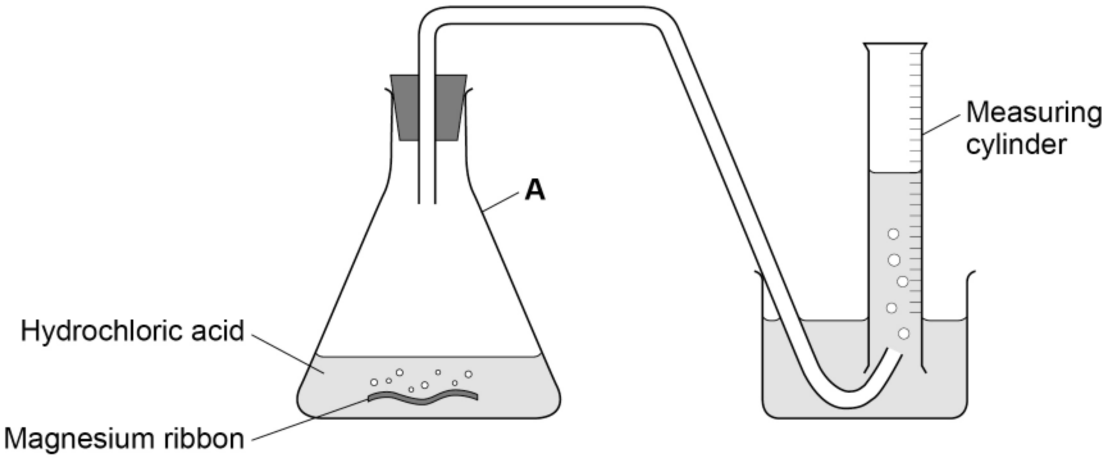
Oxygen ☐

Question 1 continues on the next page

Do not write outside the box

0 1 . 2 **Figure 1** shows the apparatus used.

Figure 1



What is the piece of equipment labelled **A**?

[1 mark]

Tick (✓) **one** box.

Conical flask ☐

Delivery tube ☐

Glass beaker ☐

Test tube ☐

Do not write outside the box

0 1 . 3 The student saw that a chemical reaction was taking place.

Give **two** observations that would show a chemical reaction was taking place.

[2 marks]

1 ____

____

2 ____

____

0 1 . 4 At the start of the investigation the volume of gas in the measuring cylinder was zero.

The student measured the volume of gas collected every 20 seconds for 2 minutes.

The readings for the volume of gas were 24 cm^3, 44 cm^3, 59 cm^3, 70 cm^3, 76 cm^3 and 79 cm^3

Complete **Table 1**.

[3 marks]

Table 1

Time in seconds	
0	0
	24
	44
	59
	70
	76
	79

Question 1 continues on the next page

Do not write outside the box

0 1 . 5 How could the student make the reaction faster?

[1 mark]

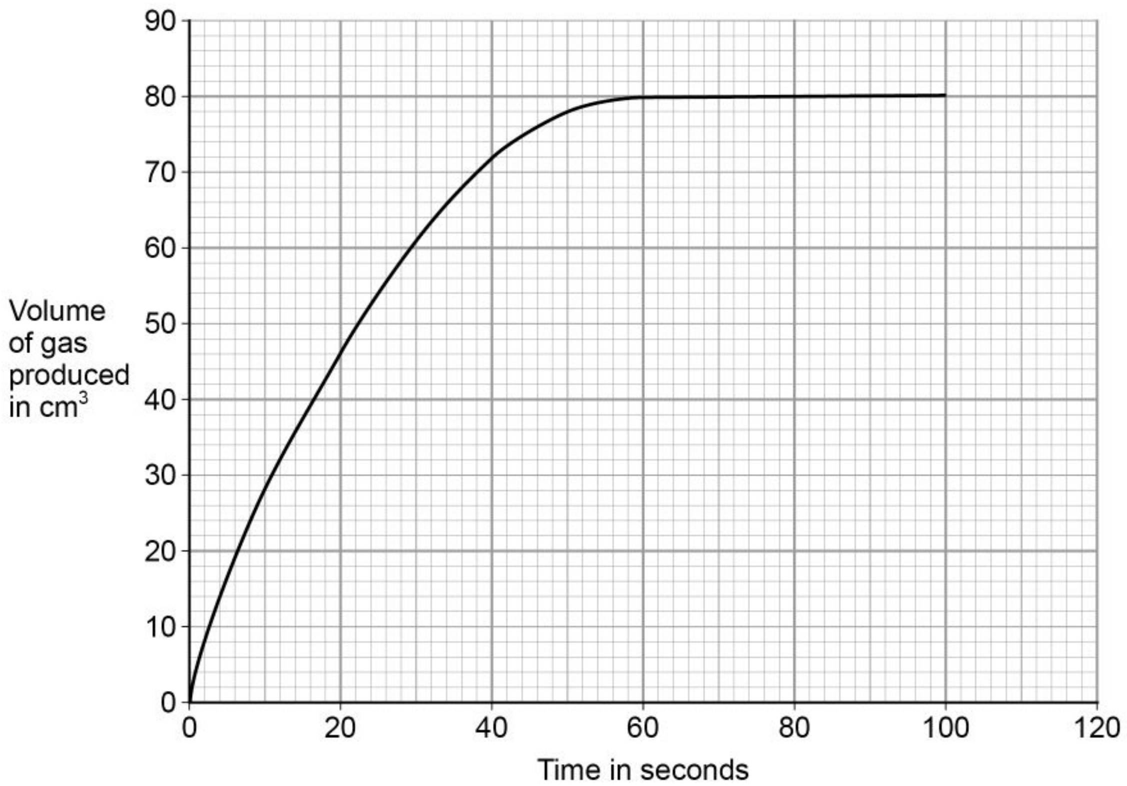
Tick (✓) **one** box.

- Dilute the hydrochloric acid ☐
- Replace magnesium ribbon with magnesium powder ☐
- Use a larger measuring cylinder ☐
- Use a smaller volume of hydrochloric acid ☐

The student repeated the investigation at a higher temperature.

Figure 2 shows the results.

Figure 2



Do not write outside the box

0 1 . 6 Determine the mean rate of reaction for the first 10 seconds.

Use the equation:

$$\text{mean rate of reaction} = \frac{\text{volume of gas formed}}{\text{time taken}}$$

Give the unit.

Choose the unit from the box.

[3 marks]

cm^3 / s	**g / s**	**s / cm^3**	**s / g**

Mean rate of reaction = ____________ Unit ____________

0 1 . 7 Determine the time at which the reaction finished and no more gas was produced.

Use **Figure 2**.

[1 mark]

Time = ____________ s

Question 1 continues on the next page

Do not write outside the box

0 1 . 8 Why does the rate of reaction increase when the temperature is higher?

[2 marks]

Tick (✓) **two** boxes.

Concentration of particles increases	☐
Particles collide more often	☐
Particles have more energy	☐
Particles increase in size	☐
Particles move more slowly	☐

14

Do not write outside the box

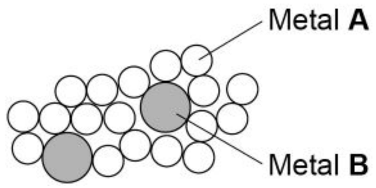
Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

0 2 A 1 kilogram mass is made from a mixture of metal **A** and metal **B**.

Figure 3 represents part of the structure of the 1 kilogram mass.

Figure 3



0 2 . 1 What is the ratio of metal **A** atoms to metal **B** atoms in **Figure 3**?

[1 mark]

Ratio of **A**:**B** atoms = ________ : ________

0 2 . 2 What is a mixture of metals called?

[1 mark]

Tick (✓) **one** box.

A polymer ☐

A salt ☐

An alkene ☐

An alloy ☐

Do not write outside the box

0 2 . 3 A silicon sphere has a mass of 1 kilogram.

The largest impurity in the silicon sphere is copper.

There are 7×10^{-5} g of copper in the silicon sphere.

What is the mass of copper in kilograms in the silicon sphere?

[1 mark]

Tick (✓) **one** box.

7×10^{-2} kg ☐

7×10^{-4} kg ☐

7×10^{-6} kg ☐

7×10^{-8} kg ☐

0 2 . 4 An atom of silicon has 14 electrons.

What is the electronic structure of silicon?

[1 mark]

Tick (✓) **one** box.

2,4,8 ☐

2,8,4 ☐

4,2,8 ☐

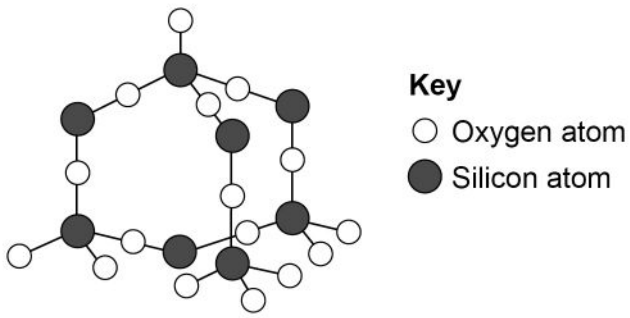
8,4,2 ☐

Question 2 continues on the next page

Silicon dioxide is a compound of silicon and oxygen.

Figure 4 represents part of the giant structure of silicon dioxide.

Figure 4



0 2 . 5 Which **two** words describe the bonding in silicon dioxide?

[2 marks]

Tick (✓) **two** boxes.

Covalent ☐

Intermolecular ☐

Ionic ☐

Metallic ☐

Strong ☐

Do not write outside the box

0 2 . 6 How many silicon atoms are bonded to each oxygen atom in silicon dioxide?

Use **Figure 4**.

[1 mark]

Tick (✓) **one** box.

1	2	3	4
☐	☐	☐	☐

0 2 . 7 Which symbol represents the state of silicon dioxide at room temperature?

[1 mark]

Tick (✓) **one** box.

(aq) ☐

(g) ☐

(l) ☐

(s) ☐

8

Turn over for the next question

Turn over ►

Do not write outside the box

0 3 Some new cars have an electric motor that is powered by a battery.

0 3 . 1 A battery supplies direct current.

What is direct current?

[1 mark]

Tick (✓) **one** box.

Current that always passes in the same direction ☐

Current that changes direction 50 times each second ☐

Current that does not have a direction ☐

There are different types of battery available.

Table 2 shows the maximum distance a car can travel before the battery needs recharging.

Table 2

Type of battery	**Maximum distance in km**
Lead-acid	130
Lithium-ion	480
Nickel-metal hydride	200

Do not write outside the box

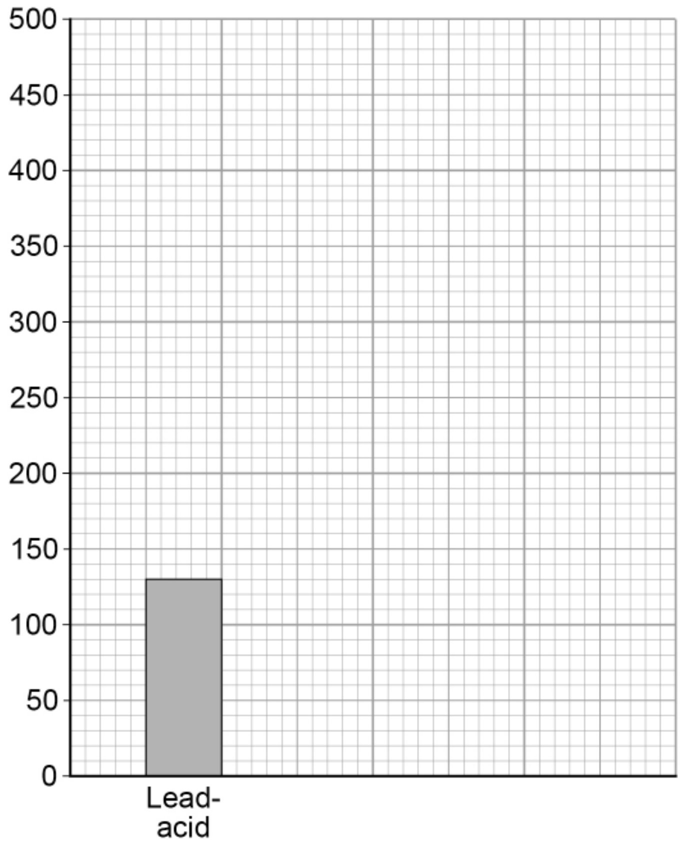
0 3 . 2 Complete **Figure 5**.

You should:

- label the x-axis
- label the y-axis
- plot the data from **Table 2**.

[4 marks]

Figure 5



0 3 . 3 A car with a lead-acid battery travels 80% of the maximum distance it can travel before the battery needs recharging.

Determine the distance the car travels.

[2 marks]

___

___

___

Distance = ______________ km

Turn over ►

Do not write outside the box

0 3 . 4 A lithium-ion battery is put on charge for 1800 s

The current is 40 A

Calculate the total charge flow during this time.

Use the equation:

charge flow = current × time

[2 marks]

____

____

____

Charge flow = ______________ C

0 3 . 5 The driver of a car saw an obstacle in the road. He applied the brakes until the car stopped.

The thinking distance was 9.0 m

The braking distance was 13.5 m

Calculate the stopping distance of the car.

[1 mark]

____

Stopping distance = ______________ m

Do not write outside the box

0 3 . 6 The driver had been drinking alcohol. The car had worn brakes.

Explain why these factors would increase the stopping distance of the car.

[4 marks]

14

Turn over for the next question

Do not write outside the box

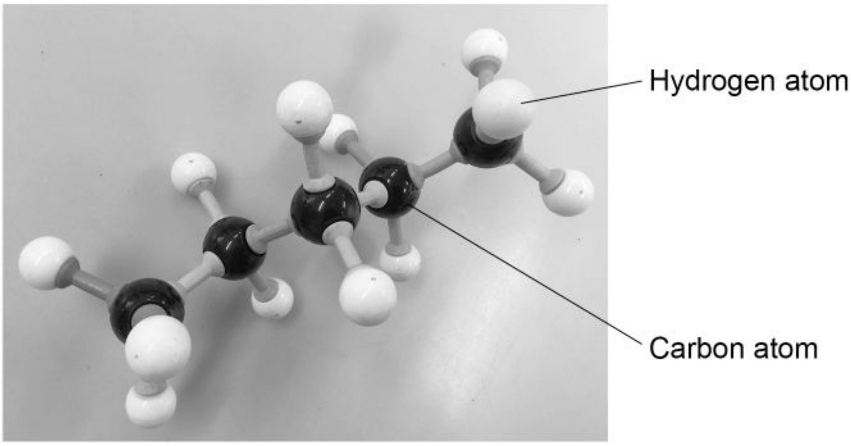
There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

0 4 This question is about hydrocarbons.

Figure 6 represents hydrocarbon **A**.

Figure 6



0 4 . 1 Complete the chemical formula of hydrocarbon **A**.

[1 mark]

C_5

0 4 . 2 What do the links between the atoms in **Figure 6** represent?

[1 mark]

____

____

Question 4 continues on the next page

Do not write outside the box

0 4 . 3 Hydrocarbon **A** is a fuel. Hydrocarbon **A** is completely combusted in air.

Which **two** substances are produced?

[2 marks]

Tick (✓) **two** boxes.

Carbon dioxide ☐

Ethene ☐

Nitrogen ☐

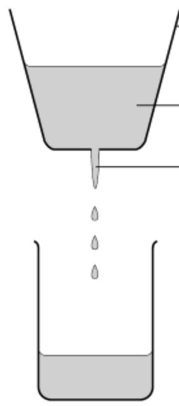
Oxygen ☐

Water ☐

Some students investigated how changing the temperature of a hydrocarbon affects the viscosity of the hydrocarbon.

Figure 7 shows the apparatus used.

Figure 7



The students recorded the time it took for 25 cm^3 of the hydrocarbon to flow through the hole in the viscometer.

0 4 . 4 **Table 3** shows a student's results at 60 °C

Table 3

Temperature in °C	**Time to flow through the viscometer in s**				
	Trial 1	**Trial 2**	**Trial 3**	**Trial 4**	**Mean**
60	21	20	24	23	**X**

Calculate the mean value **X**.

[1 mark]

____

____

Mean value **X** = ________________ s

Another student investigated a different hydrocarbon.

Table 4 shows the results.

Table 4

Temperature in °C	Time to flow through the viscometer in s
20	66
25	50
30	40
40	30
50	25

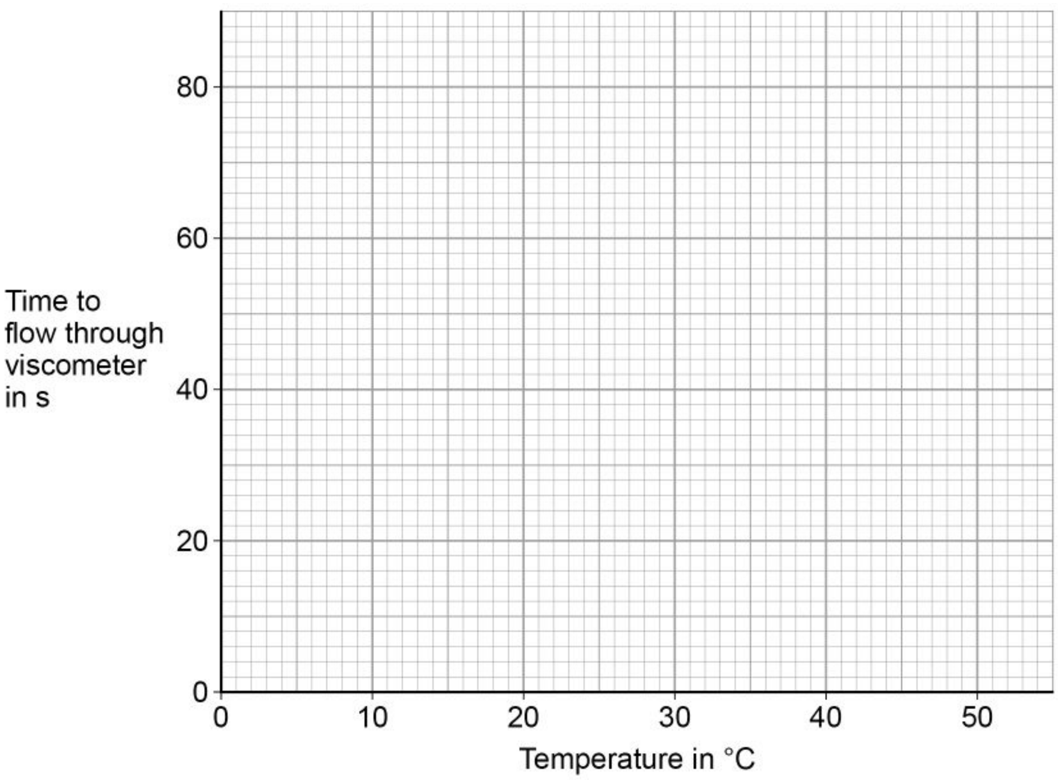
0 4 . 5 Complete **Figure 8**.

You should:

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

[3 marks]

Figure 8



Do not write outside the box

0 4 . 6 Describe the pattern shown on **Figure 8**.

[1 mark]

____

____

0 4 . 7 The viscosity of a substance is linked to how fast the substance flows.

The lower the viscosity, the faster the substance flows.

Complete the sentence.

Choose the answer from the box.

[1 mark]

decreases	**increases**	**stays the same**

As the temperature increases, the viscosity of

the hydrocarbon ______________________________ .

10

Turn over for the next question

Do not write outside the box

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 5 This question is about copper sulfate.

0 5 . 1 The formula of copper sulfate is $CuSO_4$

Table 5 shows information about the atoms in copper sulfate.

Complete **Table 5**.

[3 marks]

Table 5

Element	**Symbol**	**Relative number of atoms in $CuSO_4$**
	Cu	
Sulfur		
		4

Copper oxide and sulfuric acid react to produce copper sulfate and water.

0 5 . 2 Complete the word equation for this reaction.

[1 mark]

__________ + __________ ⟶ __________ + water

0 5 . 3 What type of substance is copper oxide?

[1 mark]

Tick (✓) **one** box.

A base ☐

A metal ☐

A salt ☐

An acid ☐

Question 5 continues on the next page

Do not write outside the box

A student planned to make blue copper sulfate crystals.

This is the method the student used.

1. Add 25 cm^3 of dilute sulfuric acid to a conical flask.
2. Gently warm the dilute sulfuric acid.
3. Add 2 g of black copper oxide to the dilute sulfuric acid.
4. Stir the mixture.
5. Evaporate some of the water from the mixture using an electric heater.
6. Leave the mixture to cool.

Not all the copper oxide reacted. The student did not remove the excess copper oxide.

0 5 . 4 What would the product look like after step 6?

[1 mark]

Tick (✓) **one** box.

Black powder only ☐

Blue crystals and black powder ☐

Blue crystals only ☐

Blue solution only ☐

0 5 . 5 The student should have filtered the mixture after step 4.

Draw a diagram of the apparatus the student could use.

You should label:

- the pieces of equipment used
- where the excess copper oxide collects.

[3 marks]

Question 5 continues on the next page

Do not write outside the box

0 5 . 6 What equipment should the student use to measure:

- 2 g of copper oxide
- 25 cm^3 of dilute sulfuric acid?

Draw **one** line from each measurement to the most suitable piece of equipment.

[2 marks]

Measurement	**Equipment**
	Balance
2 g of copper oxide	Beaker
	Measuring cylinder
25 cm^3 of dilute sulfuric acid	Metre rule
	Thermometer

0 5 . 7 1 g of copper sulfate is dissolved in water to make 25 cm^3 of copper sulfate solution.

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

[2 marks]

___

___

___

Concentration = ____________ g/dm^3

13

Do not write outside the box

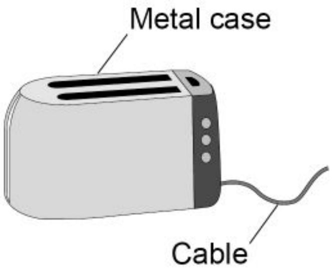
Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 6 **Figure 9** shows a toaster.

Figure 9



A three-core cable connects the toaster to the mains electricity supply.

0 6 . 1 Which material could be used for the wires in the three-core cable?

[1 mark]

Tick (✓) **one** box.

Copper ☐

Diamond ☐

Iodine ☐

Poly(ethene) ☐

0 6 . 2 What is the potential of the earth wire?

[1 mark]

Tick (✓) **one** box.

0 V ☐

1.5 V ☐

12 V ☐

230 V ☐

Do not write outside the box

The wires and the cable are covered with a plastic material.

0 6 . 3 The plastic material covering each wire is a different colour.

Draw **one** line from each wire to the colour of the plastic material.

[2 marks]

Wire	**Colour of plastic material**
	Blue
Live	Blue and yellow
	Brown
Neutral	Green
	Green and yellow

0 6 . 4 The plastic material covering the wires and cable is a type of polymer.

Explain how the plastic material acts as a safety feature if a person touches the cable.

[2 marks]

____

____

____

____

Question 6 continues on the next page

Do not write outside the box

0 6 . 5 When the toaster is switched on the current is 4.0 A

The resistance of the toaster is 60 Ω

Calculate the power of the toaster.

Use the equation:

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

Give the unit.

Choose the unit from the box.

[4 marks]

coulomb	**joule**	**volt**	**watt**

Power = ____________________ Unit ____________________

10

Do not write outside the box

0 7 Catalase is an enzyme.

0 7 . 1 What type of molecule is an enzyme?

[1 mark]

____

0 7 . 2 Hydrogen peroxide decomposes in the presence of catalase.

This is the equation for the reaction:

$$2\,H_2O_2(aq) \rightarrow 2\,H_2O(l) + O_2(g)$$

Describe how the student could test for the gas produced.

[2 marks]

Test ____

Result ____

____

Question 7 continues on the next page

Do not write outside the box

A student investigated the effect of pH on the activity of catalase.

0 7 . 3 Describe how the student could use an indicator to measure the pH of a solution.

[2 marks]

____

____

____

____

Table 6 shows the results.

Table 6

pH	Enzyme activity in arbitrary units
3.0	0
4.0	6
5.0	22
6.0	37
7.0	44
8.0	34
9.0	16
10.0	2

0 7 . 4 What is the optimum pH for catalase in this reaction?

Use **Table 6**.

[1 mark]

Optimum pH = ____________________

Do not write outside the box

0 7 . 5 How could the student find a more accurate value for the optimum pH?

[1 mark]

Tick (✓) **one** box.

Decrease the hydrogen peroxide concentration ☐

Increase the pH range ☐

Increase the temperature to 60 °C ☐

Use smaller pH intervals ☐

0 7 . 6 Explain the result for catalase at pH 3.0

[3 marks]

____

____

____

____

____

____

___ 10

Turn over for the next question

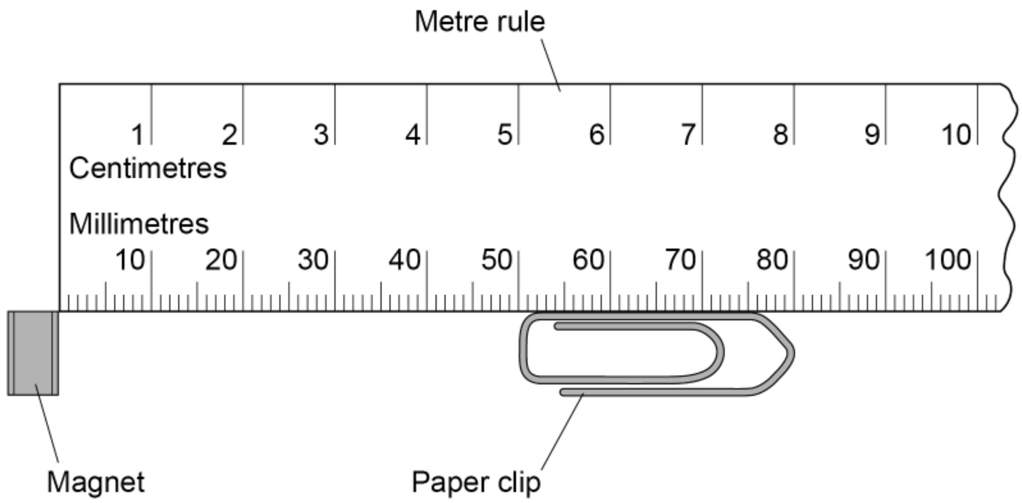
Do not write outside the box

0 8 A student investigated magnets.

The student used a paper clip, metre rule and magnets.

Figure 10 shows the apparatus with one magnet.

Figure 10



0 8 . 1 Write down the resolution of the metre rule.

[1 mark]

Resolution = ____________

0 8 . 2 Explain why the paper clip is attracted to the magnet.

[2 marks]

____

____

____

____

The student placed the paper clip at different distances from the magnet.

She recorded the minimum distance at which the paper clip did not move towards the magnet.

She repeated the investigation using different numbers of magnets.

0 8 . 3 Suggest why the magnets used should be identical.

[1 mark]

____

____

Table 7 shows the results of the investigation.

Table 7

Number of magnets	**Minimum distance at which paper clip did not move in cm**
1	1.8
2	3.6
3	5.4
4	6.6
5	**X**
6	7.1
7	7.2
8	7.2

0 8 . 4 Predict the value **X** in **Table 7**.

[1 mark]

X = ____________ cm

Question 8 continues on the next page

Do not write outside the box

There is a resultant force on the paper clip. The resultant force causes the paper clip to accelerate towards the magnet.

0 8 . 5 Write the equation which links acceleration, mass and resultant force.

[1 mark]

____

____

0 8 . 6 The mass of the paper clip is 0.0012 kg

Calculate the acceleration of the paper clip when the resultant force on it is 0.000168 N

Give the unit.

[4 marks]

____

____

____

____

____

Acceleration = ____________________ Unit ____________________

Do not write outside the box

The Earth has a magnetic field.

0 8 . 7 The magnetic field is probably caused by movements inside the Earth.

Name the part of the Earth in which the movements take place.

[1 mark]

____

0 8 . 8 Give **one** piece of evidence to show that the Earth's magnetic field has changed over time.

[1 mark]

____

____

12

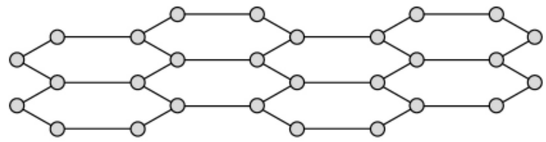
Turn over for the next question

0 9 This question is about graphene and graphite.

Graphene is a single layer of graphite.

Figure 11 represents part of the structure of graphene.

Figure 11



0 9 . 1 Graphene is one atom thick. The diameter of the atom is 3.4×10^{-10} m

What is the thickness of a graphene layer in nanometres?

1 nm = 10^{-9} m

[1 mark]

Tick (✓) **one** box.

0.034 nm ☐

0.34 nm ☐

3.4 nm ☐

34 nm ☐

Do not write outside the box

0 9 . 2 Which is **one** use of graphene?

[1 mark]

Tick (✓) **one** box.

As a detergent ☐

As a solvent ☐

In composites ☐

To produce polymers ☐

0 9 . 3 Graphene and graphite are used in electronics.

Suggest **one** reason why graphene is a more suitable material for use in electronics than graphite.

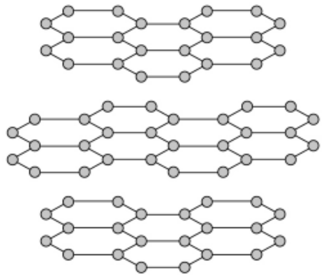
[1 mark]

Question 9 continues on the next page

Do not write outside the box

0 9 . 4 **Figure 12** represents part of the structure of graphite.

Figure 12



Graphite is used as a contact in electric motors because graphite:

- conducts electricity
- is slippery.

Explain why graphite has these properties.

You should refer to the structure and bonding of graphite in your answer.

[6 marks]

9

END OF QUESTIONS

Do not write outside the box

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED