AQA

Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

GCSE
COMBINED SCIENCE: SYNERGY

H

Higher 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	

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ANSWER IN THE SPACES PROVIDED

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

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0 1 Catalase is an enzyme.

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

[1 mark]

0 1 . 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 1 continues on the next page

Do not write outside the box

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

0 1 . 3 Describe how the student could use an indicator to measure the pH of a solution.

[2 marks]

Table 1 shows the results.

Table 1

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 1 . 4 What is the optimum pH for catalase in this reaction?

Use **Table 1**.

[1 mark]

Optimum pH = _____

Do not write outside the box

0 1 . 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 1 . 6 Explain the result for catalase at pH 3.0

[3 marks]

10

Turn over for the next question

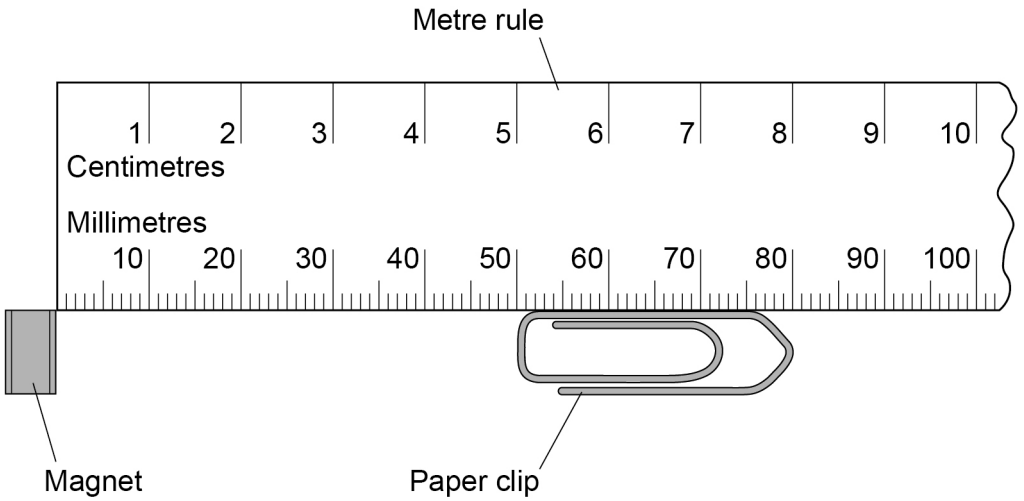
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0 2 A student investigated magnets.

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

Figure 1 shows the apparatus with one magnet.

Figure 1



0 2 . 1 Write down the resolution of the metre rule.

[1 mark]

Resolution = _____

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

[2 marks]

_____

_____

_____

_____

Do not write outside the box

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 2 . 3 Suggest why the magnets used should be identical.

[1 mark]

Table 2 shows the results of the investigation.

Table 2

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 2 . 4 Predict the value **X** in **Table 2**.

[1 mark]

X = _____ cm

Question 2 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 2 . 5 Write the equation which links acceleration, mass and resultant force.

[1 mark]

0 2 . 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 2 . 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 2 . 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

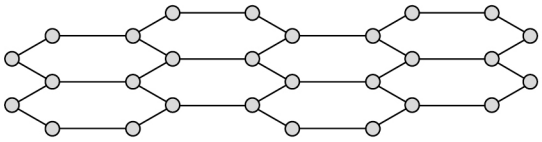
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0 3 This question is about graphene and graphite.

Graphene is a single layer of graphite.

Figure 2 represents part of the structure of graphene.

Figure 2



0 3 . 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 3 . 2 Which is **one** use of graphene?

[1 mark]

Tick (✓) **one** box.

As a detergent ☐

As a solvent ☐

In composites ☐

To produce polymers ☐

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

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

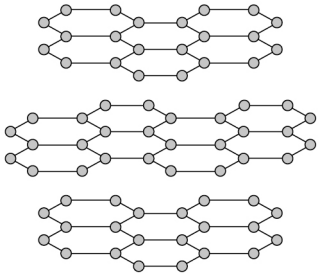
[1 mark]

Question 3 continues on the next page

Do not write outside the box

0 3 . 4 **Figure 3** represents part of the structure of graphite.

Figure 3



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

Do not write outside the box

0 4 This question is about hydrocarbons.

0 4 . 1 When a hydrocarbon $C_{10}H_{22}$ is cracked, two substances are produced.

Complete the equation for the reaction.

[1 mark]

$$C_{10}H_{22} \rightarrow C_7H_{16} + _____$$

0 4 . 2 Explain why the hydrocarbon C_7H_{16} has a lower boiling point than $C_{10}H_{22}$

[2 marks]

Question 4 continues on the next page

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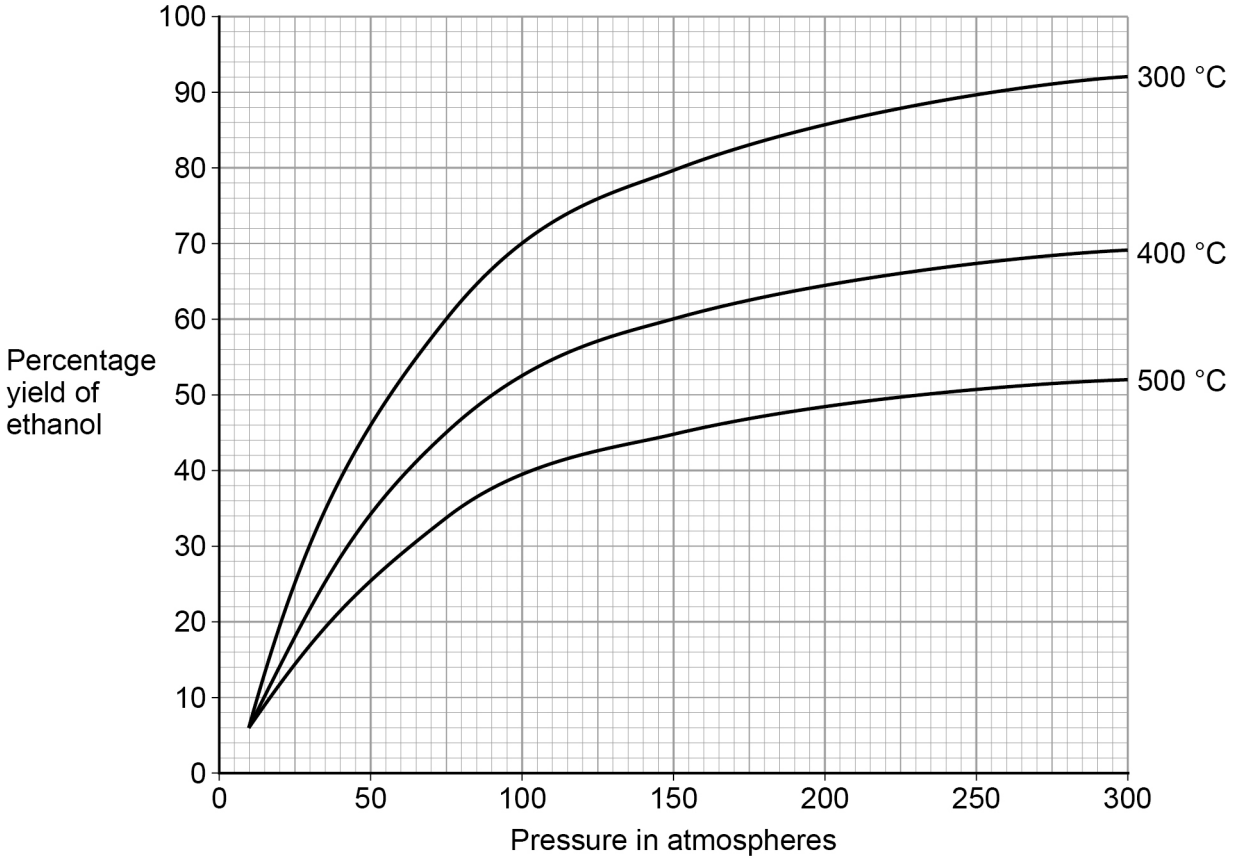
Ethanol is produced by reacting ethene with steam.

The equation for the reaction is:

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g)$$

Figure 4 shows the percentage yield of ethanol using different reaction conditions.

Figure 4



0 4 . 3 Explain why changing the pressure affects the percentage yield of ethanol.

[3 marks]

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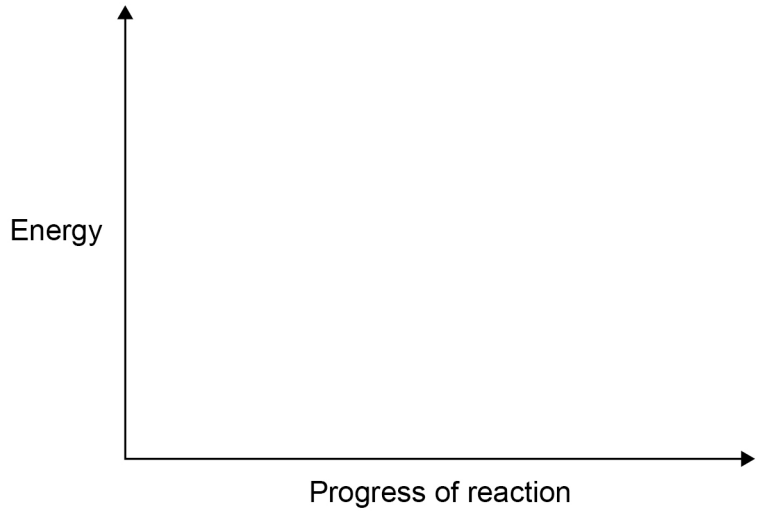
The forward reaction is exothermic.

0 4 . 4 How does **Figure 4** provide evidence for this?

[1 mark]

0 4 . 5 **Figure 5** shows part of a reaction profile diagram.

Figure 5



A catalyst is used in the reaction to produce ethanol.

Complete **Figure 5** to show how the catalyst increases the rate of this reaction.

You should label the reaction profile diagram.

[4 marks]

0 4 . 6 Suggest why the catalyst does **not** affect the yield of ethanol at equilibrium.

[2 marks]

13

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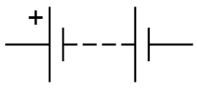
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0 5 A student investigated how the resistance of a thermistor varies with temperature.

0 5 . 1 The student made measurements to determine the resistance of the thermistor at room temperature. He used an ammeter and a voltmeter.

Complete the circuit diagram to show a circuit the student could use.

[3 marks]



Question 5 continues on the next page

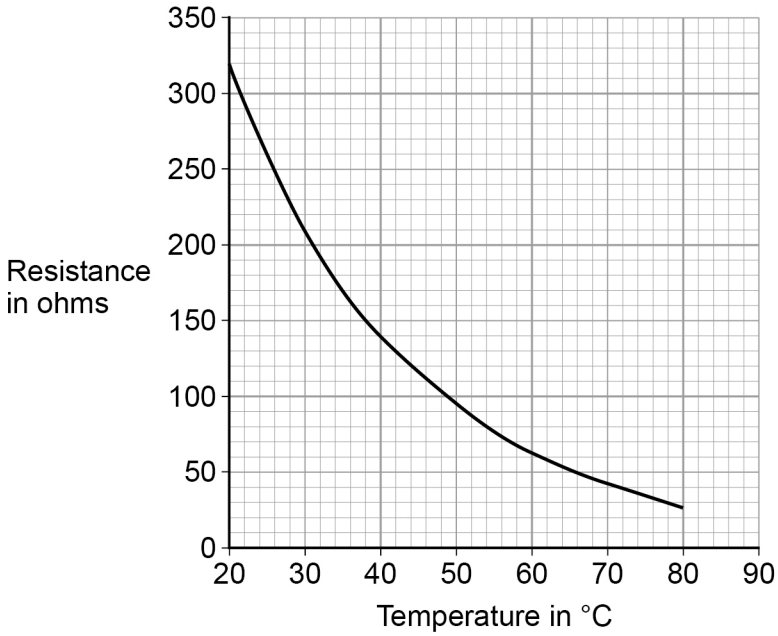
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The student repeated the measurements with the thermistor at different temperatures.

He plotted a graph of resistance against temperature.

Figure 6 shows the graph.

Figure 6



0 5 . 2 One set of readings was:

- potential difference = 5.60 V
- current = 0.04 A

Determine the temperature of the thermistor.

[4 marks]

Temperature = _____ °C

Do not write outside the box

0 5 . 3 Explain how the graph shows that the thermistor is most sensitive to changes in temperature between 20 °C and 25 °C

[2 marks]

9

Turn over for the next question

Do not write outside the box

0 6 A student investigated the rate of the reaction between magnesium and hydrochloric acid.

The student measured the volume of hydrogen gas produced.

0 6 . 1 How could the student collect and measure the volume of gas produced?

[1 mark]

0 6 . 2 At the start of the investigation the volume of gas was 0 cm^3

The student took readings at 20-second intervals.

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

Draw a results table for the investigation.

Include the student's results in the table.

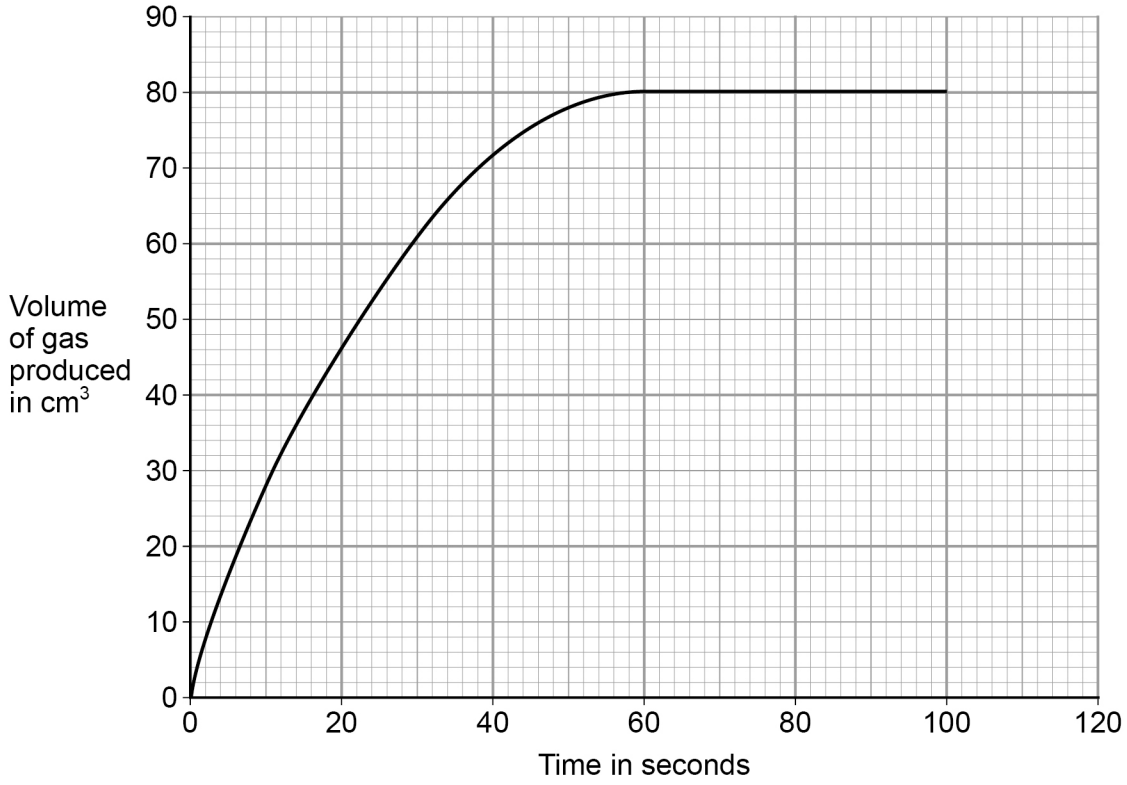
[3 marks]

Do not write outside the box

The student repeated the investigation at a higher temperature.

Figure 7 shows the results.

Figure 7



0 6 . 3 Determine the rate of reaction at 30 seconds.

Show your working on **Figure 7**.

Give your answer to 2 significant figures.

[4 marks]

Rate = _____ cm^3/s

Question 6 continues on the next page

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0 6 . 4 The rate of reaction increases at higher temperatures.

Explain why.

Answer in terms of particles.

[3 marks]

11

Do not write outside the box

0 7 A 1 kg mass is made from a platinum and iridium alloy.

0 7 . 1 The platinum and iridium alloy is harder than pure platinum.

Explain why alloys are harder than the pure metal.

[3 marks]

0 7 . 2 The 1 kilogram mass consisted of 900 g platinum and 100 g iridium.

What was the ratio of platinum atoms to iridium atoms in the alloy?

Relative atomic masses (A_r): Pt = 195 Ir = 192

[1 mark]

Tick (✓) **one** box.

0.99 :1.00 ☐

8.86 :1.00 ☐

9.00 :1.00 ☐

9.14 :1.00 ☐

Question 7 continues on the next page

Do not write outside the box

The Avogadro constant is the number of atoms in 1 mole of a substance.

0 7 . 3 What is the value of the Avogadro constant?

[1 mark]

Tick (✓) **one** box.

6.02×10^{23} per mole ☐

6.02×10^{24} per mole ☐

6.02×10^{25} per mole ☐

6.02×10^{26} per mole ☐

0 7 . 4 Scientists could use a sample of silicon to define the Avogadro constant.

Copper is an impurity in the silicon sample.

There are 70 nanograms of copper in 1 g of the sample.

Calculate the mass of copper in grams in 1 kg of the sample.

Give your answer in standard form.

1 nanogram = 10^{-9} g

[2 marks]

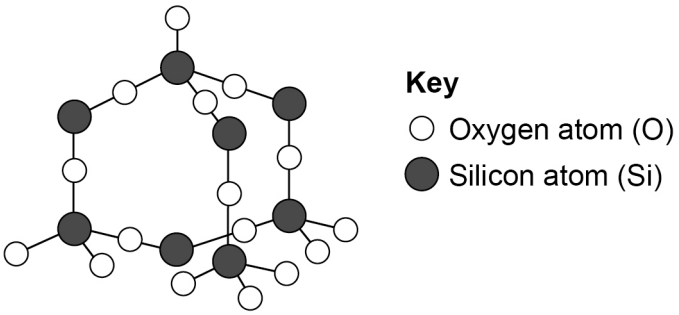
Mass of copper = _____ g

Do not write outside the box

Silicon mainly occurs in the Earth's crust as silicon dioxide.

Figure 8 represents part of the structure of silicon dioxide.

Figure 8



0 7 . 5 Determine the empirical formula of silicon dioxide.

Use **Figure 8**.

[1 mark]

Empirical formula = _____

0 7 . 6 Describe the structure and bonding in silicon dioxide.

[3 marks]

11

Turn over ►

Do not write outside the box

0 8 A student planned to make copper sulfate crystals from excess copper oxide and dilute sulfuric acid.

The equation for the reaction is:

$CuO(s) + H_2SO_4(aq) \rightarrow CuSO_4(aq) + H_2O(l)$

0 8 . 1 Why is it necessary to add excess copper oxide?

[1 mark]

0 8 . 2 This is the method used.

1. Add 25 cm^3 of dilute sulfuric acid to a conical flask.
2. Gently warm the dilute sulfuric acid.
3. Add excess copper oxide to the dilute sulfuric acid.
4. Stir the mixture.
5. Heat to evaporate all the water from the mixture.

Suggest **two** improvements to the method.

Explain why each improvement is needed.

[4 marks]

1

2

Do not write outside the box

0 8 . 3 The student used:

- 2 g of copper oxide (in excess)
- 25 cm^3 of a solution of dilute sulfuric acid with a concentration of 49 g/dm^3

Determine by how many moles the copper oxide (CuO) was in excess.

Relative atomic masses (A_r): Cu = 63.5 O = 16

Relative formula mass (M_r) of sulfuric acid = 98

[5 marks]

Number of moles in excess = _____

10

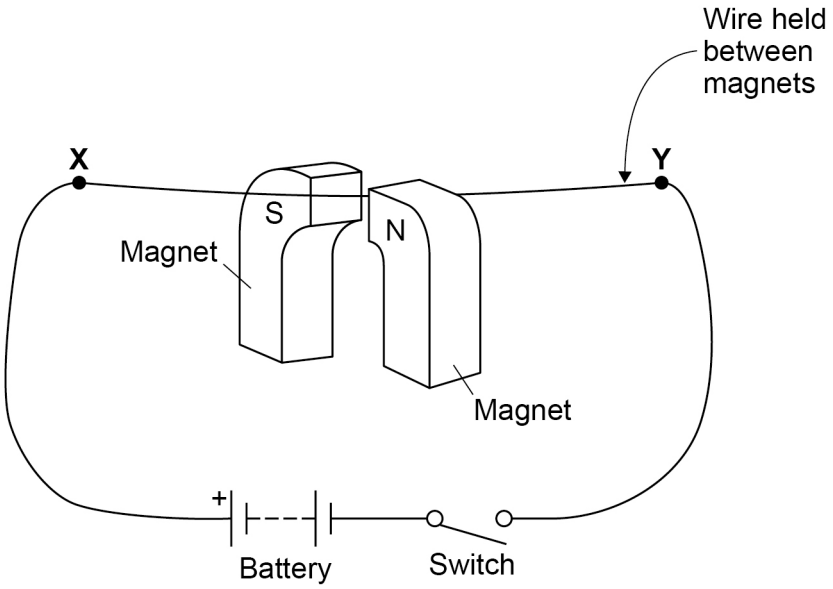
Turn over for the next question

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0 9 A student investigated the motor effect.

0 9 . 1 **Figure 9** shows the apparatus used.

Figure 9



Do not write outside the box

The student closed the switch and the wire moved.

Explain why.

[5 marks]

0 9 . 2 Give **two** ways of reversing the direction of the movement of the wire.

[2 marks]

1

2

Question 9 continues on the next page

Do not write outside the box

Electric motors use the motor effect.

Energy is supplied to the electric motor by a battery.

The battery is charged using a charger.

0 9 . 3 When the charger is connected to the battery, the potential difference across the battery is 15.0 V

The total energy stored when the battery is fully charged is 0.81 MJ

The average current used to charge the battery is 3.00 A

Calculate the time taken to fully charge the battery.

[6 marks]

Time taken = _____ s

Do not write outside the box

0 9 . 4 The charger is plugged into the mains electricity supply.

This is an alternating supply.

Give **two** other properties of the UK mains electricity supply.

[2 marks]

1 _____

_____

2 _____

_____

15

END OF QUESTIONS

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