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

H

Higher Tier Paper 3 Physical Sciences

Monday 1 June 2020 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.

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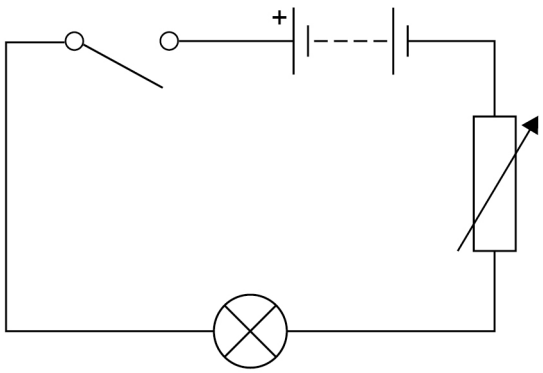
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ANSWER IN THE SPACES PROVIDED

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0 1 A student investigated how the power output of a filament lamp varied with the current in the lamp.

Figure 1 shows part of the circuit the student used.

Figure 1



0 1 . 1 To calculate power output the student measured the current in the lamp and the potential difference across the lamp.

Complete **Figure 1** by adding an ammeter and a voltmeter to make the measurements.

Use the correct circuit symbols.

[3 marks]

0 1 . 2 Which energy store in the battery decreases when the lamp is switched on?

[1 mark]

0 1 . 3 What happens to the energy transferred by the lamp?

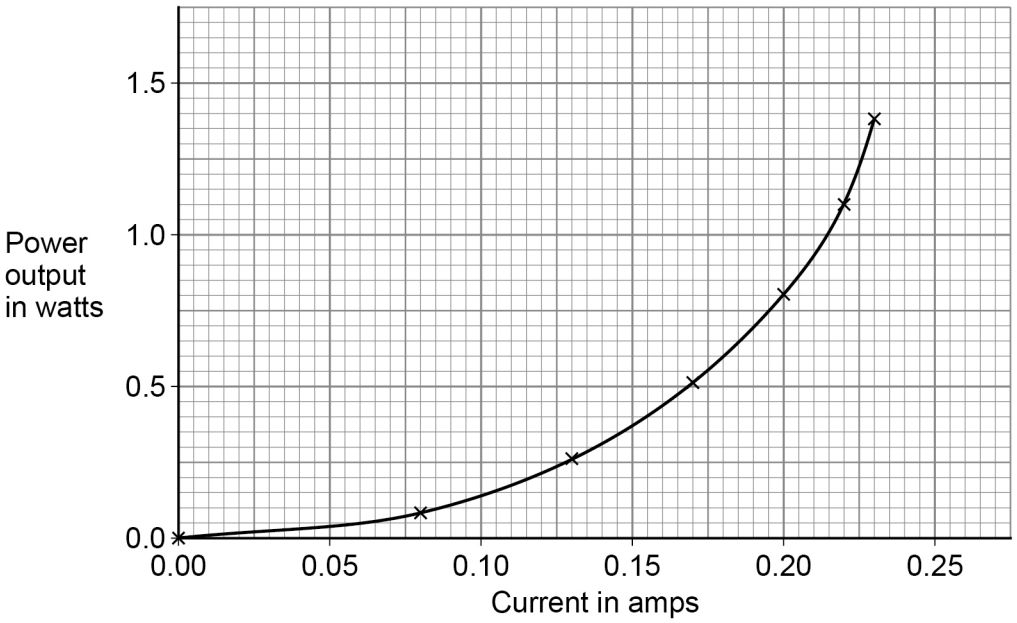
[1 mark]

Question 1 continues on the next page

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Figure 2 shows the results.

Figure 2



0 1 . 4 Describe how varying the current affects the power output of the filament lamp.

[2 marks]

0 1 . 5 Write down the equation which links current (I), power (P) and resistance (R).

[1 mark]

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0 1 . 6 Determine the resistance of the lamp when the current in the lamp is 0.22 A

[4 marks]

Resistance = _____ Ω

12

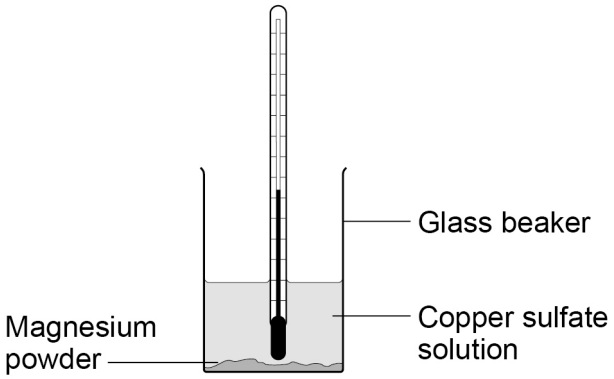
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0 2 A student investigated the temperature increase when magnesium powder was added to copper sulfate solution.

Figure 3 shows the apparatus used.

Figure 3



This is the method used.

1. Add copper sulfate solution to a beaker.
2. Measure the initial temperature of the copper sulfate solution.
3. Add 0.1 g of magnesium powder.
4. Stir the mixture.
5. Measure the maximum temperature of the mixture.
6. Repeat steps **1** to **5** with different masses of magnesium powder.

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0 2 . 1 Give **two** control variables the student should use.

[2 marks]

1 _____

_____

2 _____

_____

0 2 . 2 Suggest **one** change to improve the accuracy of the investigation.

[1 mark]

_____

_____

Question 2 continues on the next page

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0 2 . 3 **Table 1** shows the student's results.

Table 1

Mass of magnesium in g	Temperature increase in °C
0.1	3
0.2	6
0.3	9
0.4	12
0.5	15
0.6	18
0.7	21
0.8	21
0.9	24
1.0	21

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Explain the conclusions that can be made from the trends shown in the results.

Use data from **Table 1** in your answer.

[6 marks]

9

Turn over for the next question

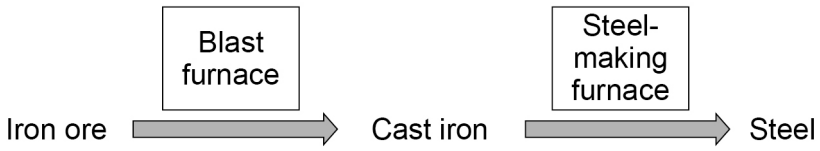
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0 3 This question is about iron and steel.

Figure 4 shows a flow chart for the production of iron and steel from iron ore.

Iron ore consists mainly of iron oxide.

Figure 4



0 3 . 1 In the blast furnace iron oxide reacts with carbon monoxide to form iron and carbon dioxide.

Complete the equation for the reaction between iron oxide and carbon monoxide.

You should balance the equation.

[2 marks]

$$Fe_2O_3 + 3CO \longrightarrow _____ + _____$$

0 3 . 2 Iron oxide is reduced in the reaction with carbon monoxide.

What does 'reduced' mean in this reaction?

[1 mark]

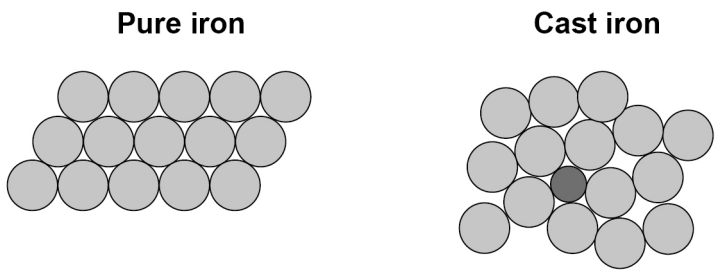
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0 3 . 3 Cast iron is an alloy.

Cast iron contains carbon.

Figure 5 shows the arrangement of atoms in pure iron and in cast iron.

Figure 5



Explain why cast iron is harder than pure iron.

[4 marks]

Question 3 continues on the next page

Do not write outside the box

0 3 . 4 In addition to cast iron, scrap steel is added to the steel-making furnace.

Give **three** environmental advantages of recycling scrap steel in this way.

[3 marks]

1 _____

_____

2 _____

_____

3 _____

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10

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ANSWER IN THE SPACES PROVIDED

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0 4 This question is about the enzyme amylase.

0 4 . 1 Amylase can only digest starch.

Explain why amylase **cannot** digest other substances.

[2 marks]

Students investigated the effect of pH on the rate of starch digestion.

This is the method used.

1. Add 2 cm^3 of amylase solution at pH 5.0 to a test tube in a water bath at 37 °C
2. Add 2 cm^3 of starch suspension to the same test tube.
3. Start the timer.
4. Remove a drop of the amylase-starch mixture after 30 seconds.
5. Test the drop for starch.
6. Repeat steps **4** to **5** until no starch is detected.
7. Record the total time taken for no starch to be detected.
8. Repeat steps **1** to **7** using amylase solution at different pHs.

Do not write outside the box

0 4 . 2 Which is the dependent variable in the investigation?

[1 mark]

Tick (✓) **one** box.

pH of amylase solution ☐

Temperature of water bath ☐

Time for no starch to be detected ☐

Volume of starch suspension ☐

0 4 . 3 Describe the test for starch.

Give the result of the test if starch is present.

[2 marks]

Test _____

_____

Result _____

_____

0 4 . 4 The amylase solution and starch suspension were kept in the water bath at 37 °C for 10 minutes before being mixed.

Why were the amylase and starch kept at 37 °C for 10 minutes before being mixed?

[1 mark]

_____

_____

Question 4 continues on the next page

Do not write outside the box

Table 2 shows the results.

Table 2

pH	Time for no starch to be detected in seconds
5.0	420
5.5	330
6.0	270
6.5	240
7.0	120
7.5	90
8.0	120
8.5	180
9.0	270

0 4 . 5 Student **A** concluded that:

'The optimum pH for amylase is 7.5'.

Give **one** reason why this conclusion could be correct.

Use **Table 2**.

[1 mark]

0 4 . 6 Student **B** concluded that:

'The optimum pH is between 7.0 and 8.0 but may **not** be 7.5'.

How can student **B** determine a more accurate value for the optimum pH?

Use **Table 2**.

[1 mark]

8

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0 5 This question is about the hydrocarbons obtained from crude oil.

Octane is a hydrocarbon.

The formula of octane is C_8H_{18}

0 5 . 1 How does the formula of octane show that octane is an alkane?

[1 mark]

Question 5 continues on the next page

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The fractions in crude oil are separated by fractional distillation.

Figure 6 shows a fractionating column.

Figure 6

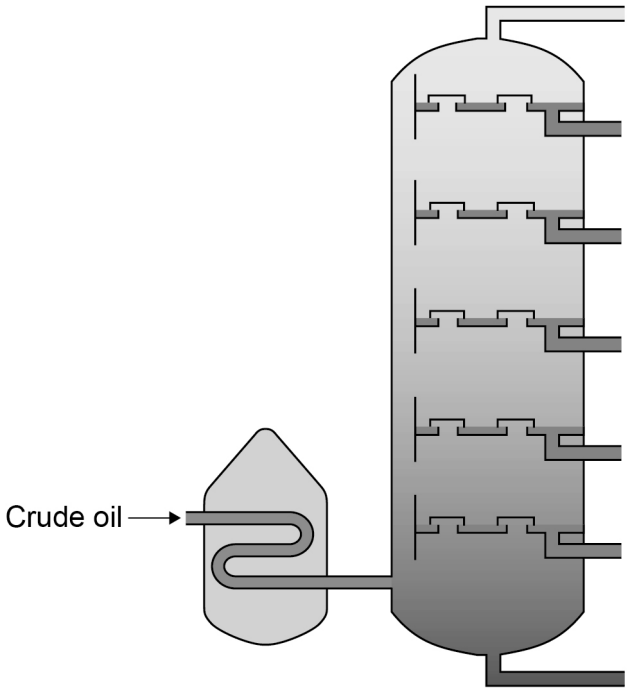


Table 3 gives some properties of different fractions separated from crude oil.

Table 3

Fraction	Range of number of carbon atoms per molecule	Boiling point range in °C
Diesel	C_{15}–C_{20}	250–300
Heavy fuel oil	C_{20}–C_{25}	300–400
Kerosene	C_{10}–C_{15}	180–250
Petrol	C_5–C_{10}	40–180

Do not write outside the box

0 5 . 2 Which fraction in **Table 3** is the most viscous?

Give **one** reason for your answer.

[2 marks]

Tick (✓) **one** box.

Diesel ☐

Heavy fuel oil ☐

Kerosene ☐

Petrol ☐

Reason _____

_____

0 5 . 3 Describe how the fraction containing octane is separated from crude oil.

Use data from **Table 3** in your answer.

[4 marks]

_____

_____

_____

_____

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_____

_____

_____

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0 6 Some security lights automatically switch on when it gets dark.

Figure 7 shows a security light.

Figure 7

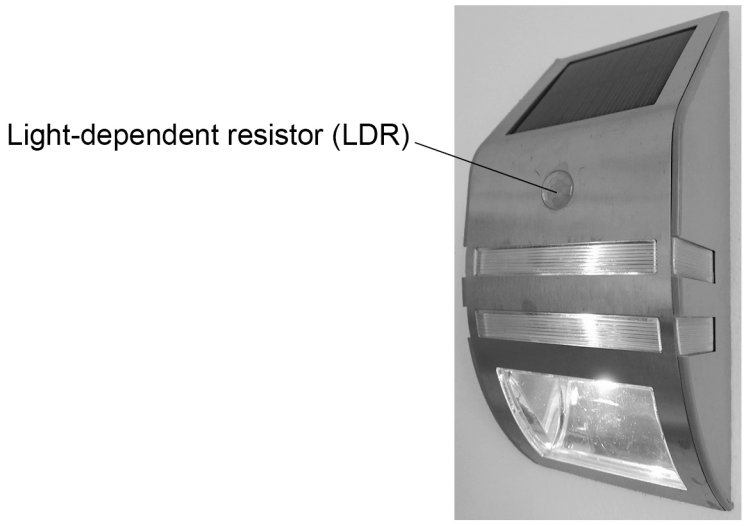
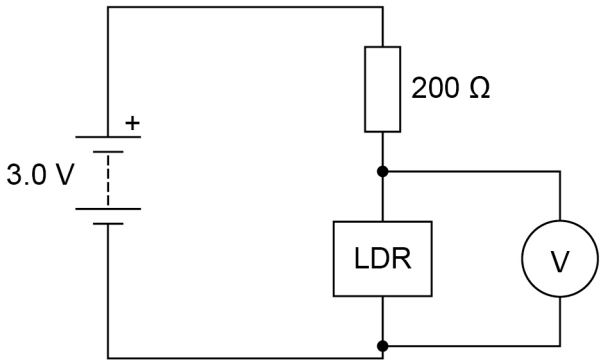


Figure 8 shows part of a circuit that can be used to switch the security light on and off.

Figure 8



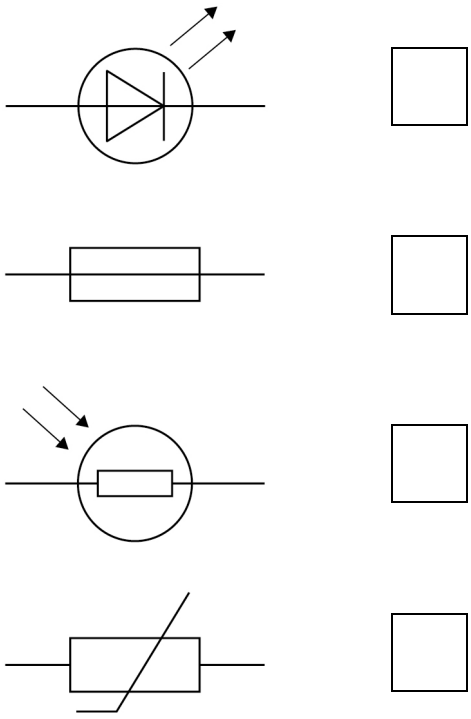
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0 6 . 1 The circuit symbol for the LDR in **Figure 8** is **not** correct.

Which is the correct circuit symbol for the LDR?

[1 mark]

Tick (✓) **one** box.



0 6 . 2 The security light turns on when the potential difference across the LDR is 2.0 V

Determine the resistance of the LDR when the potential difference across the LDR is 2.0 V

Use **Figure 8**.

[2 marks]

Resistance = _____ Ω

Question 6 continues on the next page

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0 6 . 3 A charge of 3.24 C flows through the LDR in 40.0 minutes.

Calculate the current in the LDR.

[4 marks]

Current = _____ A

0 6 . 4 Sometimes dirt can cover the LDR on the security light.

What effect would dirt on the LDR have on the security light?

[1 mark]

Tick (✓) **one** box.

- The security light would always be off. ☐
- The security light would always be on. ☐
- The security light would only be on during the day. ☐
- The security light would only be on during the night. ☐

8

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0 7 **Figure 9** shows a car travelling at a constant speed on a straight, level road.

Figure 9

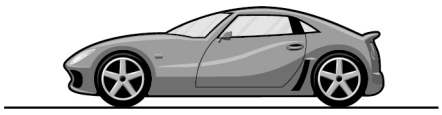
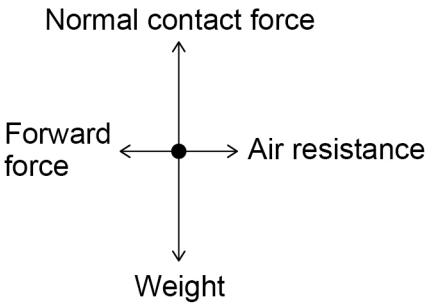


Figure 10 shows a free body diagram for the car.

Figure 10



0 7 . 1 Explain how the free body diagram shows that the resultant force on the car is zero.

[3 marks]

Question 7 continues on the next page

Do not write outside the box

Table 4 shows how the braking distance of a car varies with the speed of the car.

Table 4

Speed in metres per second	Braking distance in metres
6	3
12	12
18	27
24	48

0 7 . 2 A car decelerates from 24 m/s to 0 m/s

The work done by the brakes in decelerating the car is 210 000 J

Determine the mean braking force.

Use information from **Table 4**.

Give your answer to 2 significant figures.

[4 marks]

Mean braking force (2 significant figures) = _____ N

Do not write outside the box

0 7 . 3 The braking distance is directly proportional to the kinetic energy of the car.

Explain how the data in **Table 4** supports this relationship.

[3 marks]

10

Turn over for the next question

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0 8 This question is about halogens.

Bromine reacts with sodium to produce sodium bromide.

0 8 . 1 Describe the structure of and bonding in sodium bromide.

[2 marks]

0 8 . 2 The equation for the reaction is:

$$2\,Na + Br_2 \rightarrow 2\,NaBr$$

1 g of bromine reacts with sodium.

Calculate the number of bromine molecules in 1 g of bromine.

1 mole of bromine contains 6.02×10^{23} bromine molecules.

Relative formula mass (M_r) of bromine = 160

[3 marks]

Number of bromine molecules = _____

Do not write outside the box

0 8 . 3 **Table 5** shows the boiling points of some halogens.

Table 5

Halogen	Boiling point in °C
Bromine	60
Chlorine	−34
Fluorine	−188

Explain the trend in the boiling points of the halogens.

[4 marks]

9

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0 9 This question is about the industrial process used to produce ammonia.

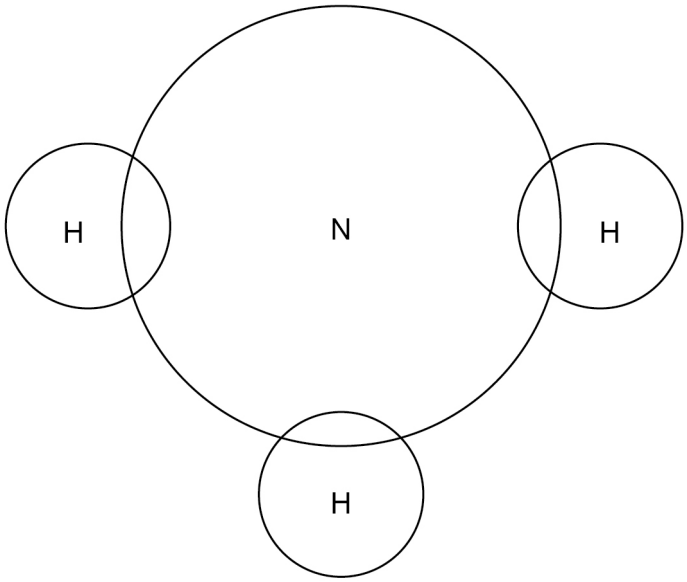
Ammonia is produced from nitrogen and hydrogen.

0 9 . 1 Complete the dot and cross diagram for the ammonia molecule shown in **Figure 11**.

Show only the electrons in the outer shell of each atom.

[2 marks]

Figure 11



Question 9 continues on the next page

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Hydrogen is obtained from natural gas.

One stage in the process is to react carbon monoxide with steam.

The equation for the reaction is:

$$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$$

The forward reaction is exothermic.

In the industrial process, the reaction occurs at approximately 400 °C

0 9 . 2 The reaction between carbon monoxide and steam reaches dynamic equilibrium.

Which statement describes dynamic equilibrium?

[1 mark]

Tick (✓) **one** box.

The forward reaction and the reverse reaction stop. ☐

The forward reaction happens at the same rate as the reverse reaction. ☐

The rate of the forward reaction is faster than the rate of the reverse reaction. ☐

The rate of the forward reaction is slower than the rate of the reverse reaction. ☐

0 9 . 3 The reaction between carbon monoxide and steam is faster at 600 °C than at 400 °C

Explain why a temperature of 600 °C is **not** used in the industrial process.

[2 marks]

Do not write outside the box

0 9 . 4 Predict the effect of increasing the pressure on the yield of hydrogen.

Give **one** reason for your answer.

[2 marks]

Prediction _____

_____

Reason _____

_____

0 9 . 5 Give **two** reasons why a catalyst is used in the reaction between carbon monoxide and steam.

[2 marks]

1 _____

_____

2 _____

_____

0 9 . 6 The carbon dioxide produced in this reaction can be used in fizzy drinks.

In fizzy drinks carbon dioxide gas dissolves in water to form an aqueous solution of carbonic acid.

Carbonic acid is a weak acid.

Explain the difference between a weak acid and a strong acid.

[2 marks]

_____

_____

_____

_____

Question 9 continues on the next page

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0 9 . 7 The equation for the production of ammonia from nitrogen and hydrogen is:

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

1.275×10^{11} kg of ammonia is used each year to manufacture fertilisers.

This is 85% of the ammonia produced each year.

Calculate the mass of nitrogen needed to manufacture the total mass of ammonia produced each year.

Relative atomic masses (A_r): H = 1 N = 14

[6 marks]

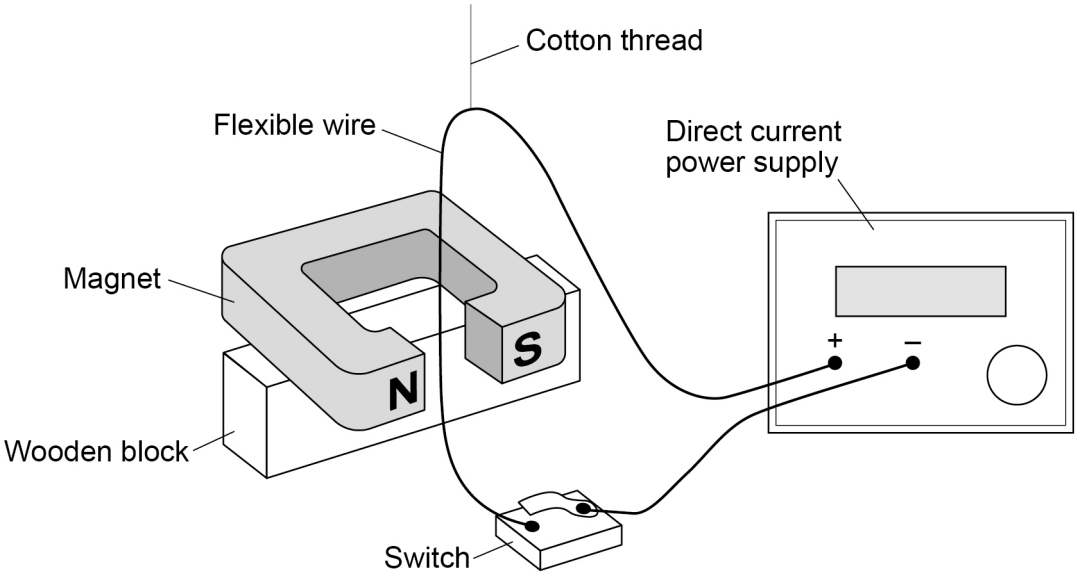
Mass of nitrogen = _____ kg

17

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1 0 **Figure 12** shows the equipment a student used to investigate the motor effect.

Figure 12



1 0 . 1 Explain why the wire moves when the switch is closed.

[4 marks]

Question 10 continues on the next page

Do not write outside the box

1 0 . 2 The student recorded these measurements:

- potential difference across wire = 1.50 V
- resistance of wire = 0.60 Ω
- length of wire in magnetic field = 0.050 m
- force on wire = 3.75×10^{-4} N

Calculate the magnetic flux density of the magnetic field.

Give the unit.

[6 marks]

Magnetic flux density = _____ Unit _____

10

END OF QUESTIONS

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