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

F

Foundation 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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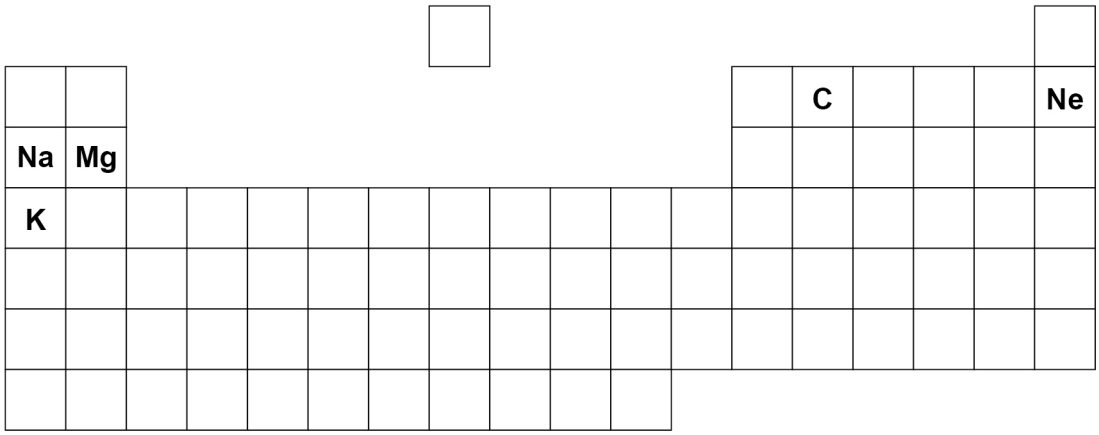
0 1 This question is about elements.

Figure 1 shows the chemical symbols of five elements in the periodic table.

Figure 1



0 1 . 1 Which element is a noble gas?

[1 mark]

Tick (✓) **one** box.

C ☐ K ☐ Mg ☐ Na ☐ Ne ☐

0 1 . 2 Which element forms fullerenes?

[1 mark]

Tick (✓) **one** box.

C ☐ K ☐ Mg ☐ Na ☐ Ne ☐

Do not write outside the box

0 1 . 3 Which **two** elements have atoms with the same number of electrons in their outer shell?

Use **Figure 1**.

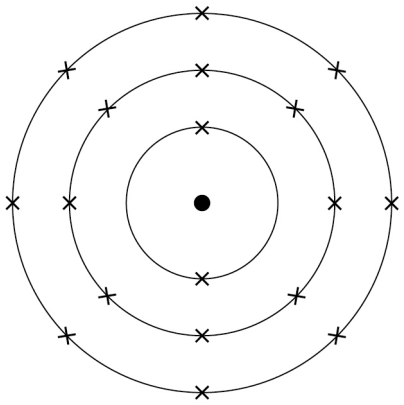
[1 mark]

_____ and _____

0 1 . 4 Argon is very unreactive.

Figure 2 represents the electronic structure of an argon atom.

Figure 2



How does the electronic structure show that argon is unreactive?

[1 mark]

_____

_____

Question 1 continues on the next page

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Figure 3 shows some of the elements in Group 7 of the periodic table.

Figure 3

19 **F** fluorine 9
35.5 **Cl** chlorine 17
80 **Br** bromine 35
127 **I** iodine 53

0 1 . 5 Chlorine gas consists of molecules.

What is the formula of a chlorine gas molecule?

[1 mark]

Tick (✓) **one** box.

Cl ☐ Cl^2 ☐ Cl_2 ☐ 2Cl ☐

0 1 . 6 Which Group 7 element is the most reactive?

[1 mark]

Tick (✓) **one** box.

Bromine ☐

Chlorine ☐

Fluorine ☐

Iodine ☐

Do not write outside the box

0 1 . 7 Lithium atoms react with bromine atoms to produce lithium bromide.

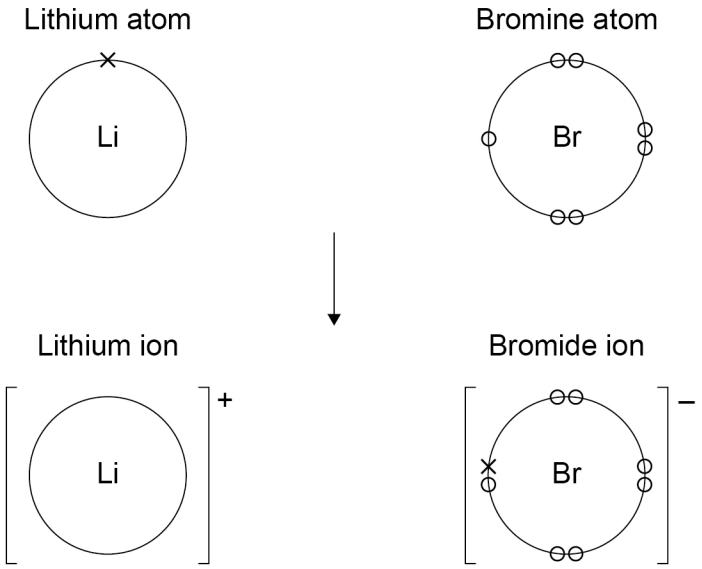
Lithium bromide contains lithium ions and bromide ions.

Figure 4 shows the electronic structure of the atoms and ions.

The symbols (**o**) and (**x**) represent electrons.

Only the outer shell electrons are shown.

Figure 4



Describe what happens when a lithium atom reacts with a bromine atom to produce a lithium ion and a bromide ion.

[4 marks]

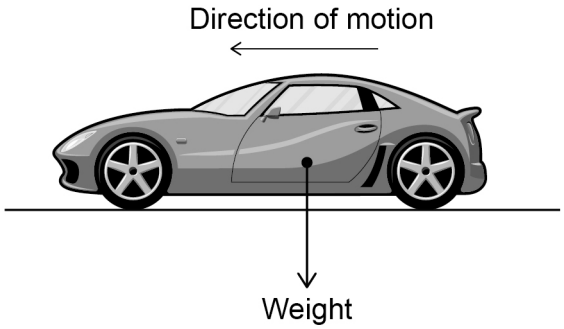
10

Turn over ►

Do not write outside the box

0 2 **Figure 5** shows a car travelling at a constant speed on a straight, level road.

Figure 5



0 2 . 1 Draw an arrow on **Figure 5** to show the direction of the force of air resistance on the car.

[1 mark]

0 2 . 2 The mass of the car is 850 kg

Calculate the weight of the car.

Use the equation:

weight = mass × gravitational field strength

gravitational field strength = 9.8 N/kg

[2 marks]

Weight = _____ N

Do not write outside the box

0 2 . 3 What is the direction of the normal contact force of the road on the wheels?

[1 mark]

Tick (✓) **one** box.

Down ☐

Left ☐

Right ☐

Up ☐

0 2 . 4 The car is travelling at constant speed.

The resultant force on the car is zero.

How does the size of the normal contact force of the road on the wheels compare with the weight of the car?

[1 mark]

Tick (✓) **one** box.

The normal contact force is equal to the weight of the car. ☐

The normal contact force is greater than the weight of the car. ☐

The normal contact force is less than the weight of the car. ☐

Question 2 continues on the next page

Do not write outside the box

0 2 . 5 A car is travelling at a constant speed.

A constant braking force of 5100 N is applied by the brakes.

The car decelerates and stops.

The braking distance is 38 m

Calculate the work done by the braking force.

Choose the unit from the box.

joule	**metre**	**newton**	**watt**

Use the equation:

work done = force × distance

[3 marks]

Work done = _____ Unit _____

0 2 . 6 Which **two** factors affect braking distance?

[2 marks]

Tick (✓) **two** boxes.

- Condition of the tyres ☐
- Distractions ☐
- Drugs ☐
- Ice on the road ☐
- Using a mobile phone ☐

Do not write outside the box

The distance a car travels during the driver's reaction time is called the thinking distance.

0 2 . 7 Which factor affects thinking distance?

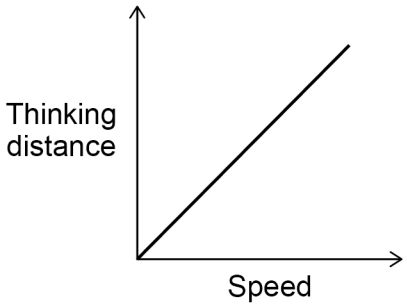
[1 mark]

Tick (✓) **one** box.

- Condition of the brakes ☐
- Mass of the car ☐
- Tiredness of the driver ☐
- Weather conditions ☐

0 2 . 8 **Figure 6** shows a sketch graph of how thinking distance varies with speed.

Figure 6



Which term describes the relationship between thinking distance and speed?

[1 mark]

Tick (✓) **one** box.

- Direct proportion ☐
- Inverse proportion ☐
- Negative correlation ☐

12

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ANSWER IN THE SPACES AVAILABLE

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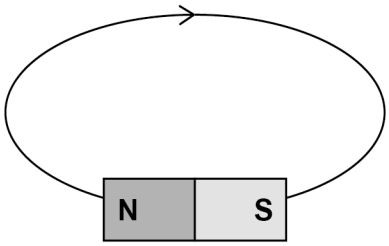
0 3 **Figure 7** shows part of the magnetic field around a bar magnet.

Figure 7



0 3 . 1 Complete **Figure 7** to show the magnetic field around the bar magnet.

You should:

- draw **one** more magnetic field line
- show the direction of the magnetic field.

[2 marks]

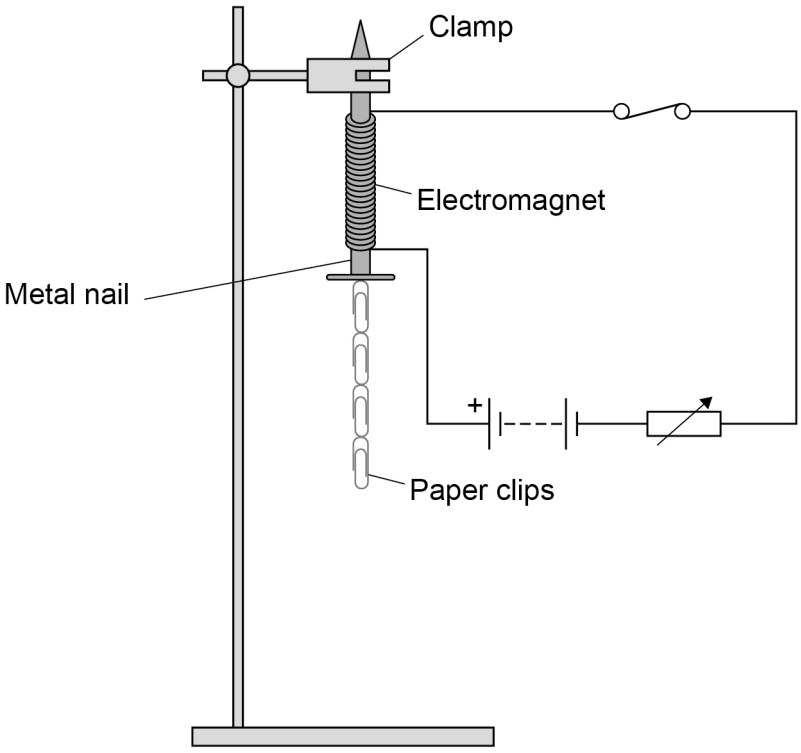
Question 3 continues on the next page

A student made an electromagnet from a metal nail and a coil of wire.

Figure 8 shows the electromagnet held in a clamp and connected to a circuit.

When the switch was closed, the electromagnet attracted paper clips.

Figure 8



0 3 . 2 Which metal should be used for the nail?

[1 mark]

Tick (✓) **one** box.

Aluminium ☐

Copper ☐

Iron ☐

Sodium ☐

Do not write outside the box

0 3 . 3 The student varied the number of turns of wire around the nail.

The student recorded how many paper clips the electromagnet could hold.

Table 1 shows the results.

Table 1

Number of turns of wire around the nail	Number of paper clips
20	5
40	10
60	**X**
80	20

Predict value **X** in **Table 1**.

[1 mark]

X = _____

Question 3 continues on the next page

Do not write outside the box

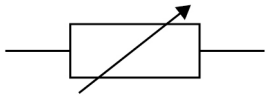
0 3 . 4 The student increased the resistance of the variable resistor.

What is the circuit symbol for a variable resistor?

[1 mark]

Tick (✓) **one** box.

☐



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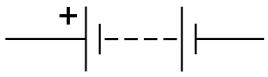

☐

0 3 . 5 Complete the sentences.

Choose answers from the box.

Each answer may be used once, more than once or not at all.

[2 marks]

decreased	**increased**	**stayed the same**

When the resistance of the variable resistor was increased, the current in the electromagnet _____ .

When the resistance of the variable resistor was increased, the number of paper clips the electromagnet could hold _____ .

Do not write outside the box

0 3 . 6 **Figure 9** shows an electromagnet being used at a scrapyard.

Figure 9

Give **two** advantages of using an electromagnet to sort scrap metal compared with using a permanent magnet.

[2 marks]

1 _____

_____

2 _____

_____

9

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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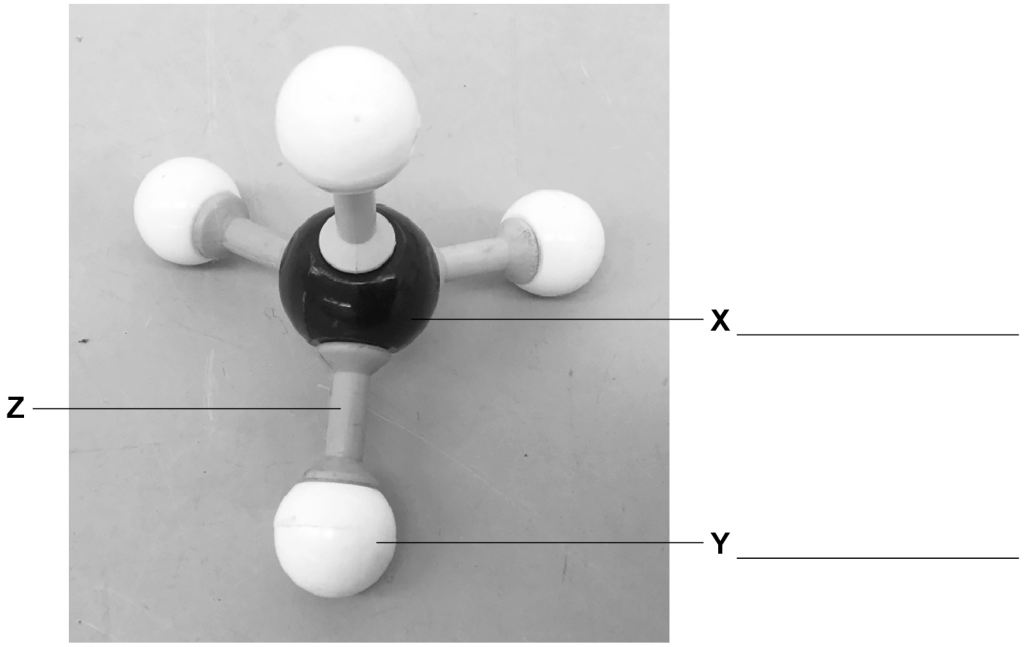
0 4 Crude oil is a mixture containing hydrocarbons.

Alkanes are hydrocarbons.

Figure 10 represents an alkane.

Figure 10



0 4 . 1 **X** and **Y** represent atoms of different elements in an alkane.

Label element **X** and element **Y** on **Figure 10**.

[2 marks]

0 4 . 2 What is represented by **Z** on **Figure 10**?

[1 mark]

Question 4 continues on the next page

Crude oil is separated into fractions in a fractionating column.

Figure 11 shows a fractionating column.

Figure 11

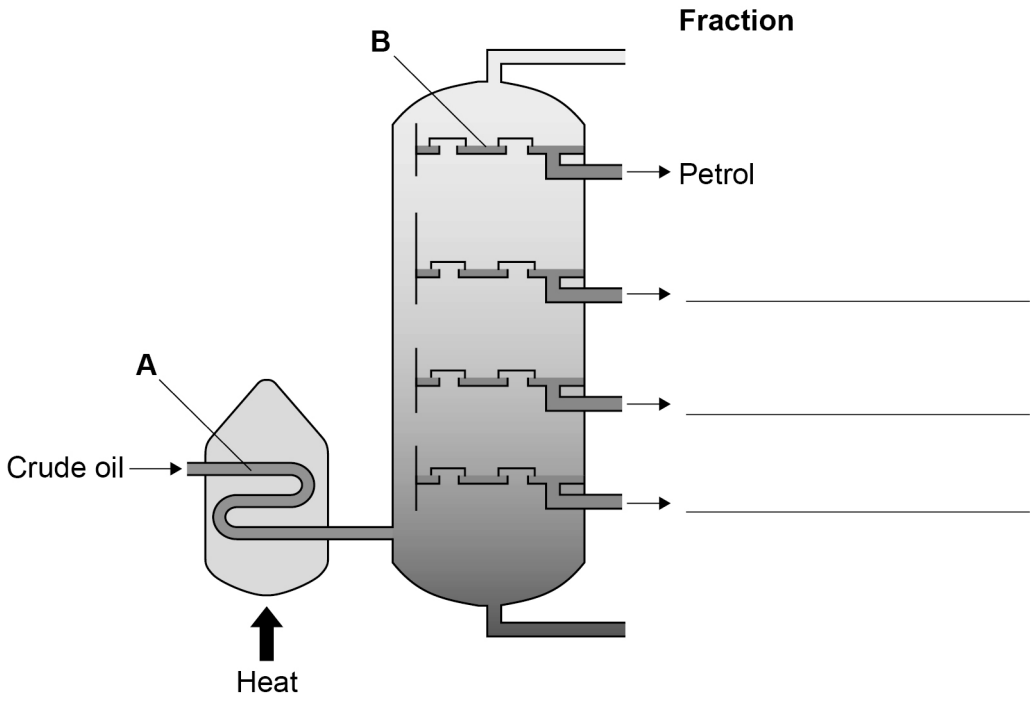


Table 2 gives some properties of different fractions separated from crude oil.

Table 2

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

Do not write outside the box

0 4 . 3 Label **Figure 11** to show where diesel, heavy fuel oil and kerosene fractions are collected.

Use **Table 2**.

[1 mark]

0 4 . 4 Complete the sentences.

Choose answers from the box.

[3 marks]

condensation	**cracking**	**distillation**
evaporation	**oxidation**	**polymerisation**

Crude oil is separated by fractional _____ .

The process happening at **A** in **Figure 11** is _____ .

The process happening at **B** in **Figure 11** is _____ .

0 4 . 5 Which statement about the flammability of petrol and diesel is correct?

Use **Table 2**.

[1 mark]

Tick (✓) **one** box.

Petrol and diesel have the same flammability. ☐

Petrol is less flammable than diesel. ☐

Petrol is more flammable than diesel. ☐

Question 4 continues on the next page

Do not write outside the box

Table 2 is repeated here.

Table 2

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

Octane is a hydrocarbon obtained from crude oil.

Octane has 8 carbon atoms.

0 4 . 6 Which fraction in **Table 2** contains octane?

[1 mark]

Tick (✓) **one** box.

Diesel ☐

Heavy fuel oil ☐

Kerosene ☐

Petrol ☐

0 4 . 7 Name the **two** substances produced from the complete combustion of octane.

[2 marks]

1 _____

2 _____

11

Do not write outside the box

0 5 One use of carbon dioxide is in fizzy drinks.

In fizzy drinks carbon dioxide gas dissolves in water to form an aqueous solution of carbonic acid (H_2CO_3).

0 5 . 1 The equation for the reaction is:

$$CO_2(g) + H_2O(l) \rightleftharpoons H_2CO_3(\_\_\_\_)$$

Complete the equation by writing the state symbol for carbonic acid (H_2CO_3).

Choose the answer from the box.

[1 mark]

aq	**g**	**l**	**s**

0 5 . 2 Which ion causes carbonic acid to be acidic?

[1 mark]

Tick (✓) **one** box.

CO_3^{2-} ☐ H^+ ☐ O^{2-} ☐ OH^- ☐

0 5 . 3 Describe how to test the pH of carbonic acid.

Give the result of the test.

[2 marks]

Test _____

_____

Result _____

_____

Question 5 continues on the next page

Turn over ►

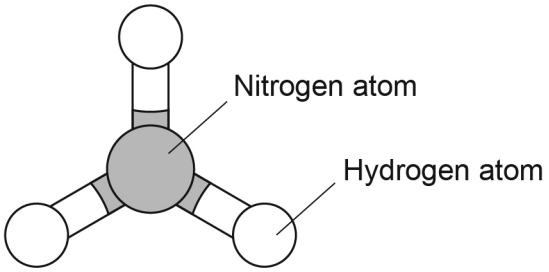
Ammonia gas is produced from nitrogen gas and hydrogen gas in a reversible reaction.

The word equation is:

nitrogen + hydrogen $\rightleftharpoons$ ammonia

0 5 . 4 **Figure 12** represents an ammonia molecule.

Figure 12



What is the formula of ammonia?

[1 mark]

0 5 . 5 When does a reversible reaction reach dynamic equilibrium?

[1 mark]

Tick (✓) **one** box.

When the forward reaction and the reverse reaction happen at the same rate. ☐

When the forward reaction is faster than the reverse reaction. ☐

When the reverse reaction is faster than the forward reaction. ☐

Do not write outside the box

0 5 . 6 Which condition is needed for the reversible reaction between nitrogen and hydrogen to be at dynamic equilibrium?

[1 mark]

Tick (✓) **one** box.

All gases can escape ☐

Ammonia can escape ☐

No gases can escape ☐

0 5 . 7 How can the direction of a reversible reaction be changed?

[1 mark]

0 5 . 8 Iron is used as a catalyst in the industrial production of ammonia.

Why is a catalyst used?

[1 mark]

0 5 . 9 150 000 million kg of ammonia is produced each year.

85% of the ammonia produced each year is used to manufacture fertilisers.

Calculate the mass of ammonia used each year to manufacture fertilisers.

[2 marks]

Mass = _____ million kg

11

Do not write outside the box

0 6 A student 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.
2. Add 2 cm^3 of starch solution to the same test tube.
3. Start the timer.
4. Remove one drop of the amylase-starch mixture after 30 seconds.
5. Test the drop for starch.
6. Remove a drop of the amylase-starch mixture every 30 seconds 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.

The student kept all the solutions in a water bath at 37 °C

0 6 . 1 What is the independent variable in the investigation?

[1 mark]

Tick (✓) **one** box.

pH of amylase solution ☐

Temperature of water bath ☐

Volume of starch solution ☐

Do not write outside the box

0 6 . 2 Describe the test for starch.

Give the result of the test if starch is present.

[2 marks]

Test _____

_____

Result _____

_____

Question 6 continues on the next page

Do not write outside the box

Table 3 shows the results.

Table 3

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 6 . 3 What is the pH range the student used?

Use **Table 3**.

[1 mark]

pH range from _____ to _____

0 6 . 4 At the optimum pH the enzyme works fastest.

What is the optimum pH for amylase enzyme?

Use **Table 3**.

[1 mark]

Optimum pH = _____

Do not write outside the box

0 6 . 5 How could the investigation be improved to get a more accurate value for the optimum pH?

[1 mark]

Tick (✓) **one** box.

Remove one drop of the amylase-starch mixture every minute. ☐

Use a less concentrated amylase solution. ☐

Use smaller pH intervals. ☐

0 6 . 6 What is the best way for the student to display the results?

[1 mark]

Tick (✓) **one** box.

Bar chart ☐

Frequency table ☐

Line graph ☐

Pie chart ☐

7

Turn over for the next question

Do not write outside the box

There are no questions printed on this page

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ANSWER IN THE SPACES PROVIDED

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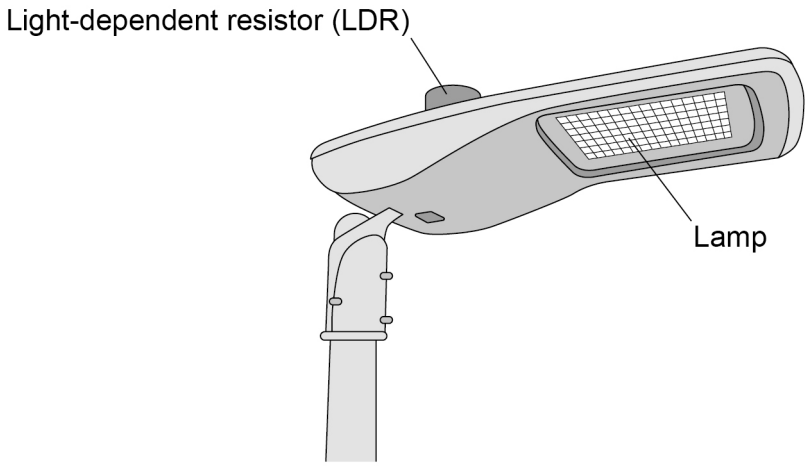
0 7 Some street lights automatically switch on when it gets dark.

Figure 13 shows a street light.

The electrical circuit for the street light includes a light-dependent resistor (LDR).

Figure 13



0 7 . 1 The power supply for the street light uses alternating current.

What is alternating current?

[1 mark]

Tick (✓) **one** box.

Current that continually changes direction. ☐

Current that increases and decreases and is in one direction only. ☐

Current that is constant and is in one direction only. ☐

Question 7 continues on the next page

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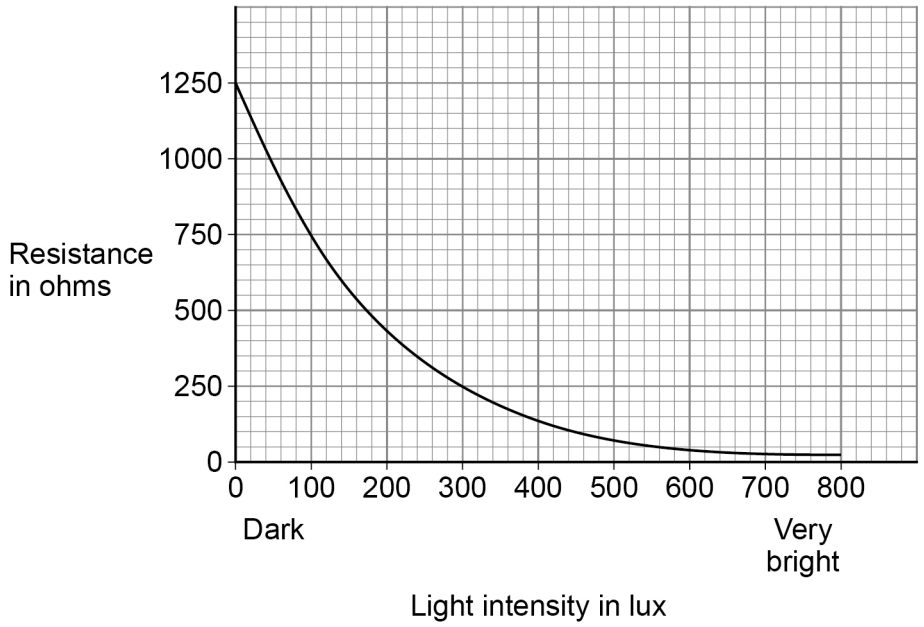
Figure 14 shows how the resistance of the LDR varies with light intensity.

Light intensity is measured in lux

Figure 14



0 7 . 2 How does light intensity affect the resistance of the LDR?

[1 mark]

0 7 . 3 Write down the equation which links current (*I*), potential difference (*V*) and resistance (*R*).

[1 mark]

Do not write outside the box

0 7 . 4 The potential difference across the LDR is 30 V

The current in the LDR is 0.05 A

Calculate the resistance of the LDR.

[3 marks]

Resistance = _____ Ω

0 7 . 5 Determine the light intensity incident on the LDR.

Use your answer to Question **07.4** and **Figure 14**.

[1 mark]

Light intensity = _____ lux

0 7 . 6 This street light may stay switched on when it is **not** dark.

What is the most likely cause of this problem?

[1 mark]

Tick (✓) **one** box.

The LDR is covered by dirt. ☐

The lamp in the street light is broken. ☐

The temperature is decreasing. ☐

Question 7 continues on the next page

Do not write outside the box

0 7 . 7 This street light is replaced with one which is more efficient.

What does more efficient mean?

[1 mark]

Tick (✓) **one** box.

Larger proportion of useful energy output ☐

Larger proportion of wasted energy output ☐

Larger total energy input per second ☐

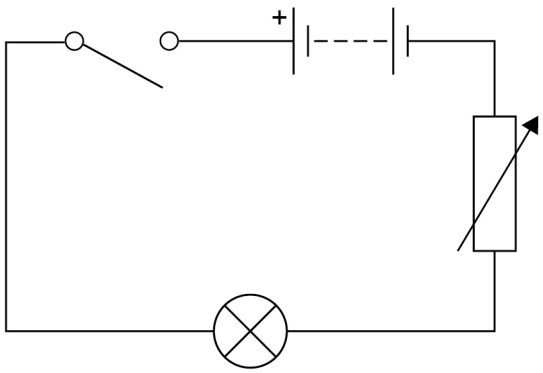
9

Do not write outside the box

0 8 A student investigated how the power output of a filament lamp varied with the current in the lamp.

Figure 15 shows part of the circuit the student used.

Figure 15



0 8 . 1 To calculate power output the student measured the current in the lamp and the potential difference across the lamp.

Complete **Figure 15** by adding an ammeter and a voltmeter to make the measurements.

Use the correct circuit symbols.

[3 marks]

0 8 . 2 Which energy store in the battery decreases when the lamp is switched on?

[1 mark]

0 8 . 3 What happens to the energy transferred by the lamp?

[1 mark]

Question 8 continues on the next page

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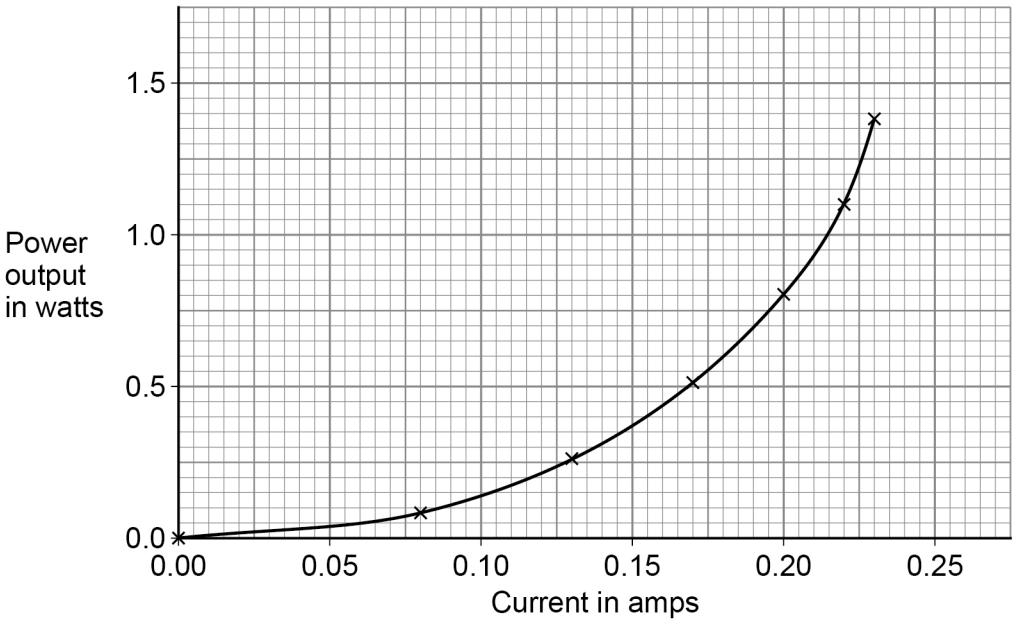
Figure 16 shows the results.

Figure 16



0 8 . 4 Describe how varying the current affects the power output of the filament lamp.

[2 marks]

0 8 . 5 Write down the equation which links current (I), power (P) and resistance (R).

[1 mark]

Do not write outside the box

0 8 . 6 Determine the resistance of the lamp when the current in the lamp is 0.22 A

[4 marks]

Resistance = _____ Ω

12

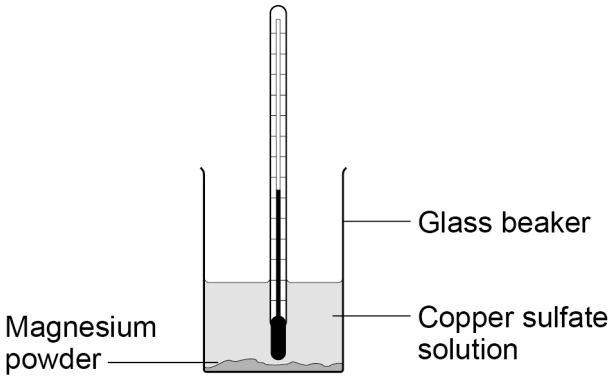
Turn over for the next question

Do not write outside the box

0 9 A student investigated the temperature increase when magnesium powder was added to copper sulfate solution.

Figure 17 shows the apparatus used.

Figure 17



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.

Do not write outside the box

0 9 . 1 Give **two** control variables the student should use.

[2 marks]

1 _____

_____

2 _____

_____

0 9 . 2 Suggest **one** change to improve the accuracy of the investigation.

[1 mark]

_____

_____

Question 9 continues on the next page

Do not write outside the box

0 9 . 3 **Table 4** shows the student's results.

Table 4

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

Do not write outside the box

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

Use data from **Table 4** in your answer.

[6 marks]

9

Turn over for the next question

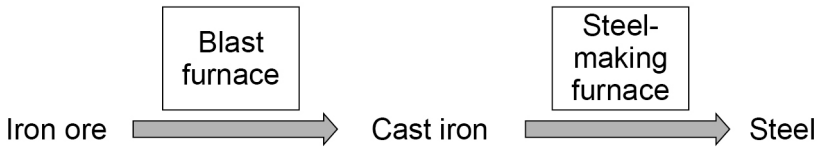
Do not write outside the box

1 0 This question is about iron and steel.

Figure 18 shows a flow chart for the production of iron and steel from iron ore.

Iron ore consists mainly of iron oxide.

Figure 18



1 0 . 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]

$$Fe_2O_3 + 3CO \longrightarrow \_\_\_\_\_ + \_\_\_\_\_$$

1 0 . 2 Iron oxide is reduced in the reaction with carbon monoxide.

What does 'reduced' mean in this reaction?

[1 mark]

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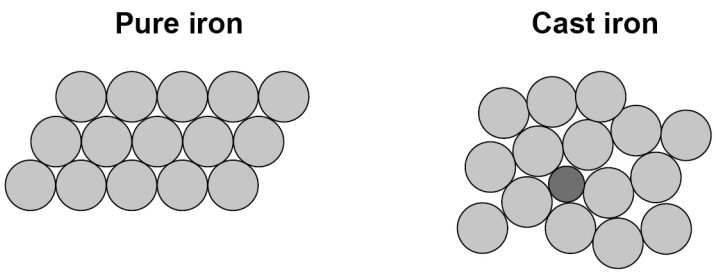
1 0 . 3 Cast iron is an alloy.

Cast iron contains carbon.

Figure 19 shows the arrangement of atoms in pure iron and in cast iron.

Figure 19



Explain why cast iron is harder than pure iron.

[4 marks]

Question 10 continues on the next page

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1 0 . 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 _____

_____

10

END OF QUESTIONS

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