A

Surname ______________________

Other Names ______________________

Centre Number ______________________

Candidate Number ______________________

Candidate Signature ______________________

I declare this is my own work.

GCSE
COMBINED SCIENCE: SYNERGY
Foundation Tier

F

Paper 3 Physical Sciences

8465/3F

Monday 1 June 2020 Afternoon

Time allowed: 1 hour 45 minutes

At the top of the page, write your surname and other names, your centre number, your candidate number and add your signature.

[Turn over]

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.**

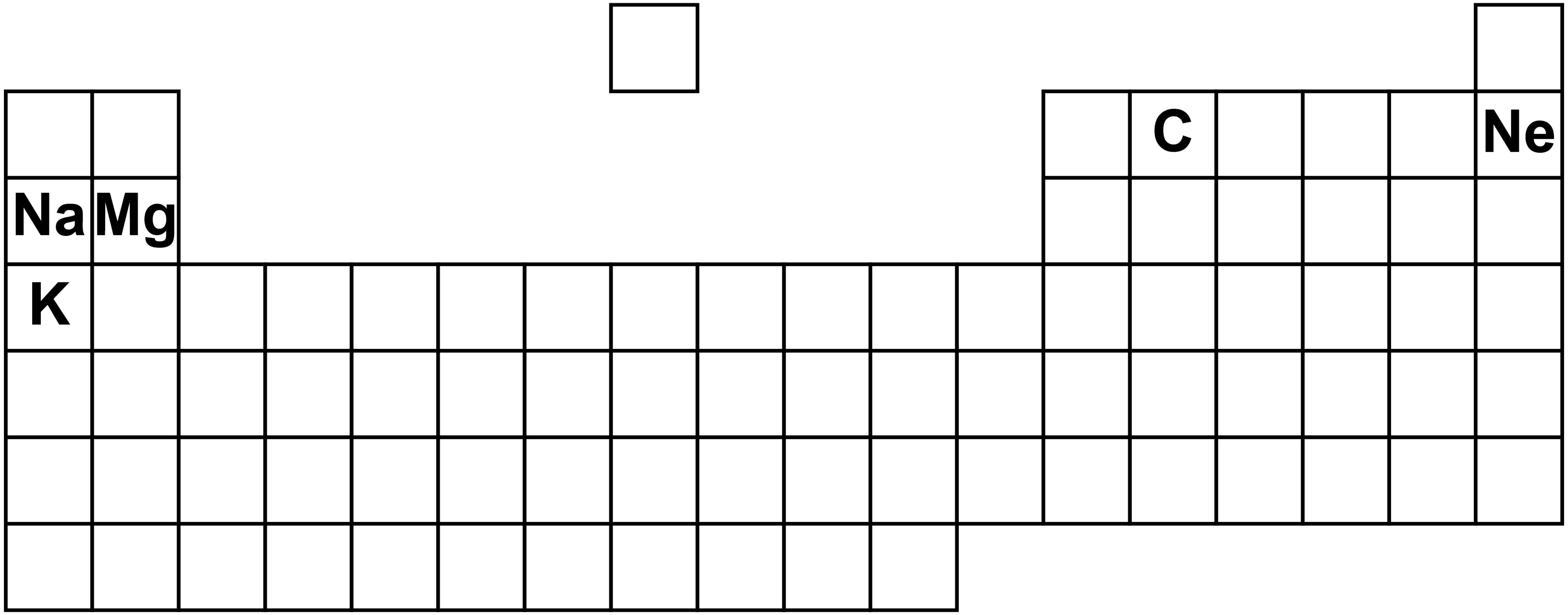
DO NOT TURN OVER UNTIL TOLD TO DO SO

0 1

This question is about 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 marks]

Tick (✓) ONE box.

- ☐ **C**
- ☐ **K**
- ☐ **Mg**
- ☐ **Na**
- ☐ **Ne**

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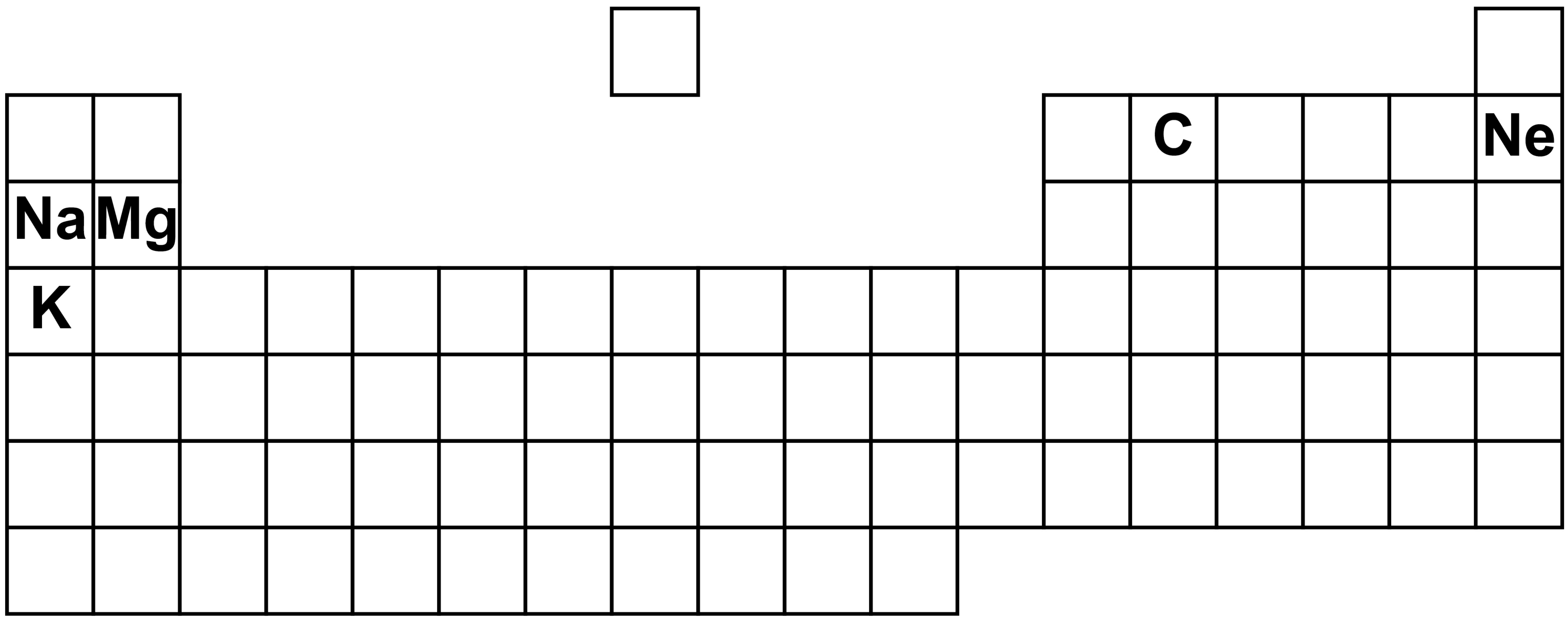
[Turn over]

REPEAT OF FIGURE 1



0 1 . 3

Which TWO elements have atoms with the same number of electrons in their outer shell?

Use FIGURE 1. [1 mark]

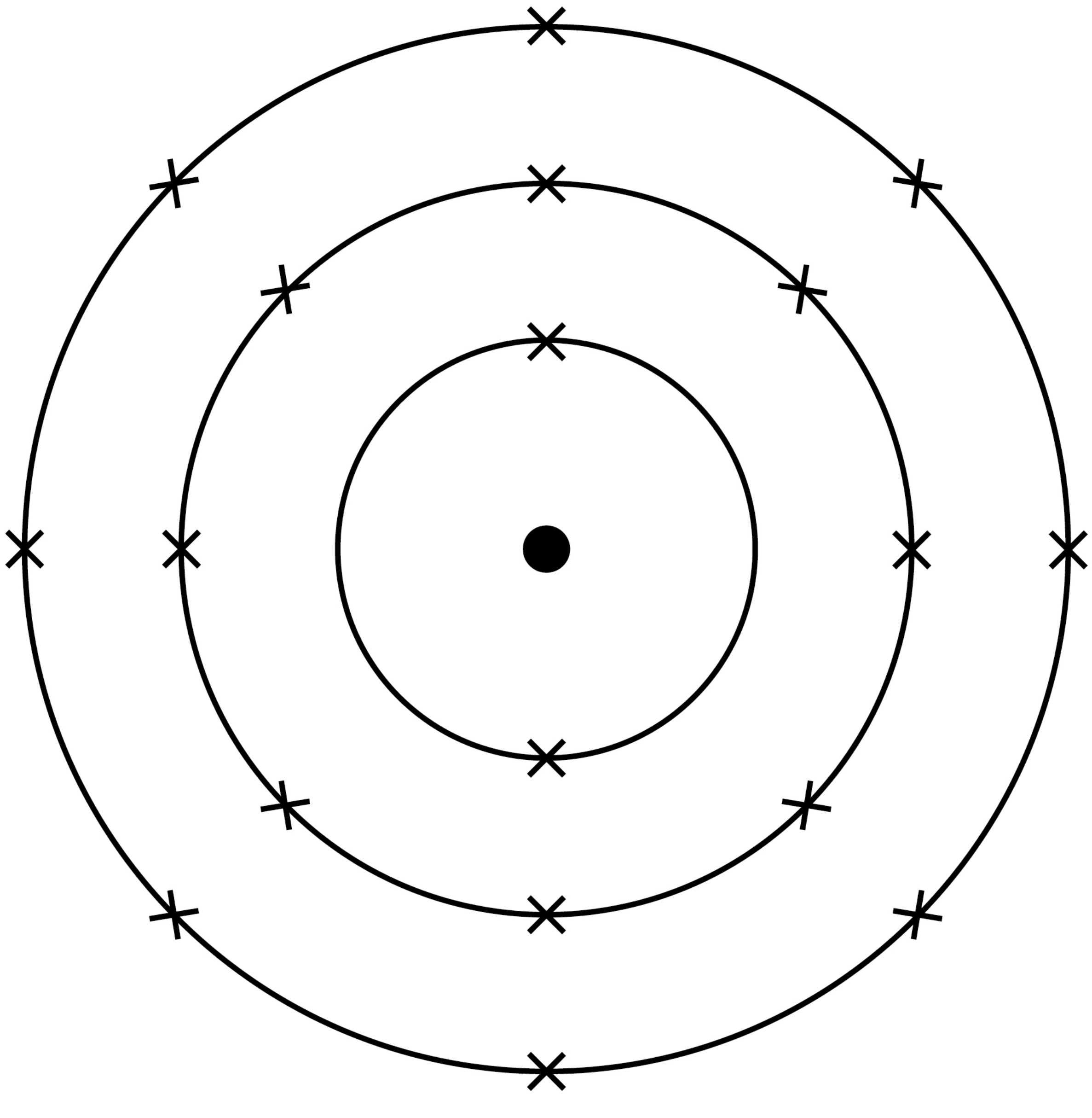
____________________ and ____________________

01.4

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]

[Turn over]

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

☐ $2Cl$

[Turn over]

REPEAT OF FIGURE 3

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

0 1 . 6

Which Group 7 element is the most reactive? [1 mark]

Tick (✓) ONE box.

☐ **Bromine**

☐ **Chlorine**

☐ **Fluorine**

☐ **Iodine**

[Turn over]

0 1 . 7

Lithium atoms react with bromine atoms to produce lithium bromide.

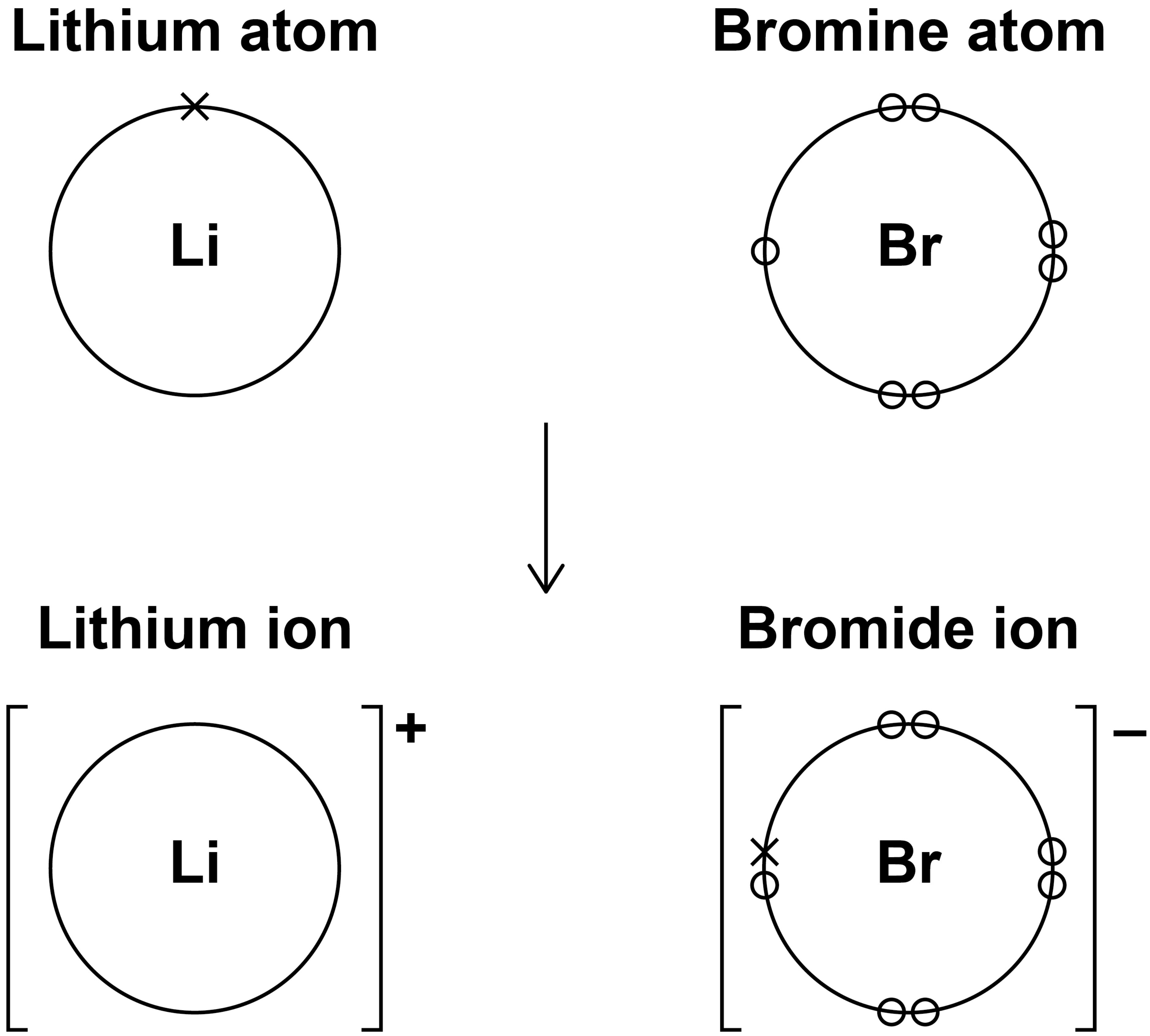
Lithium bromide contains lithium ions and bromide ions.

FIGURE 4, on the opposite page, 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



[Turn over]

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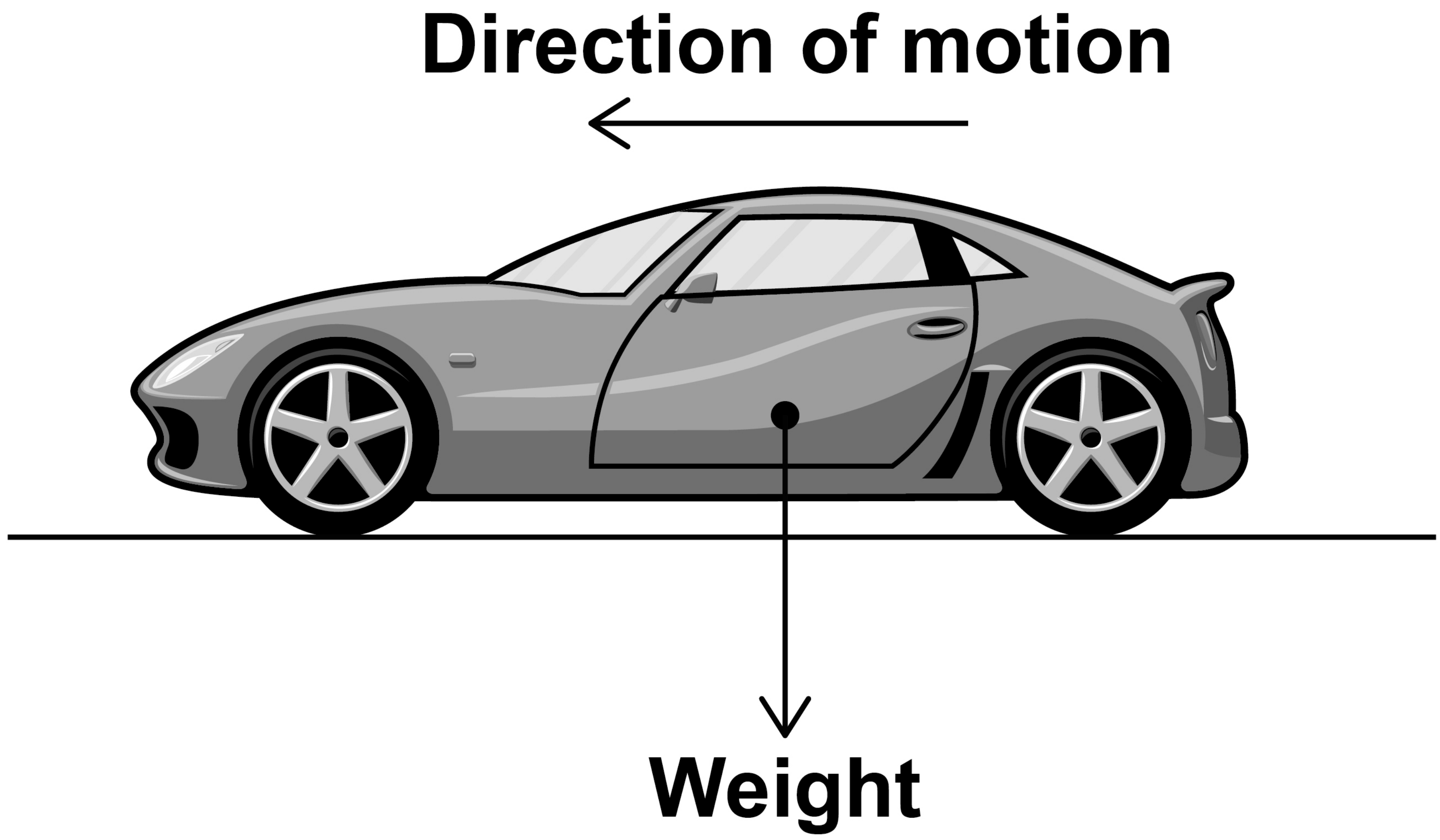
Describe what happens when a lithium atom reacts with a bromine atom to produce a lithium ion and a bromide ion. [4 marks]

10

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

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.**

[Turn over]

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 list.

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

Use the equation:

work done = force × distance [3 marks]

Work done = ______________________

Unit ______________________

[Turn over]

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**

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**

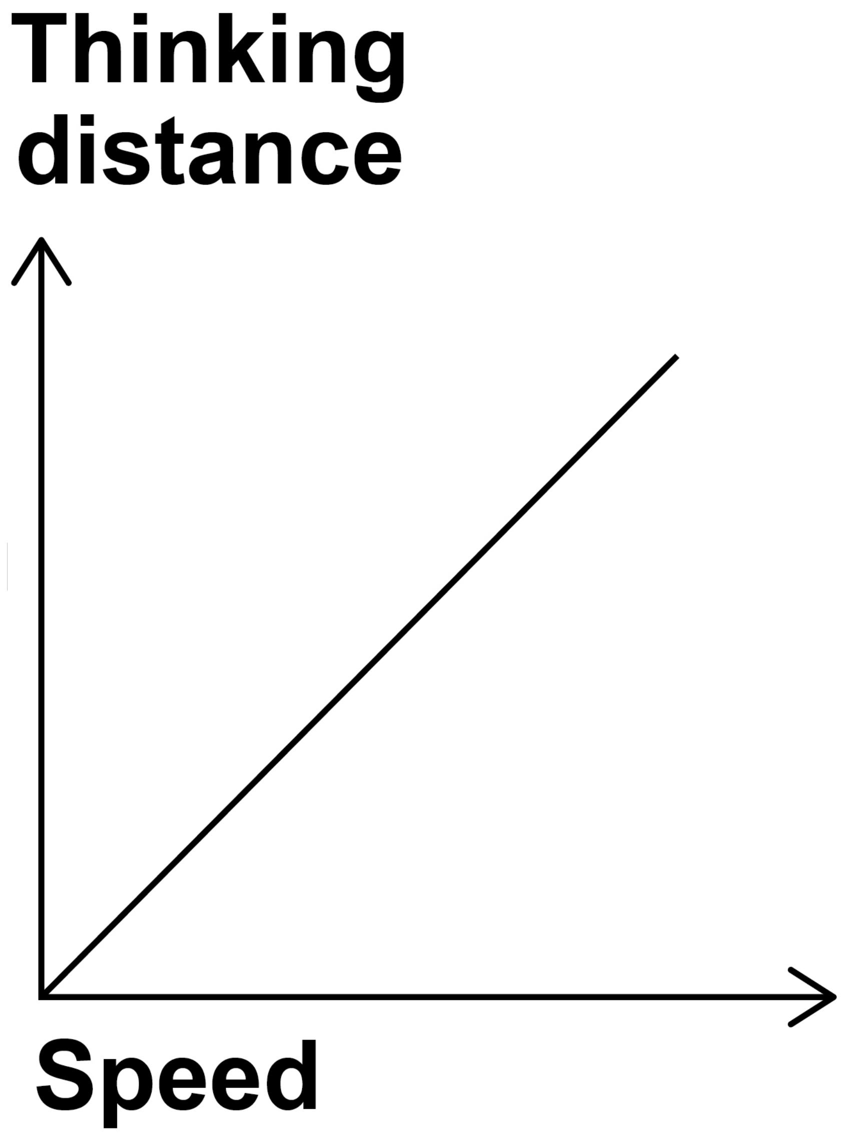
☐ **Weather conditions**

[Turn over]

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**

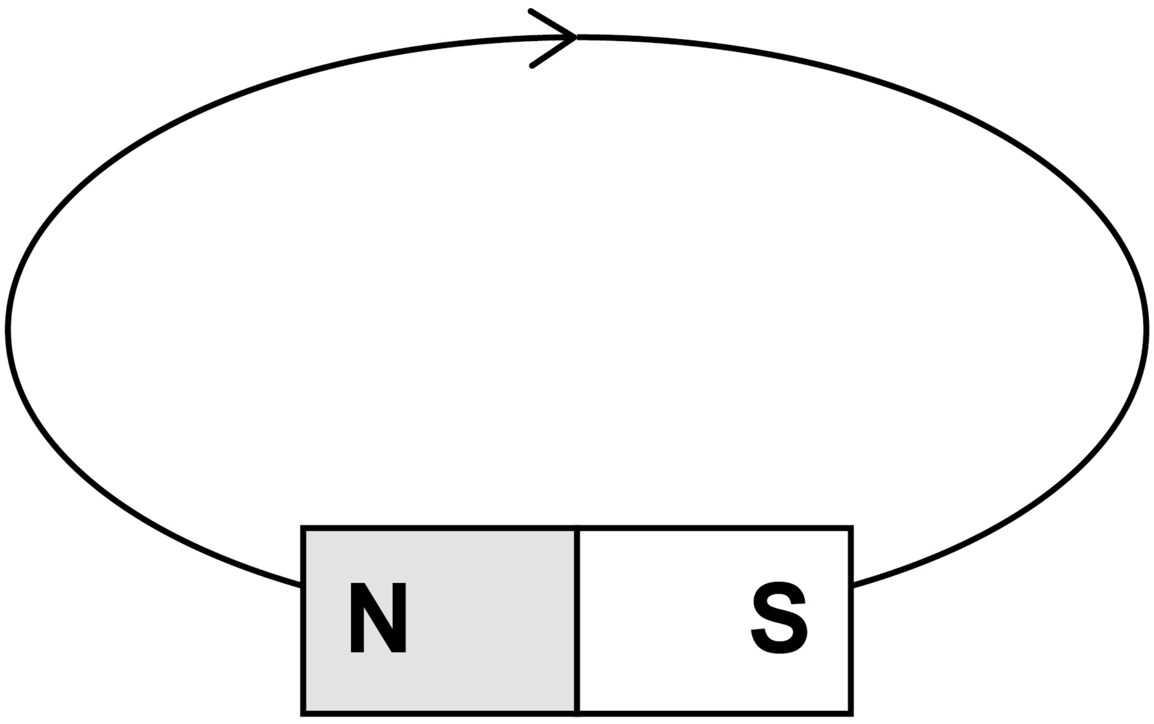
[Turn over]

12

0 3

FIGURE 7 shows part of the magnetic field around a bar magnet.

FIGURE 7



0 3 . 1

Complete FIGURE 7, on the opposite page, 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]

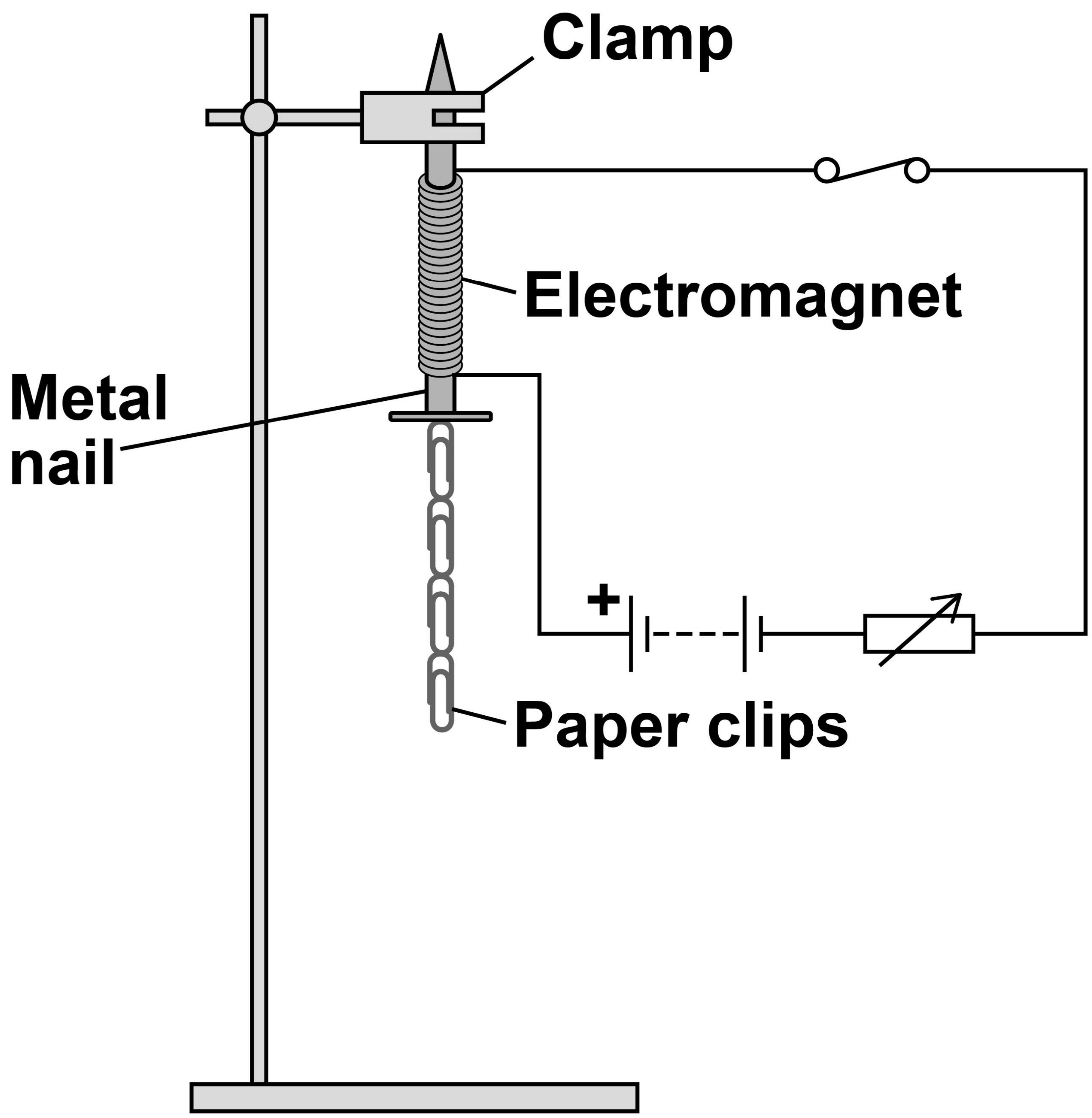
[Turn over]

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

FIGURE 8, on the opposite page, shows the electromagnet held in a clamp and connected to a circuit.

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

FIGURE 8



[Turn over]

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0 3 . 2

Which metal should be used for the nail?
[1 mark]

Tick (✓) ONE box.

☐ Aluminium

☐ Copper

☐ Iron

☐ Sodium

[Turn over]

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 = ____________________________

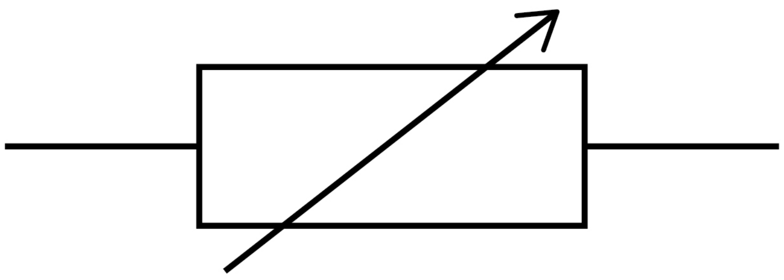
0 3 . 4

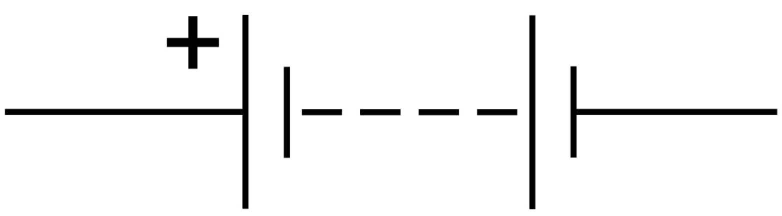
The student increased the resistance of the variable resistor.

What is the circuit symbol for a variable resistor? [1 mark]

Tick (✓) ONE box.

☐ 

☐ 

☐ 

[Turn over]

0 3 . 5

Complete the sentences.

Choose answers from the list.

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 __________________________ .

[Turn over]

0 3 . 6

FIGURE 9 shows an electromagnet being used at a scrapyard.

FIGURE 9

Electromagnet

Scrap metal

Give TWO advantages of using an electromagnet to sort scrap metal compared with using a permanent magnet. [2 marks]

1 ____

____

____

2 ____

____

____

[Turn over]

9

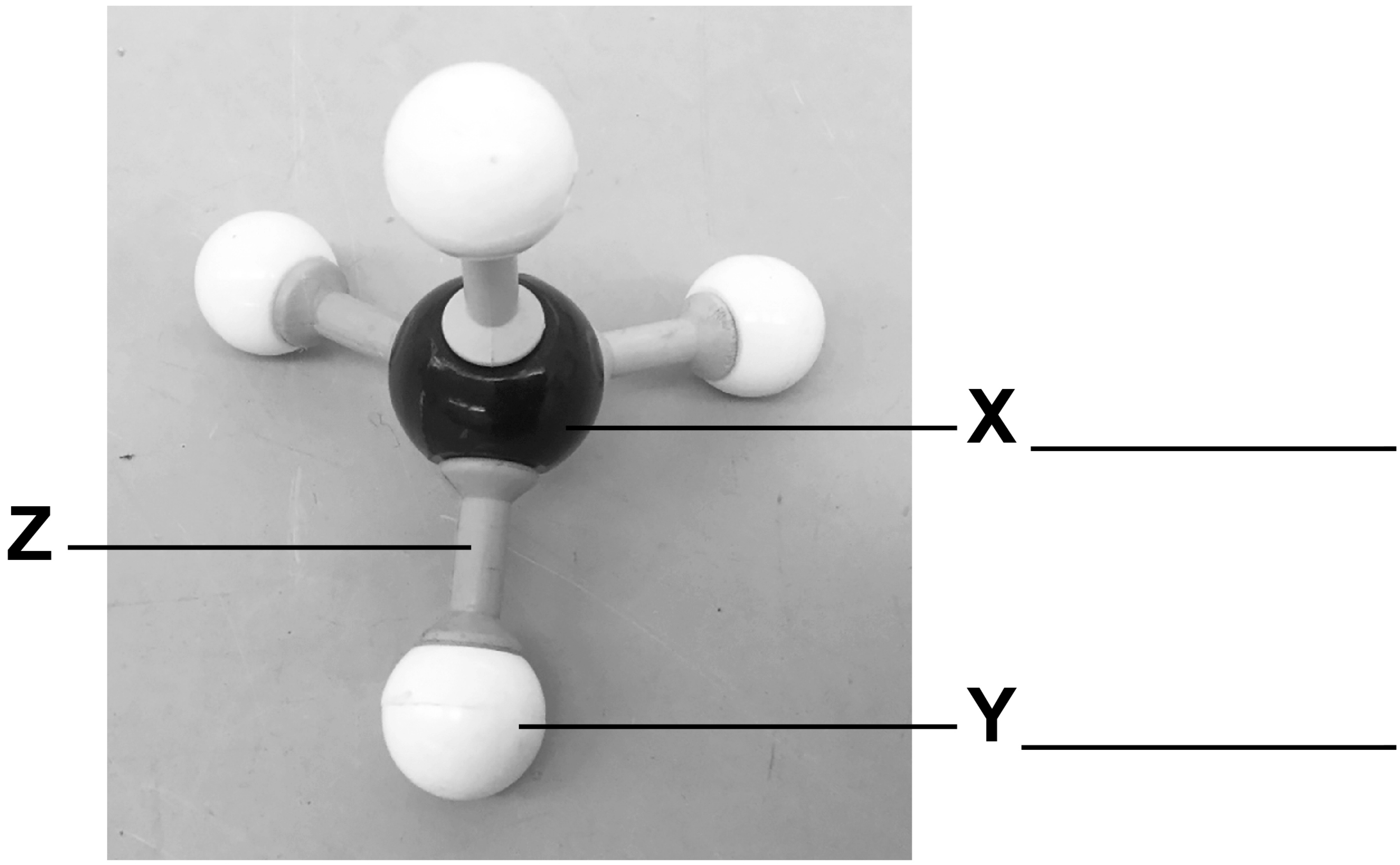
0 4

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, on the opposite page.
[2 marks]

0 4 . 2

What is represented by Z on FIGURE 10?
[1 mark]

[Turn over]

Crude oil is separated into fractions in a fractionating column.

FIGURE 11, on page 47, shows a fractionating column.

TABLE 2, on the opposite page, 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

[Turn over]

REPEAT OF TABLE 2

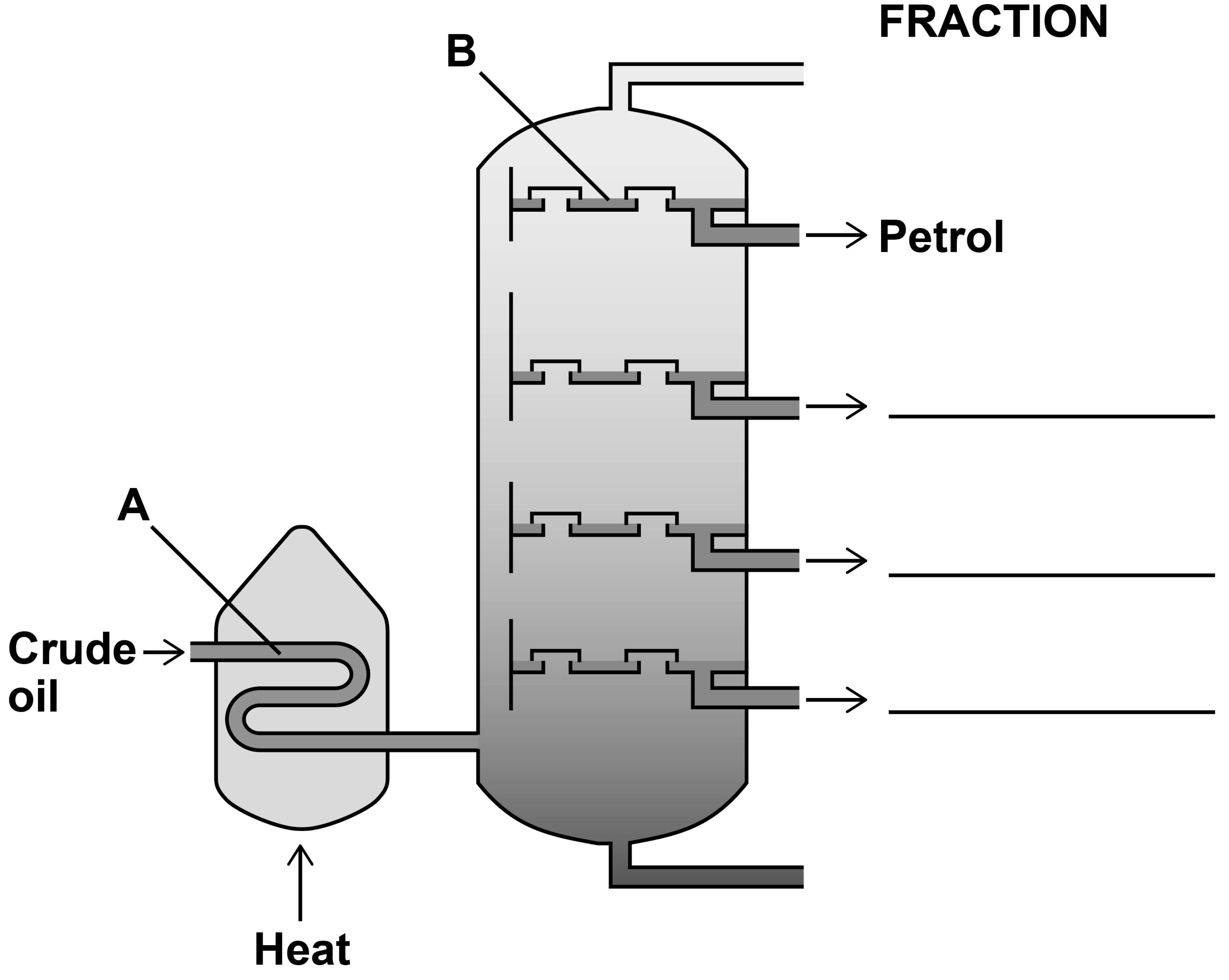
Fraction	Range of number of carbon atoms in one molecule	Boiling point range in °C
Heavy fuel oil	$C_{20} – C_{25}$	300 – 400
Diesel	$C_{15} – C_{20}$	250 – 300
Kerosene	$C_{10} – C_{15}$	180 – 250
Petrol	$C_5 – C_{10}$	40 – 180

0 4 . 3

Label FIGURE 11, on page 47, to show where diesel, heavy fuel oil and kerosene fractions are collected.

Use TABLE 2. [1 mark]

FIGURE 11



[Turn over]

0 4 . 4

Complete the sentences.

Choose answers from the list. [3 marks]

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

Crude oil is separated by fractional

________________________________ .

The process happening at A in FIGURE 11, on page 47, is

_______________________________ .

The process happening at B in FIGURE 11, on page 47, is

_______________________________ .

[Turn over]

REPEAT OF 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

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.**

[Turn over]

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**

[Turn over]

0 4 . 7

Name the TWO substances produced from the complete combustion of octane.
[2 marks]

1 ____

____

2 ____

____

11

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 list. [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 ______________________________

____

____

[Turn over]

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

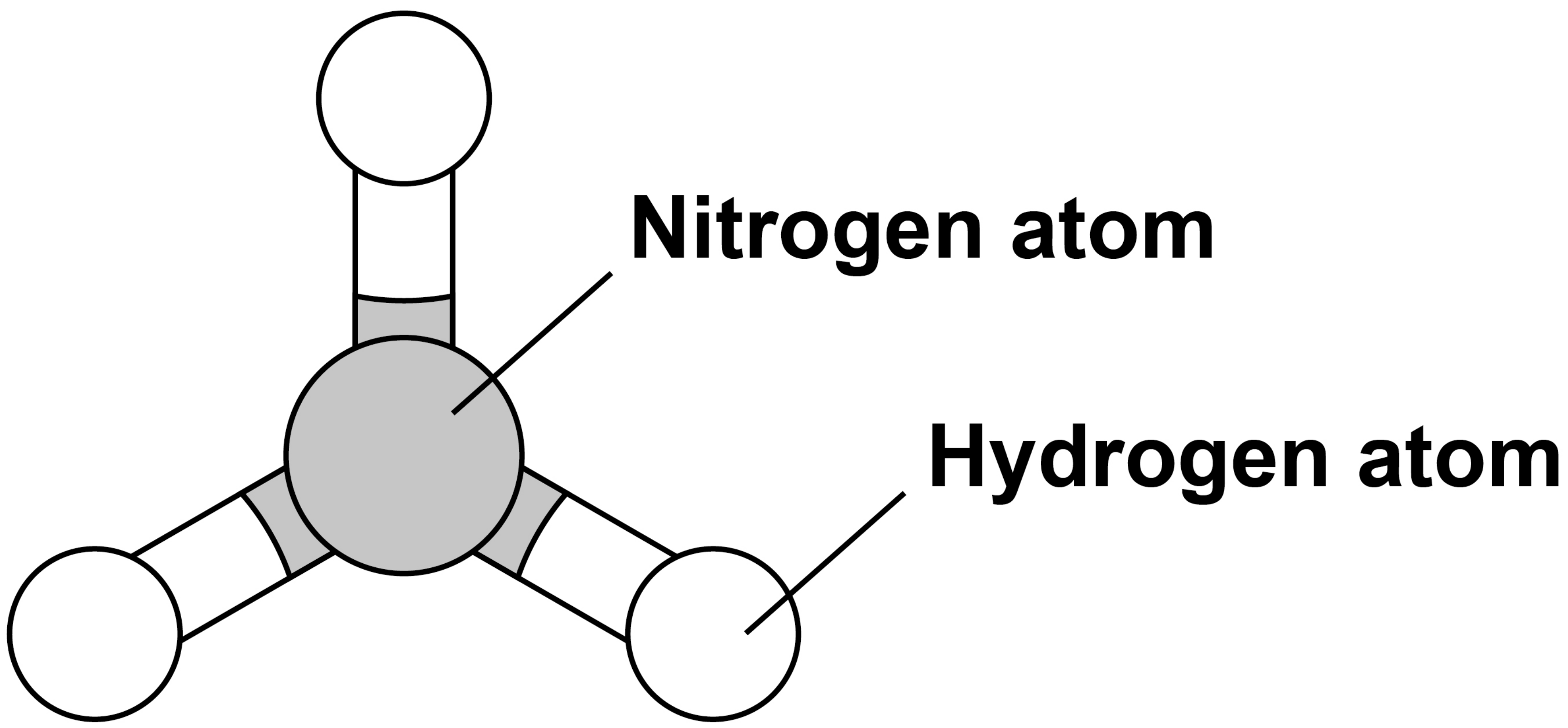
The word equation is:

nitrogen + hydrogen $\rightleftharpoons$ ammonia

0 5 . 4

FIGURE 12 represents an ammonia molecule.

FIGURE 12



What is the formula of ammonia? [1 mark]

____

____

05.5

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.**

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**

05.7

How can the direction of a reversible reaction be changed? [1 mark]

05.8

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

Why is a catalyst used? [1 mark]

[Turn over]

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

BLANK PAGE

[Turn over]

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

[Turn over]

0 6 . 2

Describe the test for starch.

Give the result of the test if starch is present. [2 marks]

Test ____________________________________

____

____

Result __________________________________

____

____

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[Turn over]

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 = ____________________________

[Turn over]

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**

[Turn over]

7

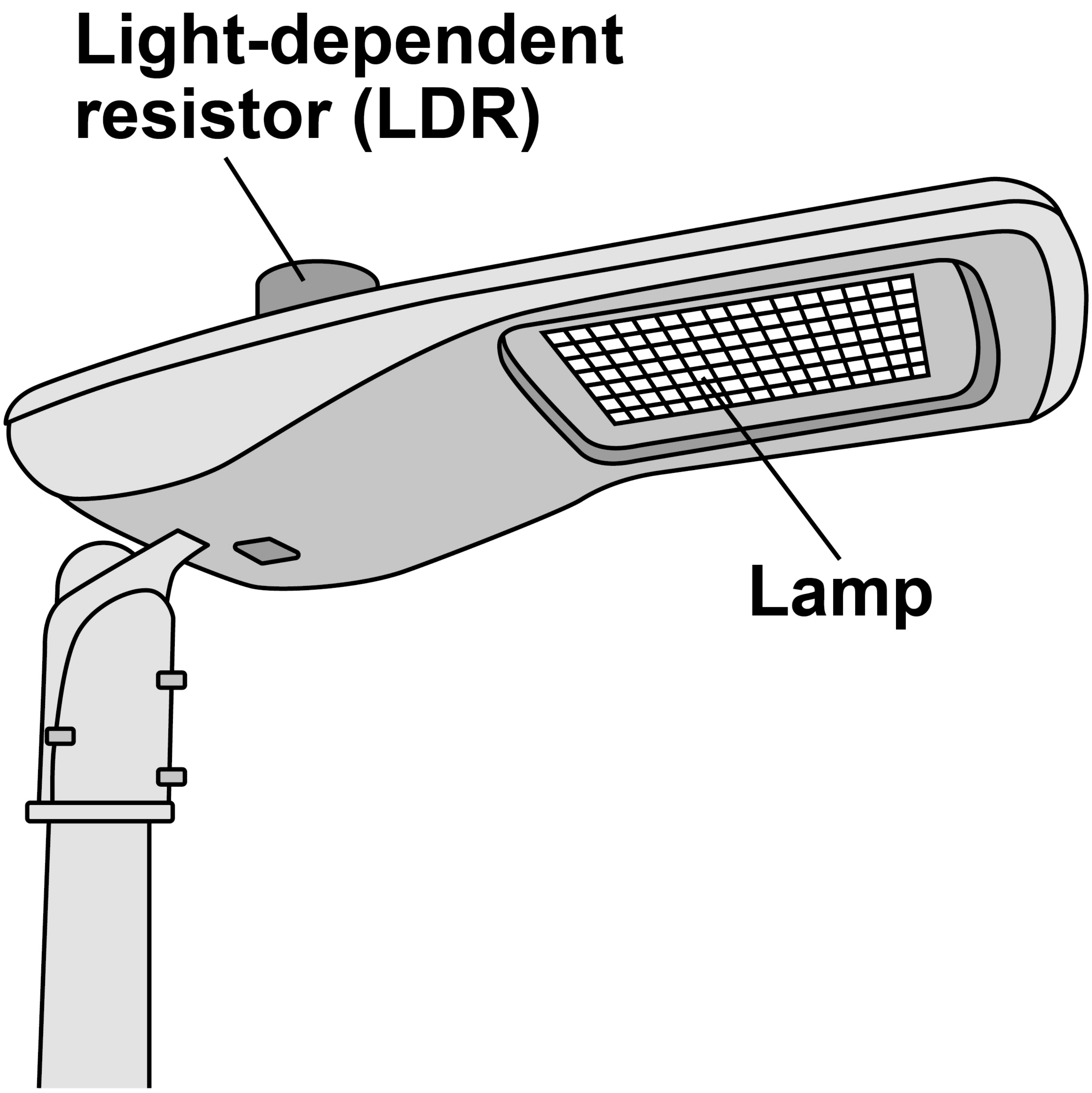
0 7

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



07.1

The power supply for the street light uses alternating current.

What is alternating current? [1 mark]

Tick (✓) ONE box.

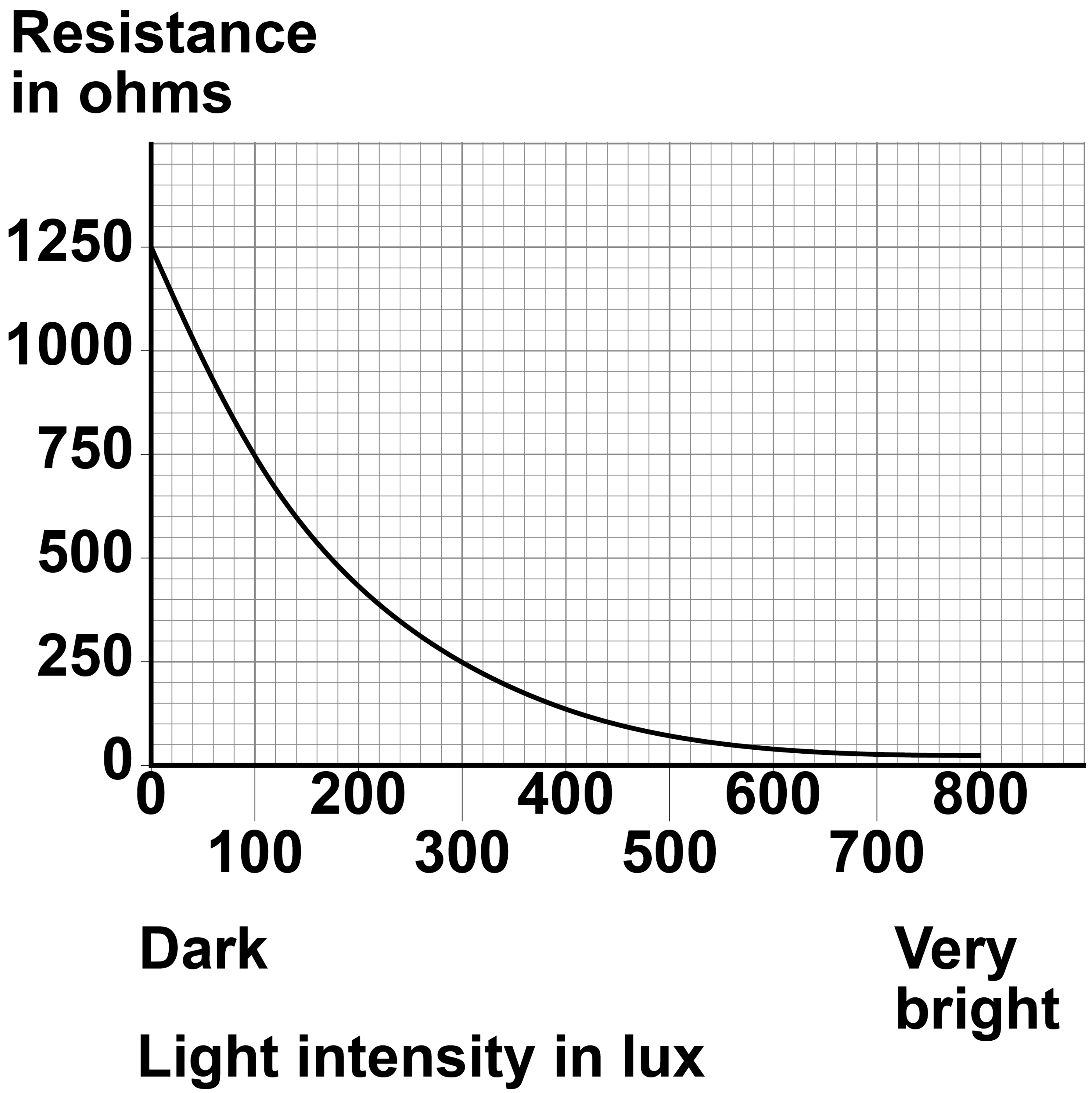
- ☐ **Current that continually changes direction.**
- ☐ **Current that increases and decreases and is in one direction only.**
- ☐ **Current that is constant and is in one direction only.**

[Turn over]

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

Light intensity is measured in lux

FIGURE 14



07.2

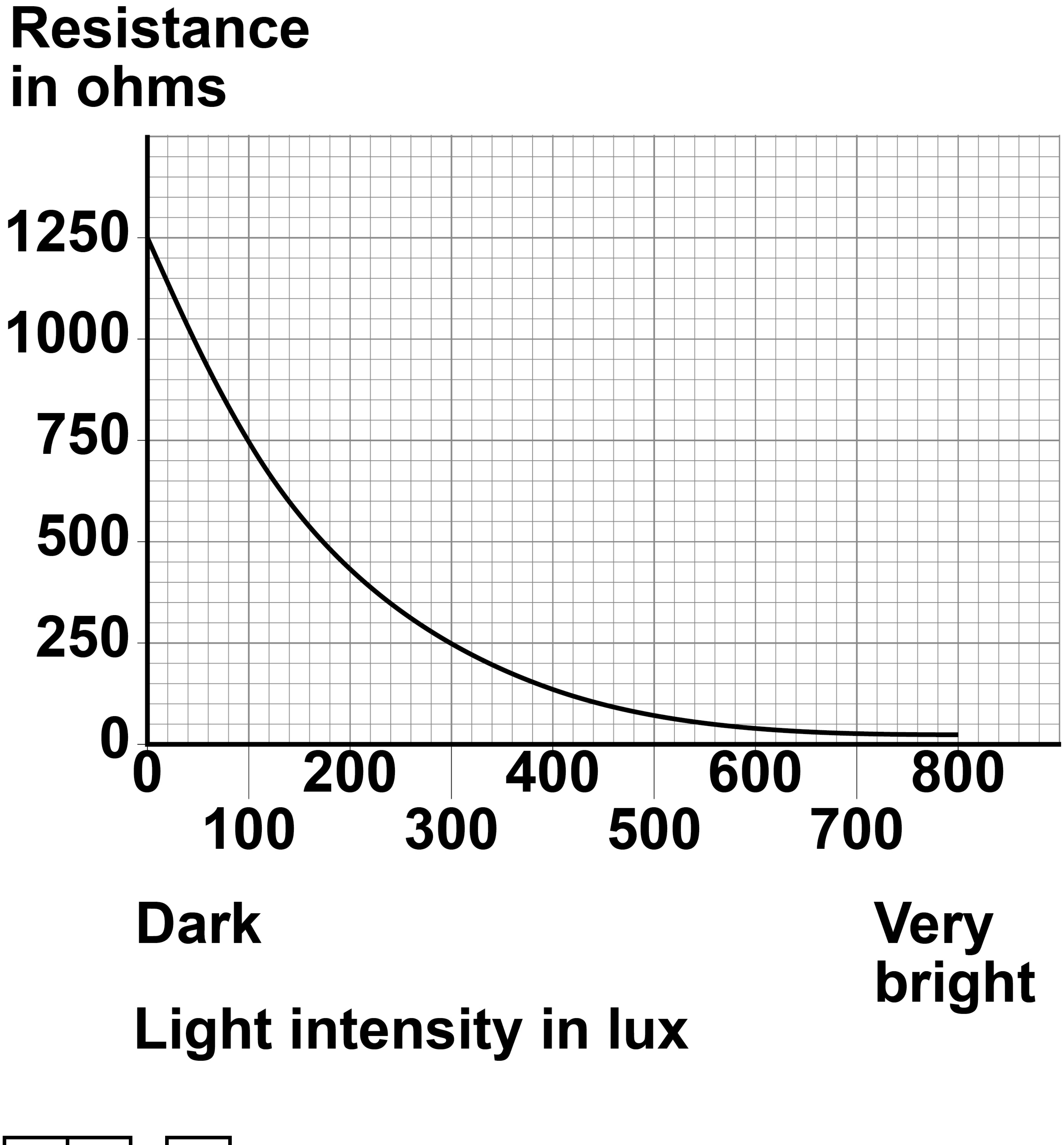
How does light intensity affect the resistance of the LDR? [1 mark]

07.3

Write down the equation which links current (*I*), potential difference (*V*) and resistance (*R*). [1 mark]

[Turn over]

REPEAT OF FIGURE 14



07.4

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

07.6

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.**

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**

[Turn over]

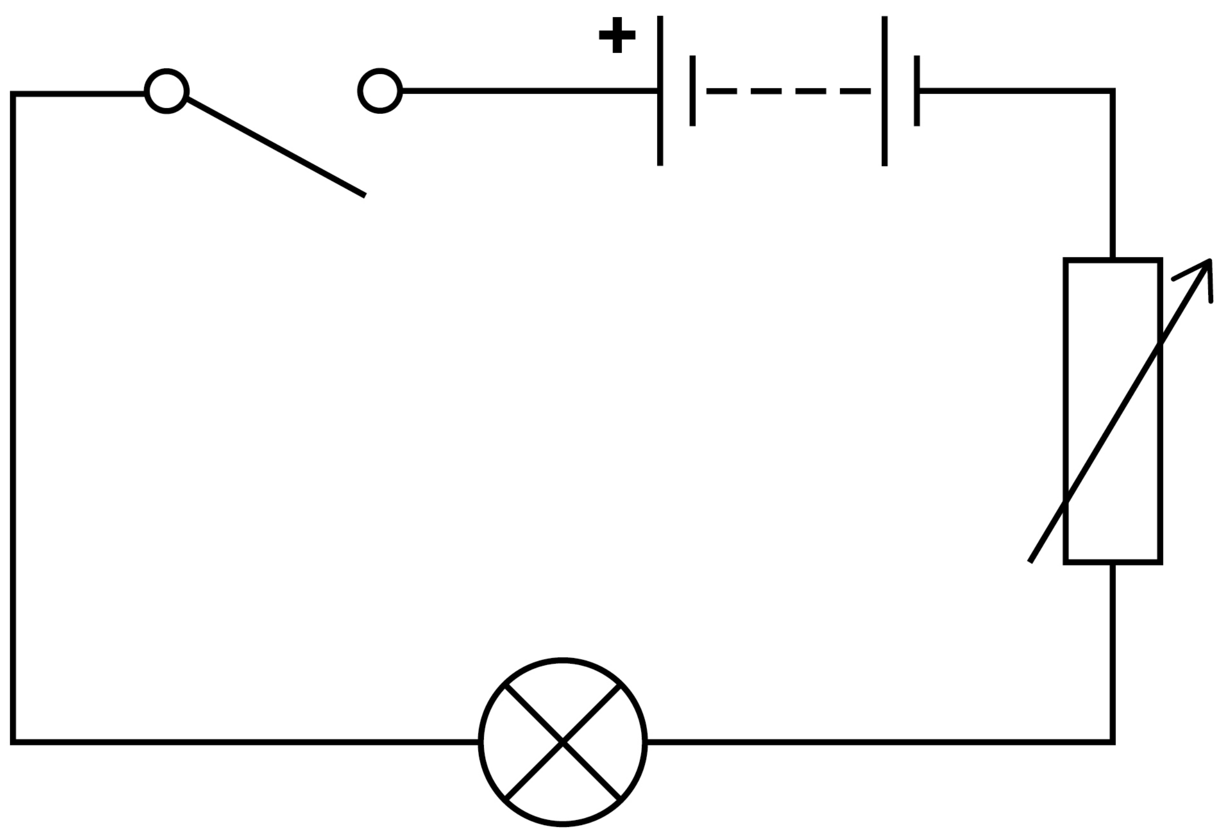
9

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, on the opposite page, 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]

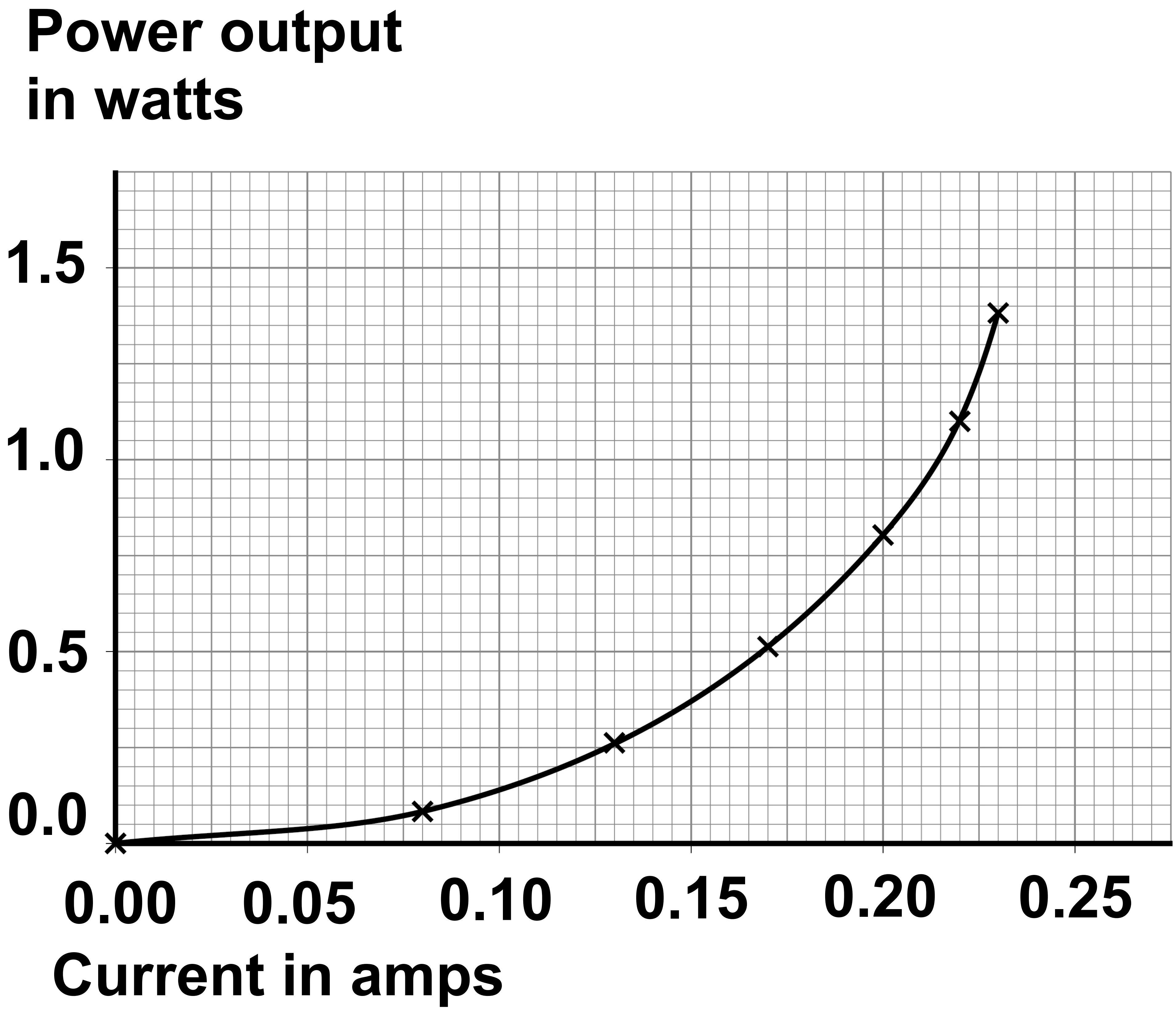
0 8 . 3

What happens to the energy transferred by the lamp? [1 mark]

[Turn over]

FIGURE 16 shows the results.

FIGURE 16



08.4

Describe how varying the current affects the power output of the filament lamp. [2 marks]

08.5

Write down the equation which links current (*I*), power (*P*) and resistance (*R*). [1 mark]

0 8 . 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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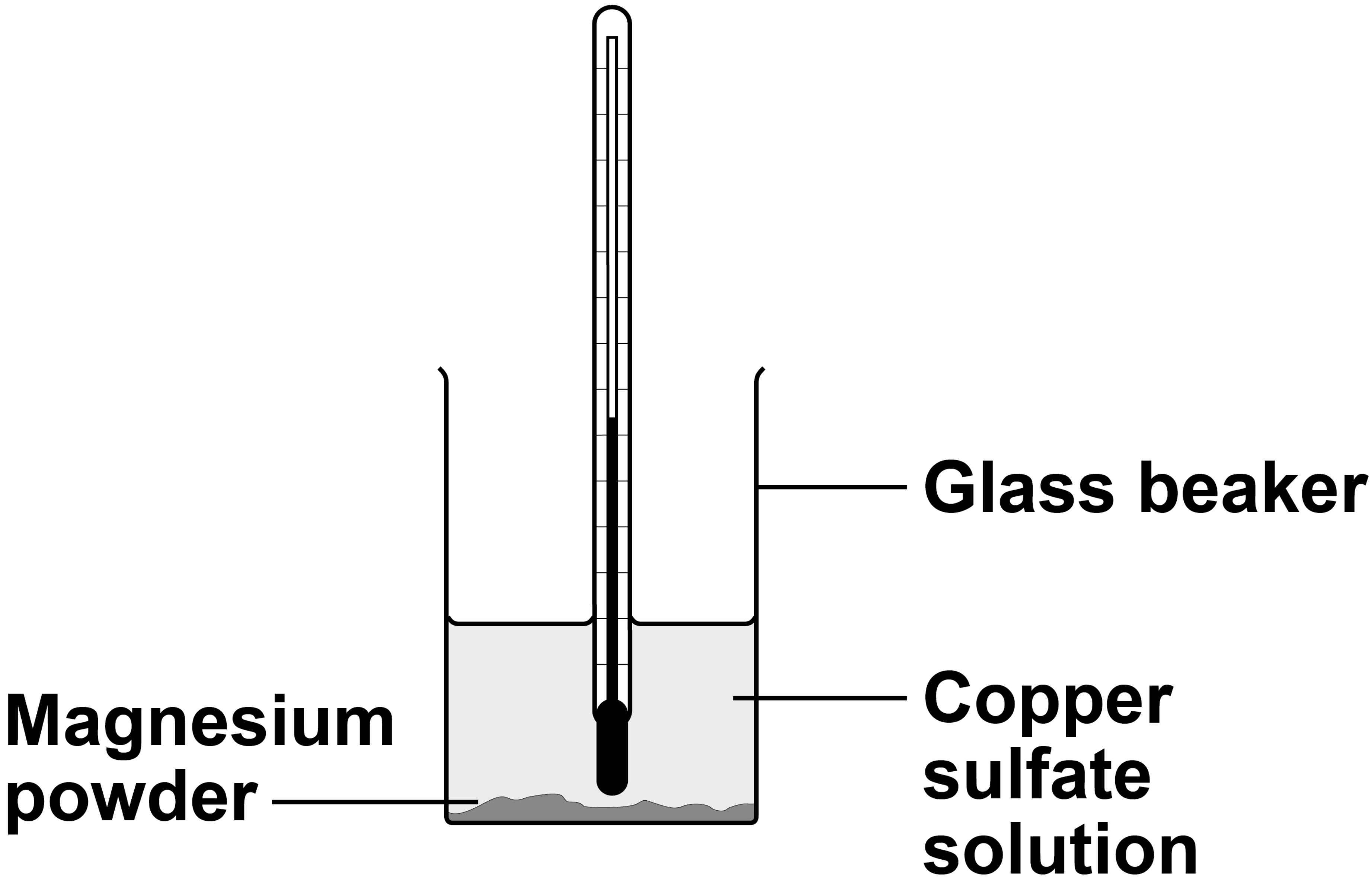
[Turn over]

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.

[Turn over]

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09.1

Give TWO control variables the student should use. [2 marks]

1 ______________________________

____

____

2 ______________________________

____

____

09.2

Suggest ONE change to improve the accuracy of the investigation. [1 mark]

____

____

____

[Turn over]

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

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

Use data from TABLE 4 in your answer.
[6 marks]

[Turn over]

9

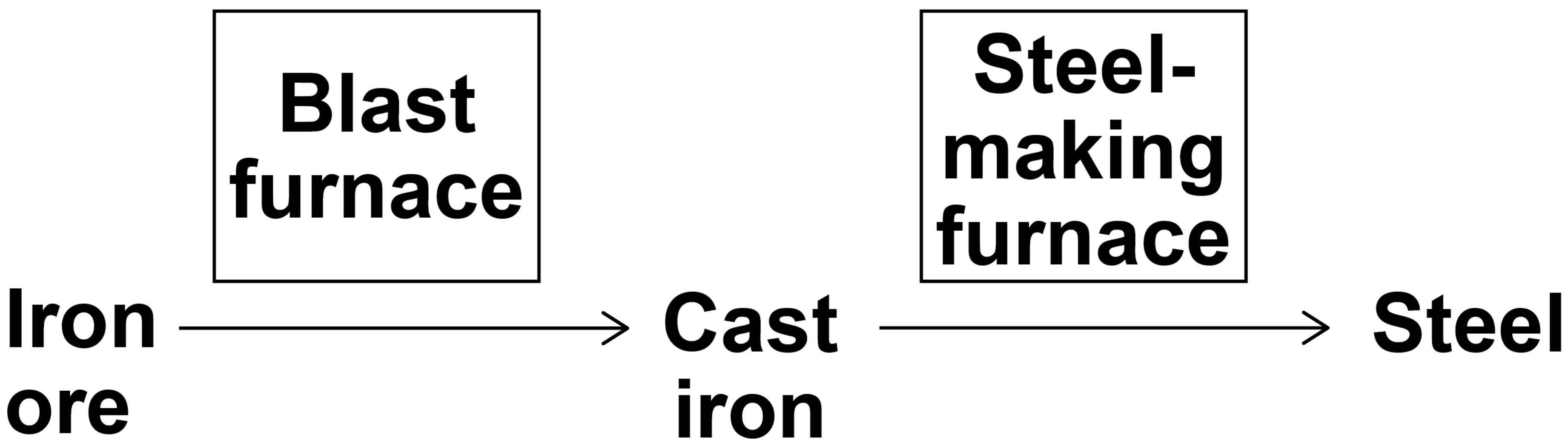
1 0

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



10.1

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]

$Fe_2O_3 + 3CO \longrightarrow$ __________ + __________

10.2

Iron oxide is reduced in the reaction with carbon monoxide.

What does ‘reduced’ mean in this reaction? [1 mark]

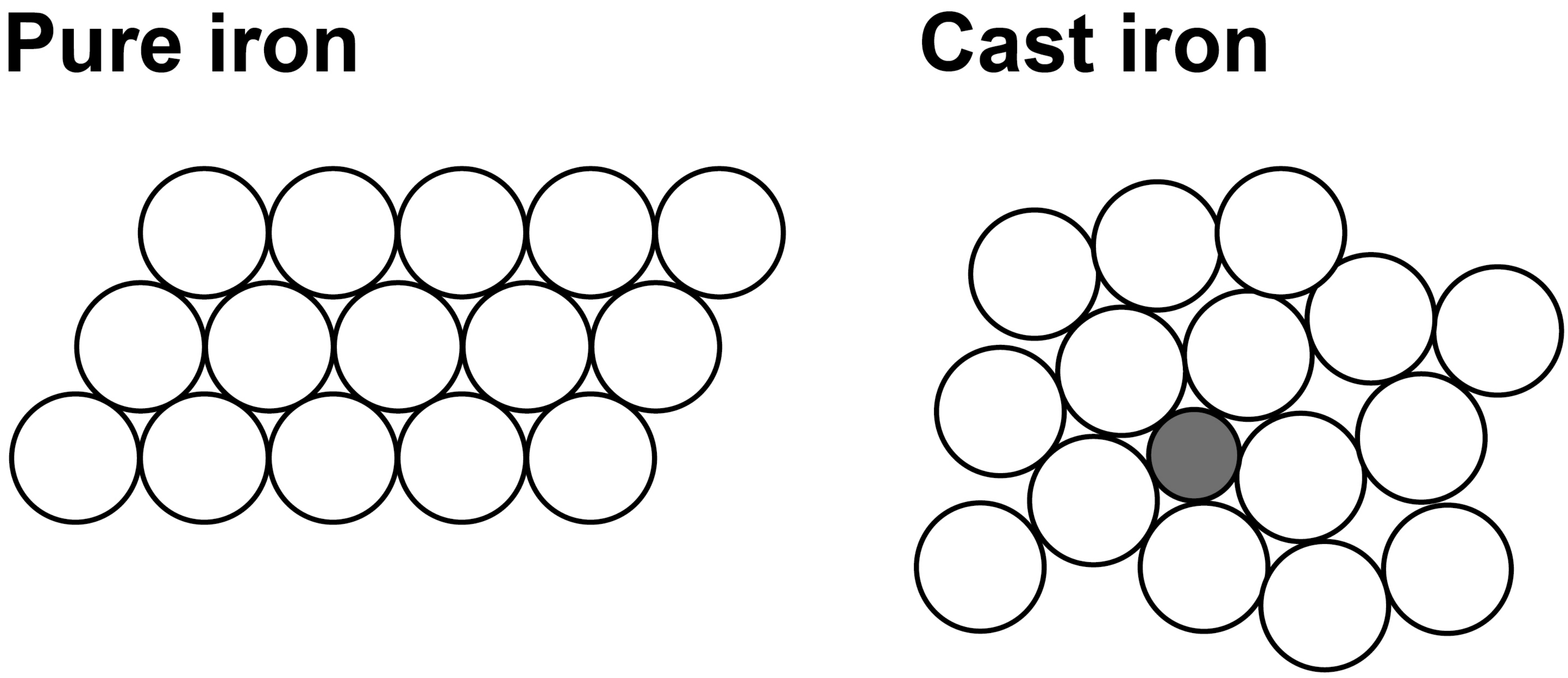
10.3

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]

[Turn over]

10.4

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 ____

____

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2 ____

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3 ____

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END OF QUESTIONS

10

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