A

AQA

Surname _____

Other Names _____

Centre Number _____

Candidate Number _____

Candidate Signature _____

I declare this is my own work.

GCSE
COMBINED SCIENCE: SYNERGY

H

8465/2H

Higher Tier

Paper 2 Life and Environmental Sciences

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).

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

[Turn over]

J U N 2 1 8 4 6 5 2 H 0 1

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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.**

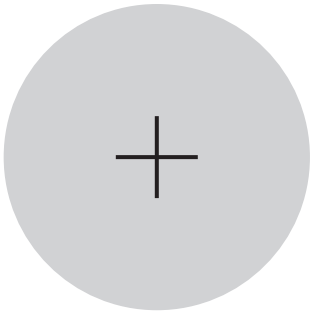
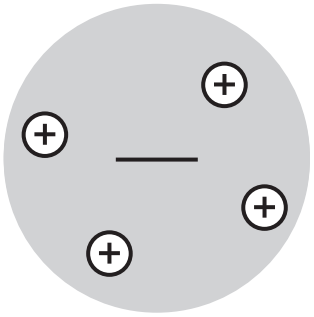
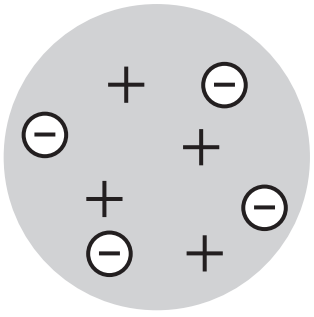
DO NOT TURN OVER UNTIL TOLD TO DO SO

0 1

The model of the atom has changed over time.

0 1 . 1

Draw ONE line from each atomic model to the representation of that model. [2 marks]

Atomic model	Representation of model
	
Dalton atom	
Plum pudding model	
	

Scientists investigated the structure of the atom.

The scientists directed alpha particles at a thin sheet of gold foil.

0 1 . 2

What is an alpha particle the same as? [1 mark]

Tick (✓) ONE box.

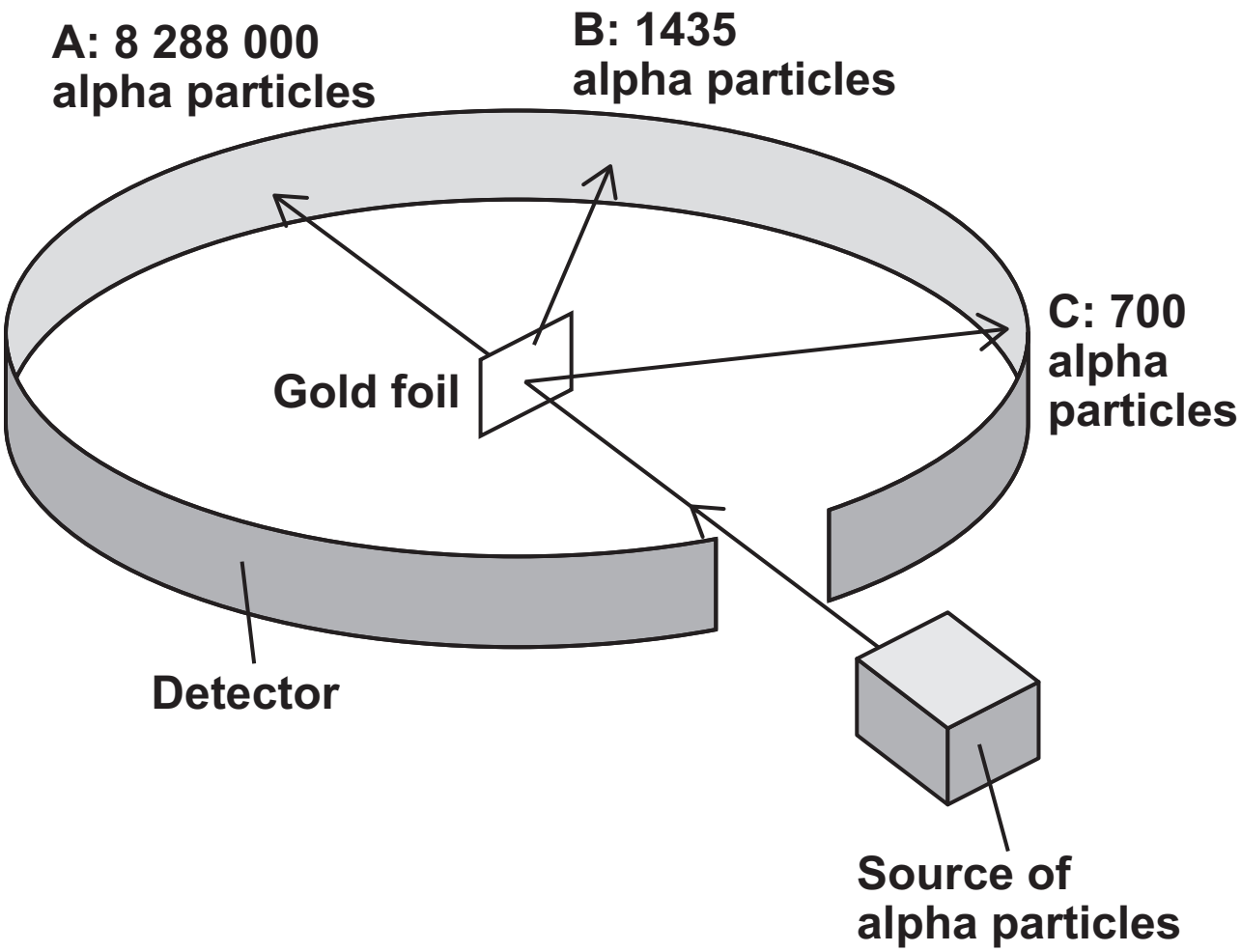
- ☐ **A fast-moving electron**
- ☐ **A helium nucleus**
- ☐ **A radioactive isotope**
- ☐ **Electromagnetic radiation**

[Turn over]

FIGURE 1 shows:

- **three of the pathways the alpha particles take**
- **the number of alpha particles detected at positions A, B and C.**

FIGURE 1



0 1 . 3

Determine the simplest ratio of the number of alpha particles detected at A to those detected at C.

Use FIGURE 1, on page 6. [2 marks]

_____

_____

_____

_____

_____

Simplest ratio of A : C = _____ : 1

[Turn over]

The scientists concluded that a gold atom:

- **is mostly empty space**
- **has a charged nucleus at its centre.**

0 1 . 4

How do the results in FIGURE 1, on page 6, show that a gold atom is mostly empty space? [1 mark]

0 1 . 5

Explain how the results in FIGURE 1, on page 6, show that a gold atom contains a charged nucleus. [2 marks]

BLANK PAGE

[Turn over]

0 1 . 6

A gold atom can be represented as:

$$^{197}_{79}\mathrm{Au}$$

Describe the atomic structure of this gold atom.

You should include the numbers of each type of sub-atomic particle. [5 marks]

13

[Turn over]

0 2

Some bacteria are pathogens.

0 2 . 1

What is meant by the term 'pathogen'? [1 mark]

_____

_____

_____

Bacterial infections can be treated using antibiotics.

Some bacteria are resistant to antibiotics.

TABLE 1 shows the percentage of bacteria resistant to four antibiotics.

TABLE 1

Antibiotic	Percentage (%) of bacteria resistant to antibiotic	
	2004	2018
A	10	23
B	2	11
C	3	14
D	1	2

0 2 . 2

Which antibiotic had the greatest increase in bacteria that were resistant between 2004 and 2018? [1 mark]

Tick (✓) ONE box.

☐ **A** ☐ **B** ☐ **C** ☐ **D**

0 2 . 3

One of the antibiotics in TABLE 1, on page 12, is only used for serious infections in hospitals.

Suggest which antibiotic is only used for serious infections.

Give a reason for your answer. [2 marks]

Antibiotic ☐ **A** ☐ **B** ☐ **C** ☐ **D**

Reason _____

_____

_____

_____

_____

Many strains of the bacterium 'Staphylococcus aureus' (SA) are resistant to the antibiotic methicillin.

TABLE 2 shows information on methicillin-resistant 'Staphylococcus aureus' (MRSA) infections in England.

TABLE 2

Year	Total population	Number of people with MRSA infection	
		Total	Per 100 000 population
2008	51 800 000	1606	3.10
2012	53 400 000	398	0.75
2015	55 000 000	297	X
2018	55 600 000	271	0.49

0 2 . 4

Calculate value X in TABLE 2. [3 marks]

X = _____

0 2 . 5

The number of people with MRSA infection in hospitals decreased between 2008 and 2018.

Suggest ONE reason for the decrease. [1 mark]

0 2 . 6

Scientists are trying to develop a vaccine for MRSA.

Explain how a vaccine for MRSA would make people immune to MRSA. [6 marks]

14

[Turn over]

0 3

Fat, protein and carbohydrate are important parts of the human diet.

TABLE 3 shows information for cow's milk and three plant-based milks.

TABLE 3

Nutrient	Mass of nutrient in grams per 100 grams of milk			
	Cow	Oat	Almond	Soy
Fat	3.7	1.5	2.1	1.7
Protein	3.5	1.0	0.9	2.9
Total carbohydrate	4.6	6.5	3.0	2.8
of which are sugars	4.6	3.8	3.0	2.7

0 3 . 1

The different types of milk in TABLE 3 can be bought in bottles.

Suggest why the nutritional information is given as 'grams per 100 grams' of milk instead of 'grams per bottle'. [1 mark]

0 3 . 2

Suggest which milk in TABLE 3, on page 18, has the greatest energy content.

Give ONE reason for your answer. [2 marks]

Milk _____

Reason _____

_____

_____

0 3 . 3

A student added iodine solution to each milk.

Explain why ONLY the oat milk and the soy milk turned blue-black.

Use TABLE 3, on page 18. [2 marks]

_____

_____

_____

_____

_____

_____

A student tested samples of the different milks for sugar.

This is the method used.

1. **Add 1.0 cm^3 of the milk sample to a test tube.**

2. **Add 1.0 cm^3 of water and 2.0 cm^3 of Benedict's solution.**

3. **Place the test tube in a water bath at 80 °C.**

4. **Record the colour of the mixture at the end of the test.**

5. **Repeat steps 1 to 4 for the other milk samples.**

0 3 . 4

The volume of each mixture in the test tube and the temperature of the water bath were control variables.

Give ONE other variable that should have been a control variable.

Do NOT refer to volume or temperature in your answer.
[1 mark]

_____

_____

_____

0 3 . 5

What was the dependent variable in the investigation?
[1 mark]

_____

_____

_____

0 3 . 6

To improve the method the student set up a control test tube.

What should the student add to the control test tube?
[1 mark]

_____

_____

_____

[Turn over]

The fat in milk is broken down in the digestive system.

0 3 . 7

Describe the breakdown of fat in the digestive system. [2 marks]

0 3 . 8

Explain why the fat in milk needs to be broken down before it can be used in the body. [2 marks]

0 3 . 9

Protein in milk is broken down into amino acids.

Describe how unwanted amino acids are processed and removed from the body. [2 marks]

_____

_____

_____

_____

_____

_____

14

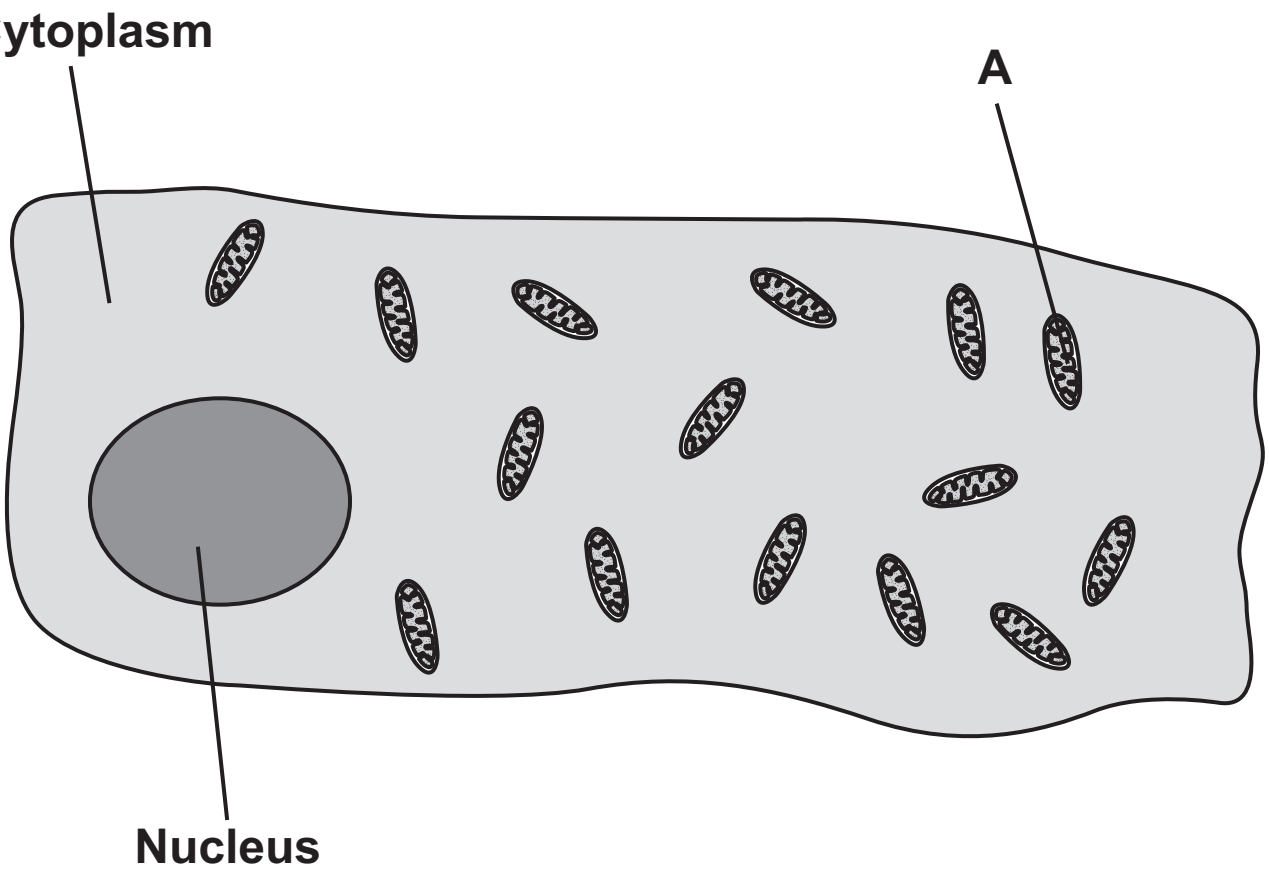
[Turn over]

0 4

Heart tissue is made of cardiac muscle cells.

FIGURE 2 shows a cardiac muscle cell.

FIGURE 2



0 4 . 1

Cardiac muscle needs to contract and relax continuously.

Cardiac muscle cells contain a large number of the structures labelled A.

Name structure A. [1 mark]

0 4 . 2

Oxygen moves from the cytoplasm into structure A by the process of diffusion.

Why does the oxygen move by diffusion? [1 mark]

_____

_____

_____

0 4 . 3

Which change would cause the rate of diffusion of oxygen across an exchange surface to decrease? [1 mark]

Tick (✓) ONE box.

- ☐ **An increase in the surface area of the exchange surface**
- ☐ **An increase in the temperature of the cell**
- ☐ **An increase in the thickness of the exchange surface**

[Turn over]

0 4 . 4

The cardiac muscle cells in humans can respire aerobically and anaerobically.

- **Aerobic respiration uses oxygen.**
- **Anaerobic respiration does NOT use oxygen.**

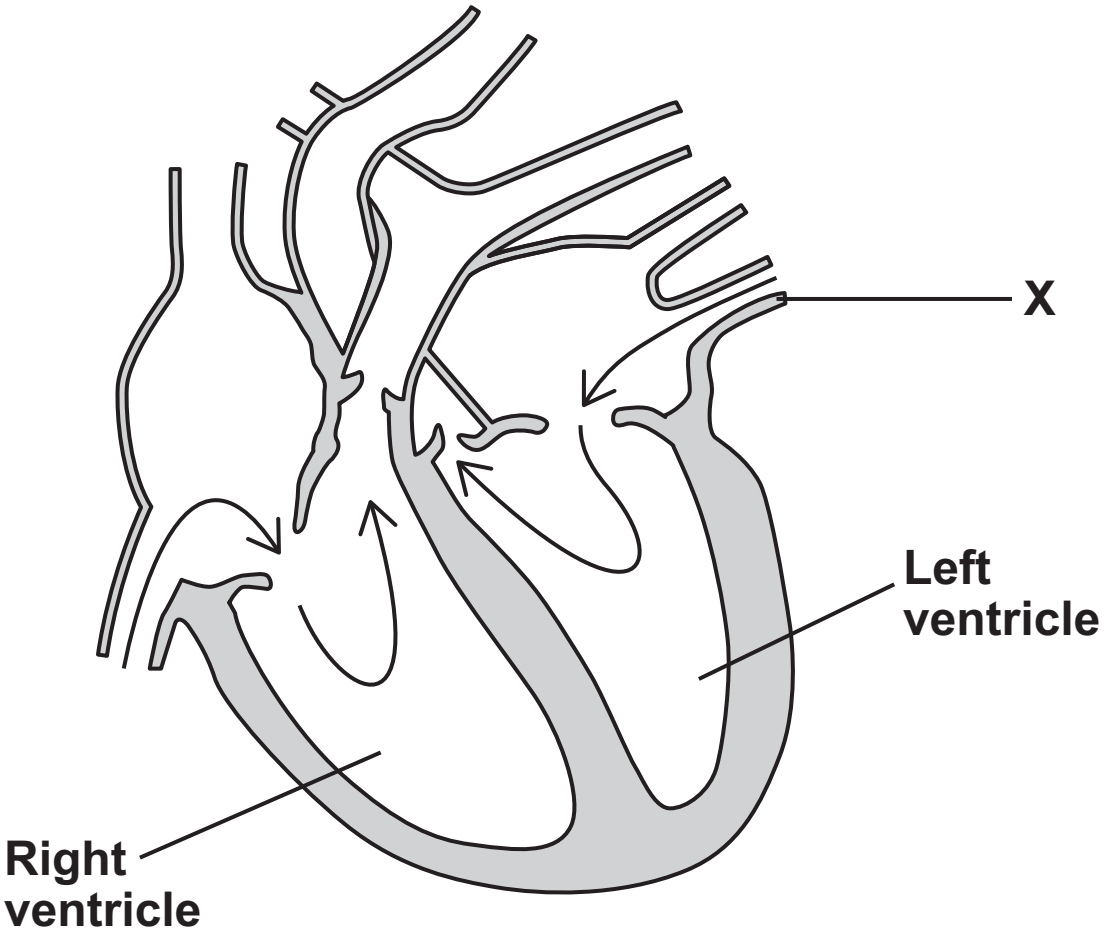
Compare the processes of aerobic respiration and anaerobic respiration.

Do NOT refer to oxygen in your answer. [4 marks]

[Turn over]

FIGURE 3 shows a diagram of a human heart.

FIGURE 3



0 4 . 5

What is the name of blood vessel X in FIGURE 3 on page 28? [1 mark]

Tick (✓) ONE box.

- ☐ **Aorta**
- ☐ **Pulmonary artery**
- ☐ **Pulmonary vein**
- ☐ **Vena cava**

0 4 . 6

Give ONE difference in the composition of the blood in the right ventricle compared with the blood in the left ventricle. [1 mark]

_____

_____

_____

[Turn over]

When the walls of the atria and ventricles contract, the pressure increases.

TABLE 4 shows information about the pressure during one contraction of the heart.

TABLE 4

	Maximum pressure in arbitrary units
Left atrium	10
Left ventricle	120
Right atrium	X
Right ventricle	25

0 4 . 7

The left ventricle has the highest pressure.

Why does the left ventricle need to have the highest pressure? [1 mark]

0 4 . 8

What is the most likely maximum pressure in the right atrium?

Use TABLE 4, on page 30. [1 mark]

Tick (✓) ONE box.

☐ **< 25** ☐ **= 25** ☐ **> 25**

[Turn over]

0 4 . 9

Some people have a medical condition called a 'hole in the heart'.

A 'hole in the heart' is a small hole between the right ventricle and the left ventricle.

Some blood flows from the right ventricle to the left ventricle.

Explain why a 'hole in the heart' causes a person to feel tired. [4 marks]

15

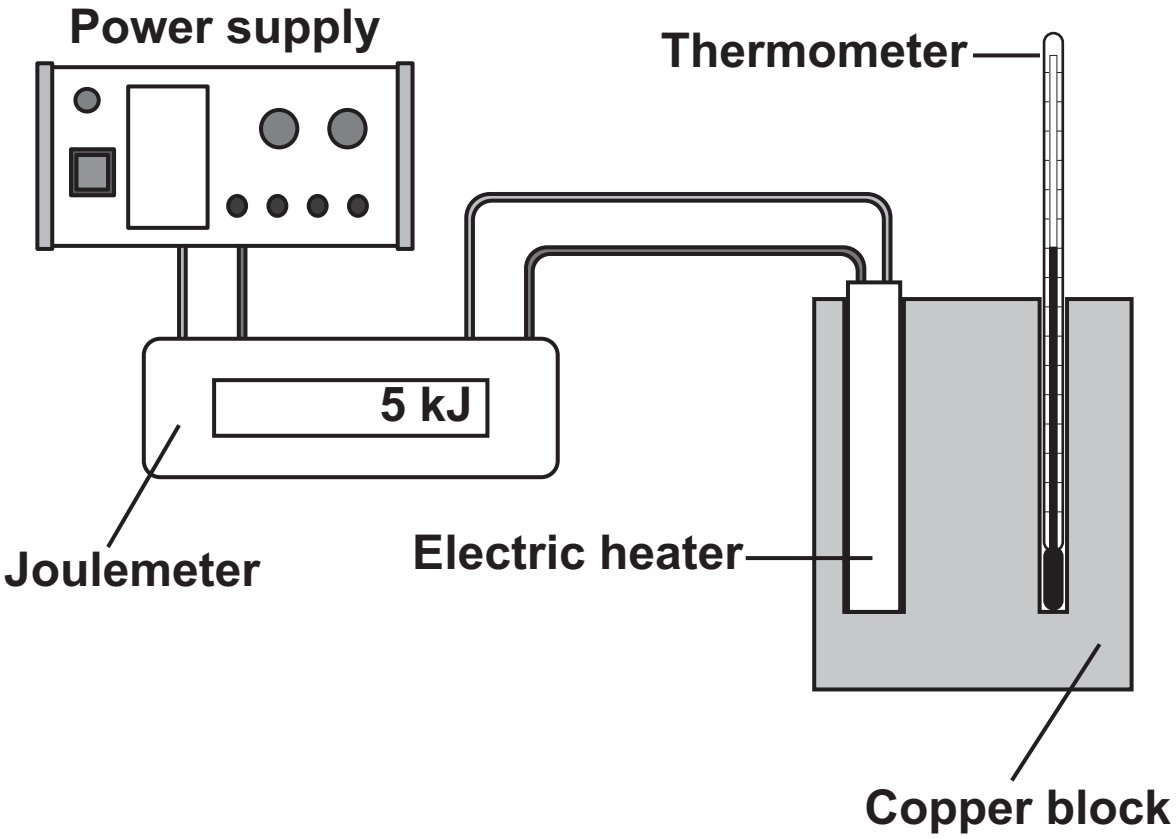
0 5

A student investigated the heating of a copper block.

An electric heater and a thermometer were inserted into holes in the copper block.

FIGURE 4 shows the apparatus used.

FIGURE 4



The joulemeter measured the energy transferred to the electric heater.

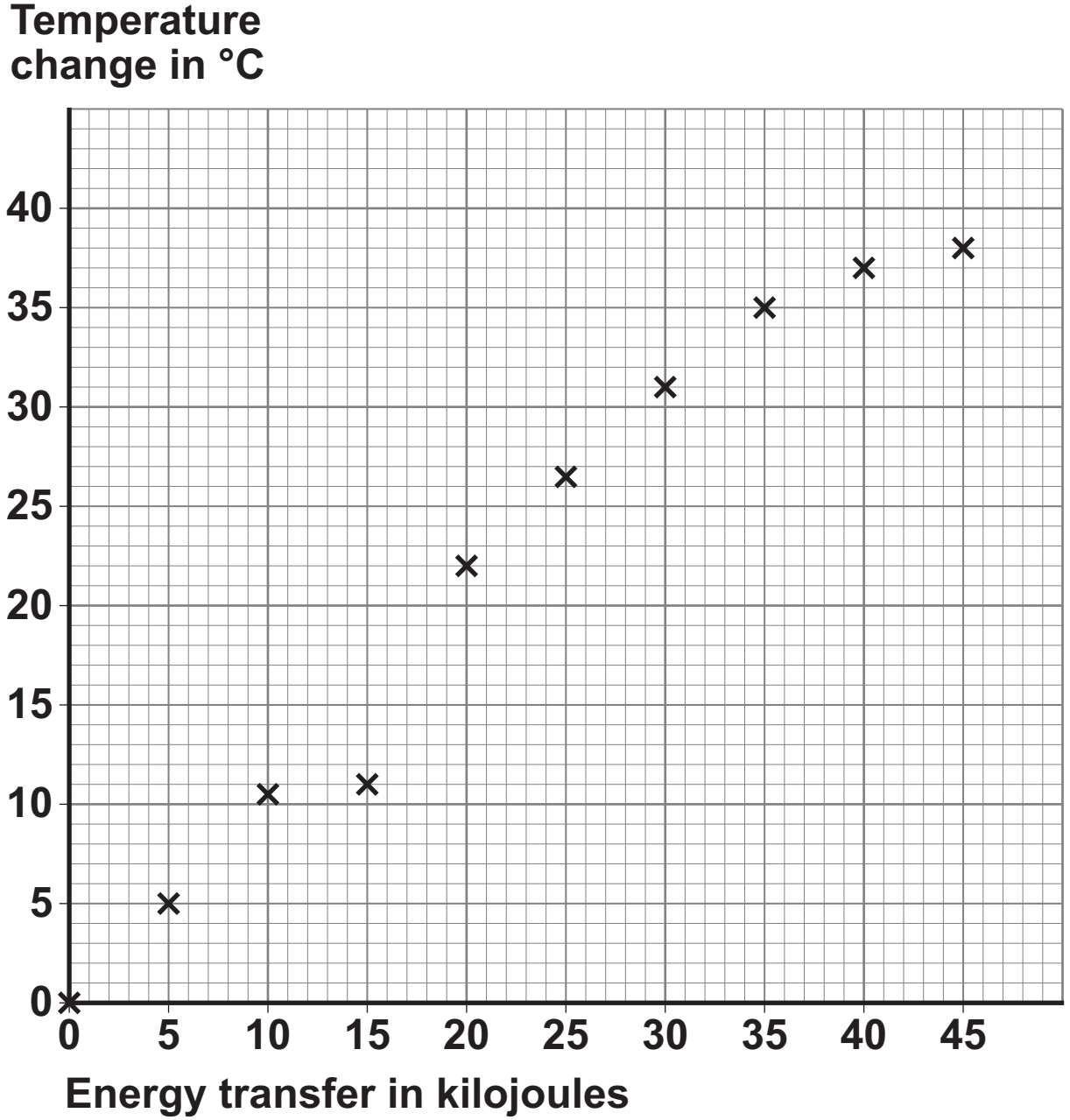
Every minute, the student recorded:

- **the temperature of the copper block**
- **the energy transferred to the electric heater.**

[Turn over]

FIGURE 5 shows the results.

FIGURE 5



0 5 . 1

Draw a line of best fit on FIGURE 5. [1 mark]

0 5 . 2

What conclusion can be made from FIGURE 5, on page 34? [1 mark]

0 5 . 3

The student calculated the specific heat capacity of copper using the final temperature of the copper block.

The copper block was NOT insulated.

Explain why the student's calculated value of specific heat capacity was higher than expected. [2 marks]

[Turn over]

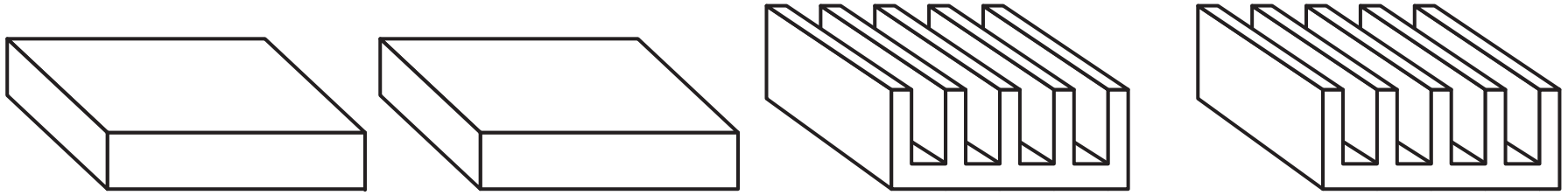
Computer components get hot when they are in use.

To prevent components overheating, energy is transferred from the components to a heat sink made of metal.

Metal heat sinks can be different shapes and have different types of surface.

FIGURE 6 shows four metal heat sinks.

FIGURE 6

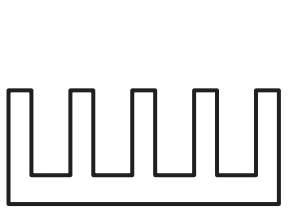


A
Shiny silver surface

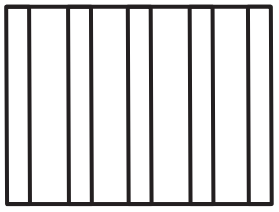
B
Matt black surface

C
Shiny silver surface

D
Matt black surface

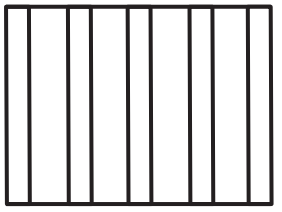


C
Front view



C
Top down view

D
Front view



D
Top down view

A student investigated the thermal energy transfer from the four heat sinks.

The heat sinks were all made of the same metal and had the same mass.

This is the method used.

1. Place heat sink A in an oven and heat until the temperature of the heat sink reaches 100 °C.
2. Remove the heat sink from the oven.
3. Record the time taken for the heat sink to cool to room temperature.
4. Repeat steps 1 to 3 for heat sinks B, C and D.

[Turn over]

TABLE 5 shows the results.

TABLE 5

Heat sink	Type of surface	Time to cool to room temperature in minutes
A	Shiny silver	107
B	Matt black	75
C	Shiny silver	54
D	Matt black	42

0 5 . 4

Explain TWO features of heat sink D that make it the best to prevent a computer component overheating. [3 marks]

0 5 . 5

A computer component transfers 89 J of energy to a copper heat sink.

The mass of the copper heat sink is 5.0 g.

The starting temperature of the copper heat sink is 20 °C.

specific heat capacity of copper = 386 J/kg °C

Calculate the final temperature of the copper heat sink.
[5 marks]

Final temperature = _____ °C

12

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[Turn over]

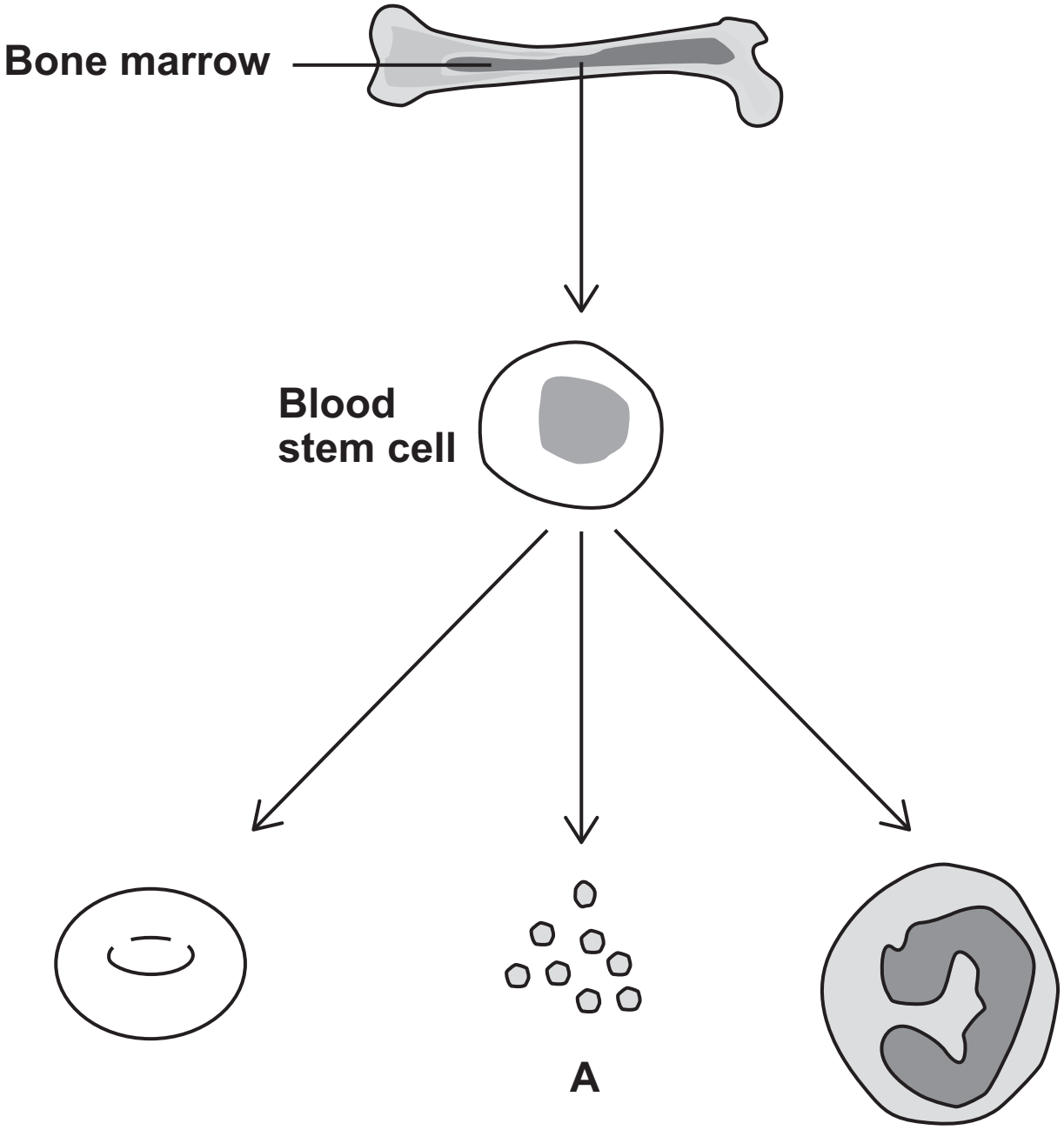
0 6

Adult stem cells are found in human bone marrow.

Bone marrow stem cells can differentiate into many types of blood components.

FIGURE 7 shows the components the bone marrow stem cells can differentiate into.

FIGURE 7



0 6 . 1

Name the component of the blood labelled A. [1 mark]

_____

_____

0 6 . 2

Damage to the bone marrow will lead to a reduction in the number of blood components produced in a person.

Describe the effect a reduction of component A will have on the person. [1 mark]

_____

_____

_____

[Turn over]

0 6 . 3

A person has 5.1×10^9 red blood cells per cm^3 of blood.

The person has 4.25 dm^3 of blood in their body.

A total of 2.0×10^{11} of the red blood cells are replaced each day.

Calculate the percentage of red blood cells that are replaced each day. [4 marks]

1 dm^3 = 1000 cm^3

Percentage of red blood cells replaced each day

= _____ %

0 6 . 4

Explain why red blood cells CANNOT divide by mitosis. [2 marks]

_____

_____

_____

_____

_____

_____

[Turn over]

0 6 . 5

The different components of the blood can be used to treat different medical conditions.

TABLE 6 gives information about:

- **blood from blood donation by volunteers**
- **the production of red blood cells from stem cells in laboratories.**

TABLE 6

Blood from blood donation	Production of red blood cells from stem cells
It can take 10 minutes to collect blood from a vein in the arm. A person can donate blood every 12 weeks. Blood can be stored for 35 days. Blood can be separated into different blood components and plasma.	Red blood cells can be produced when needed in small quantities. It takes 28 days to produce red blood cells. A patient's own stem cells can be used to make red blood cells.

Evaluate the use of blood donation to provide blood components compared with using stem cells to provide blood components.

Use information from TABLE 6 and your own knowledge.
[6 marks]

14

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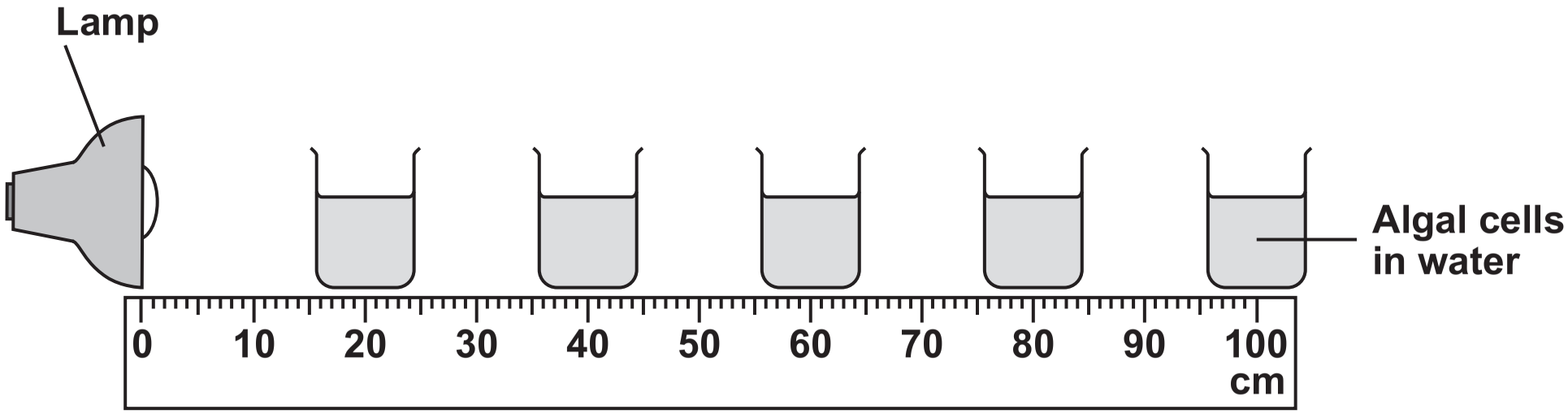
[Turn over]

0 7 Algal cells can photosynthesise.

A student investigated the effect of light intensity on photosynthesis in algal cells.

FIGURE 8 shows the apparatus used.

FIGURE 8



0 7 . 1 Describe the relationship between light intensity and distance, as the distance of the algal cells from the lamp is doubled.

You MUST include calculations of light intensity at 20 cm and 40 cm in your answer.

Use the equation:

$$\text{light intensity} \propto \frac{1}{\text{distance}^2}$$

[3 marks]

[Turn over]

The student recorded the pH of the water at the start and after one hour in each beaker.

TABLE 7 shows the results.

TABLE 7

Distance of algal cells from lamp in cm	pH of water at start	pH of water after one hour
20	7.8	9.1
40	7.8	8.8
60	7.8	8.5
80	7.8	8.3
100	7.8	8.2

The method produced valid results.

0 7 . 2

Carbon dioxide is an acidic gas.

Explain the results in TABLE 7. [4 marks]

[Turn over]

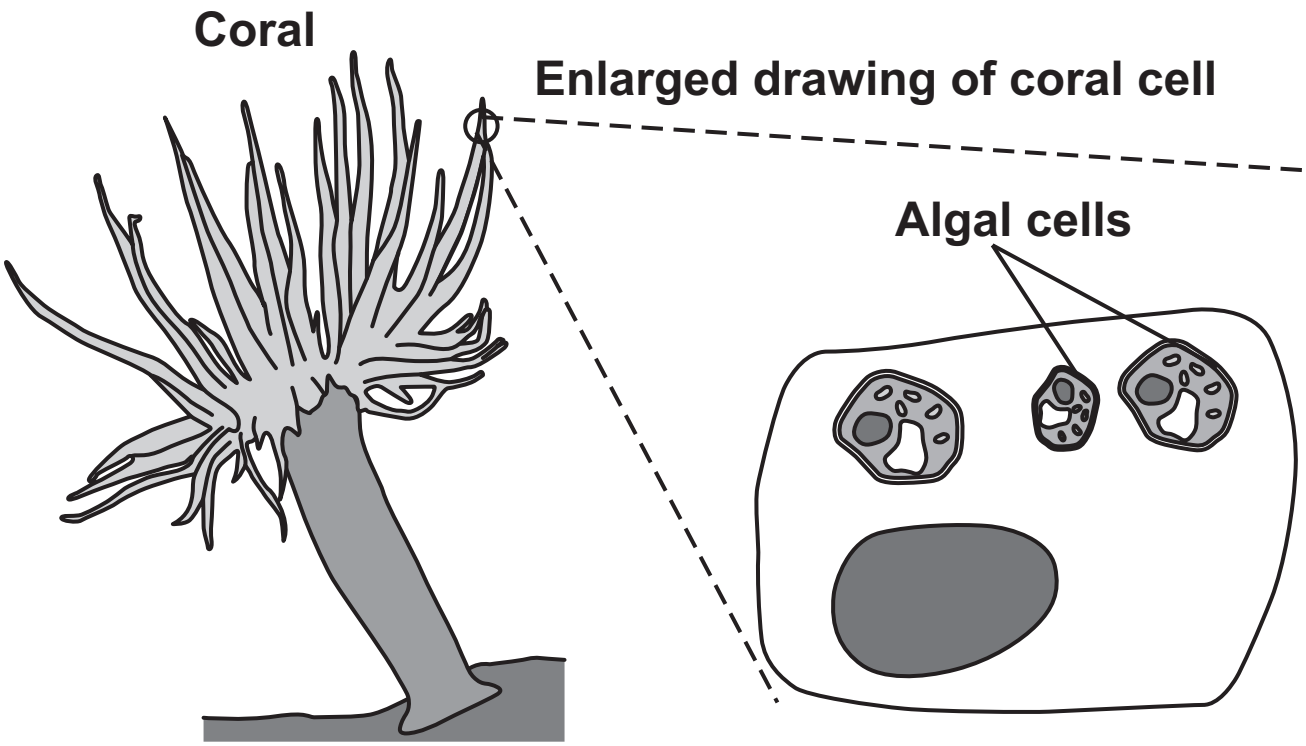
Corals are animals that live in the sea.

Corals:

- **cannot move from one place to another place**
- **feed on tiny animals that float past in the water**
- **have algal cells living inside their own cells.**

FIGURE 9 shows a coral and an enlarged coral cell.

FIGURE 9



Algal cells photosynthesise to produce glucose ($C_6H_{12}O_6$).

0 7 . 3

Write the balanced symbol equation for photosynthesis.
[3 marks]

_____ + _____ ⟶

_____ + _____

0 7 . 4

Explain ONE way the algal cells use glucose for growth.
[2 marks]

_____

_____

_____

_____

_____

_____

[Turn over]

0 7 . 5

Suggest ONE advantage to the algal cells of living inside the coral cells. [1 mark]

0 7 . 6

An increase in water temperature can cause coral to release the algal cells.

Releasing algal cells can result in the death of coral.

Suggest why coral may NOT survive without the algal cells. [1 mark]

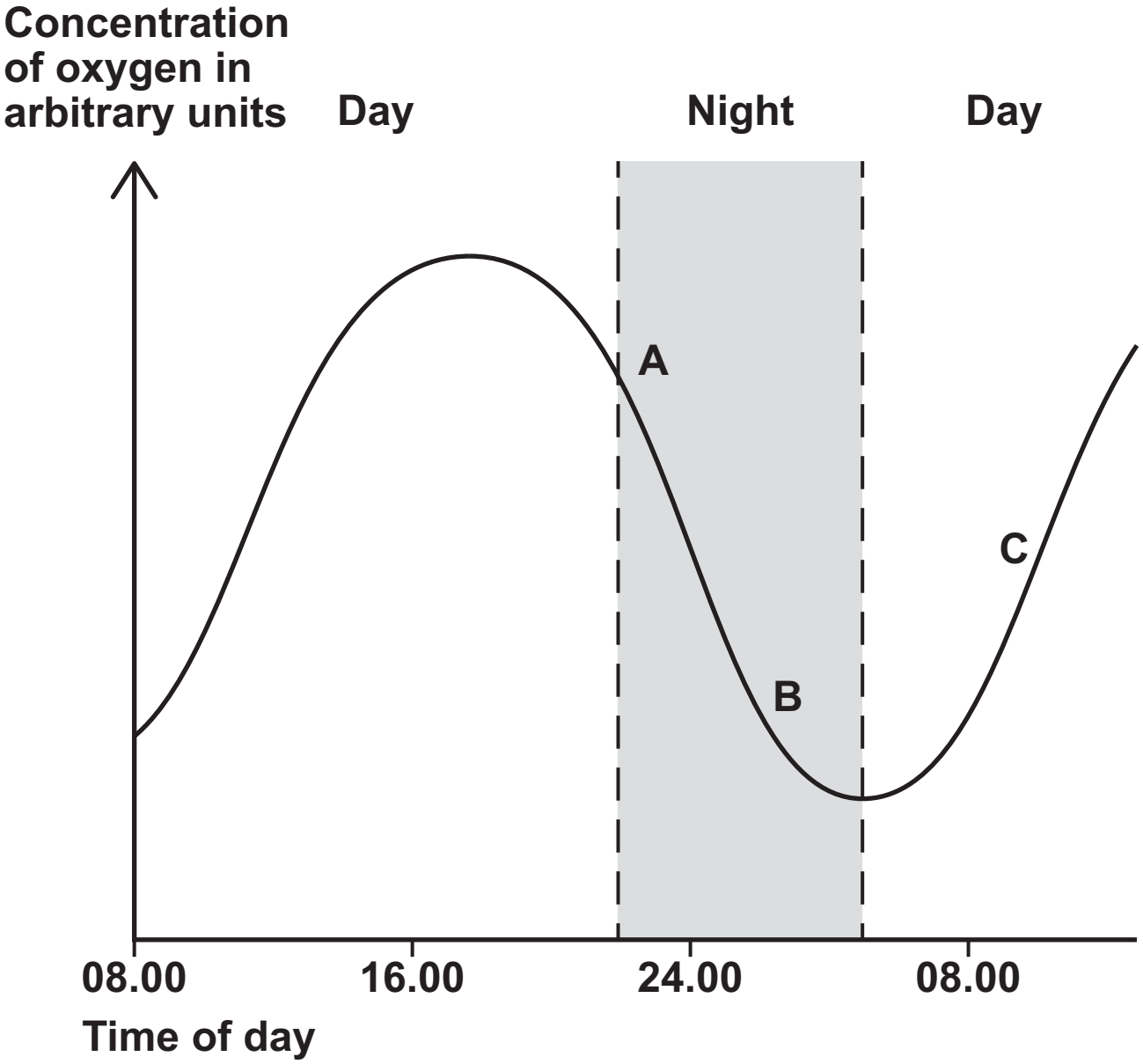
BLANK PAGE

[Turn over]

Scientists investigated how the concentration of oxygen in the water around one coral changed during the day.

FIGURE 10 shows the results.

FIGURE 10



0 7 . 7

Explain the changes in oxygen concentration between A and B. [3 marks]

0 7 . 8

At C the rate at which oxygen is being produced equals the rate at which oxygen is being used.

Give the reason why. [1 mark]

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END OF QUESTIONS

Additional page, if required.
Write the question numbers in the left-hand margin.

Additional page, if required.
Write the question numbers in the left-hand margin.

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For Examiner's Use	
Question	Mark
1	
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