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 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).

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	
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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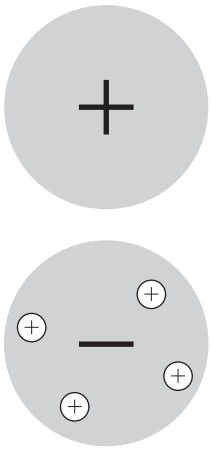
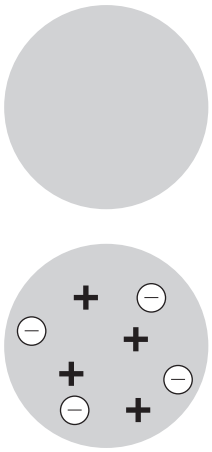
0 1 The model of the atom has changed over time.

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	

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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 ☐

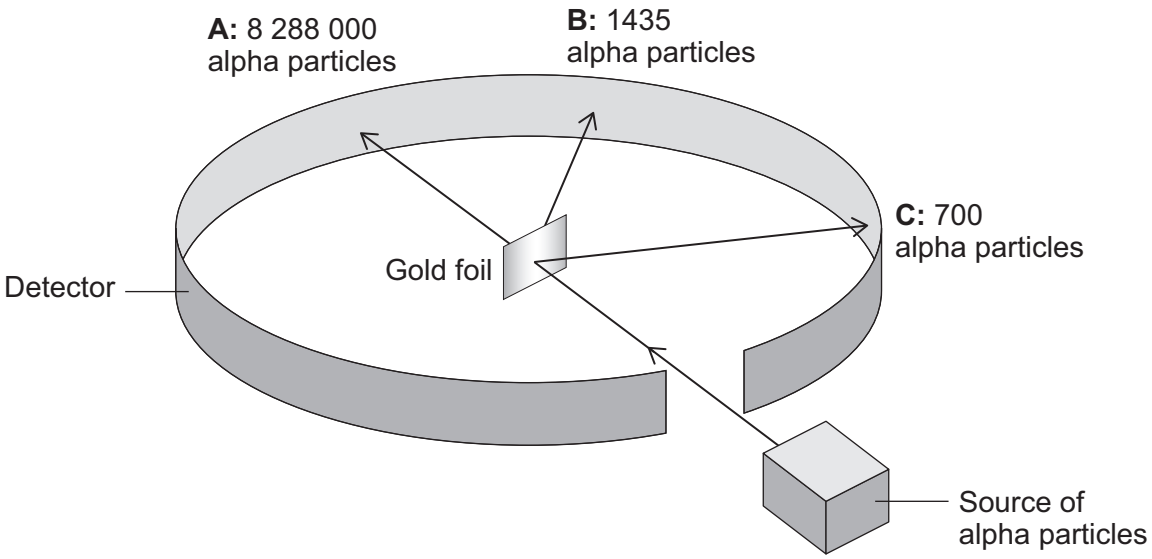
Electromagnetic radiation ☐

Question 1 continues on the next page

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**.

[2 marks]

Simplest ratio of **A** : **C** = _____ : 1

Do not write outside the box

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** show that a gold atom is mostly empty space?

[1 mark]

0 1 . 5 Explain how the results in **Figure 1** show that a gold atom contains a charged nucleus.

[2 marks]

Question 1 continues on the next page

Do not write outside the box

0 1 . 6 A gold atom can be represented as:

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

Describe the atomic structure of this gold atom.

You should include the numbers of each type of sub-atomic particle.

[5 marks]

13

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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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** ☐

Do not write outside the box

0 2 . 3 One of the antibiotics in **Table 1** 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 _____

_____

_____

Question 2 continues on the next page

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 = _____

Do not write outside the box

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

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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** has the greatest energy content.

Give **one** reason for your answer.

[2 marks]

Milk _____

Reason _____

_____

Do not write outside the box

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**.

[2 marks]

_____

_____

_____

_____

Question 3 continues on the next page

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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]

_____

_____

Do not write outside the box

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

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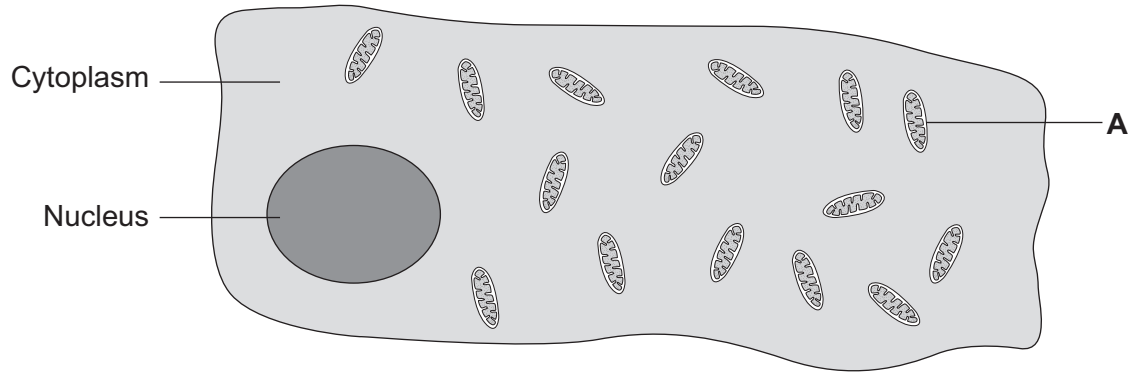
0 4 Heart tissue is made of cardiac muscle cells.

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]

_____

_____

Do not write outside the box

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 ☐

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]

Question 4 continues on the next page

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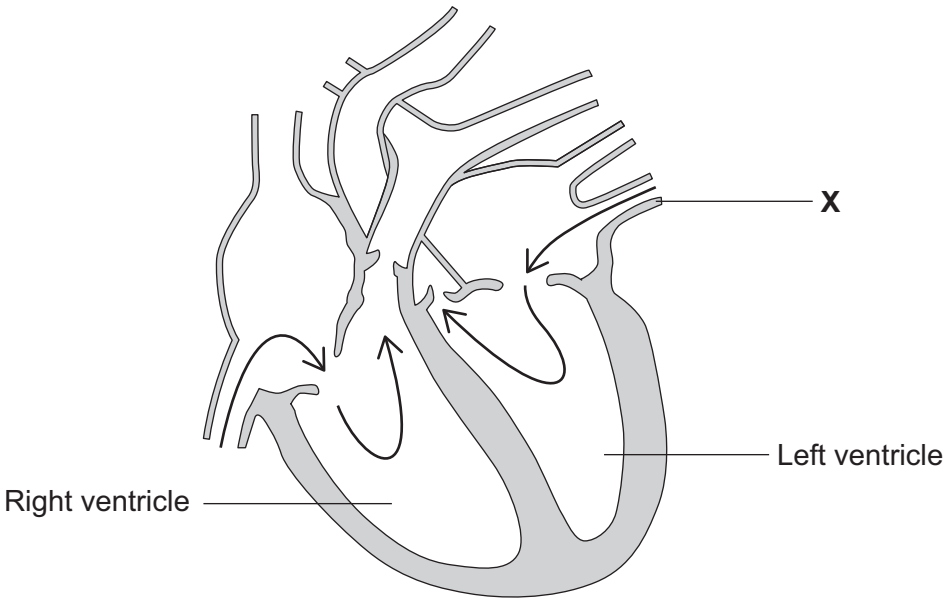
Figure 3 shows a diagram of a human heart.

Figure 3



0 4 . 5 What is the name of blood vessel **X**?

[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]

_____

_____

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**.

[1 mark]

Tick (✓) **one** box.

< 25 ☐ = 25 ☐ > 25 ☐

Question 4 continues on the next page

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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

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Turn over for the next question

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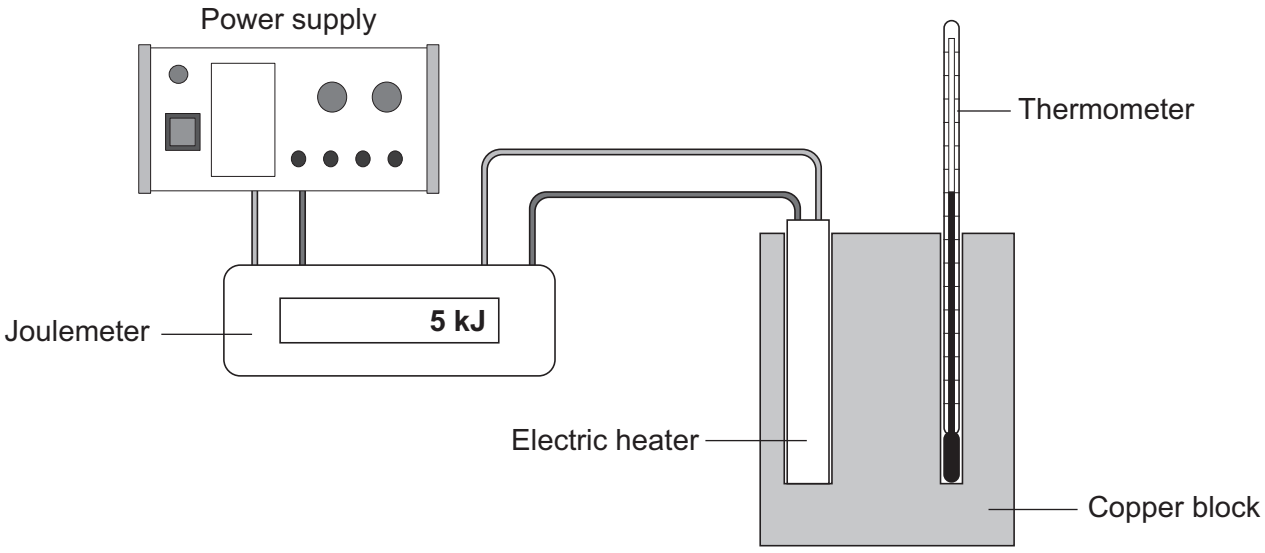
ANSWER IN THE SPACES PROVIDED

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.

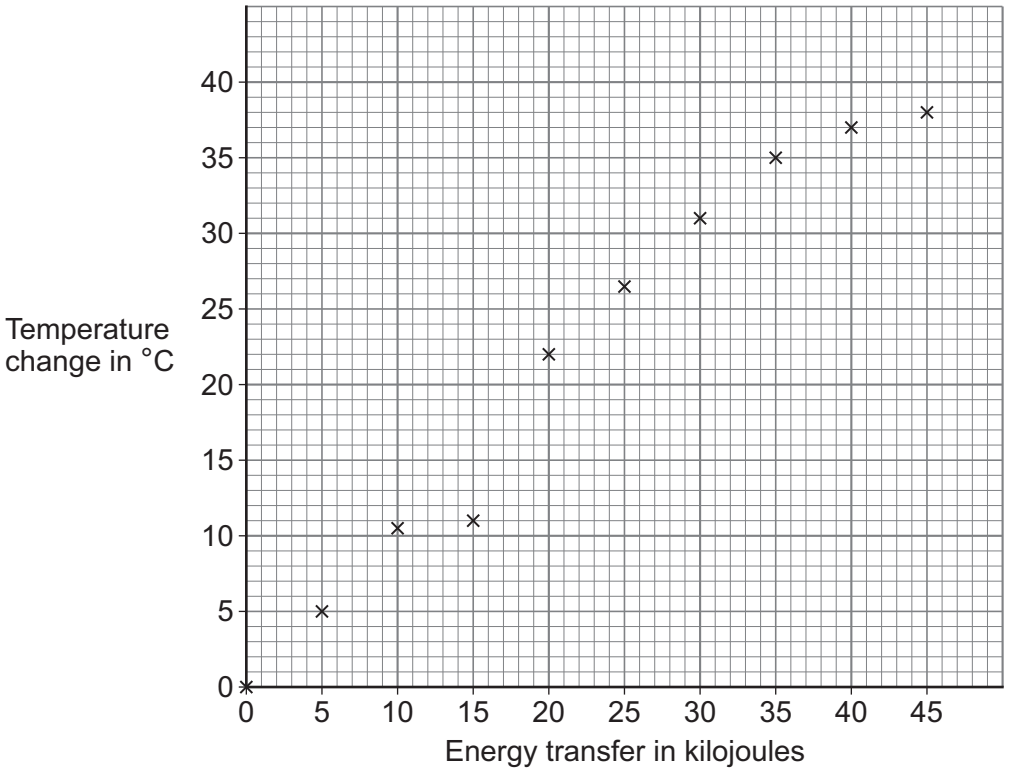
Every minute, the student recorded:

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

Do not write outside the box

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**?

[1 mark]

_____

_____

Question 5 continues on the next page

Do not write outside the box

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]

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Question 5 continues on the next page

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ANSWER IN THE SPACES PROVIDED

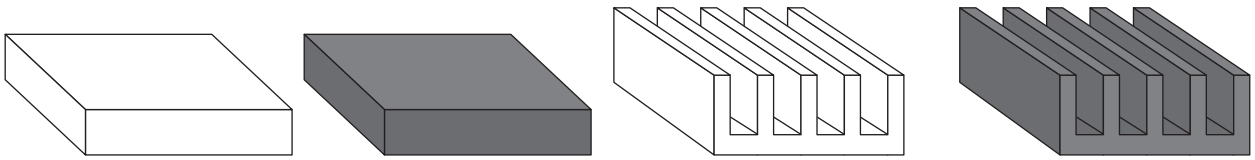
Computer components get hot when they are in use.

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 **B** **C** **D**

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**.

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

Do not write outside the box

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

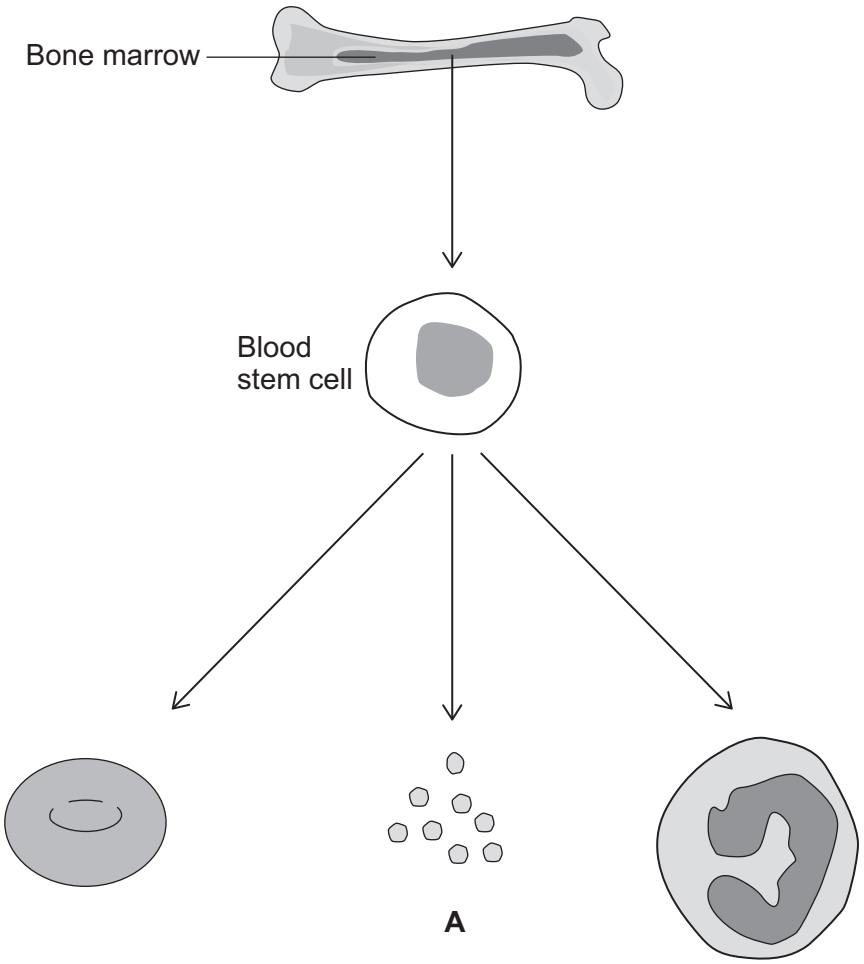
12

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]

Do not write outside the box

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]

_____

_____

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.

1 dm^3 = 1000 cm^3

[4 marks]

_____

_____

_____

_____

_____

_____

_____

_____

Percentage of red blood cells replaced each day = _____ %

Question 6 continues on the next page

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0 6 . 4 Explain why red blood cells **cannot** divide by mitosis.

[2 marks]

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.

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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

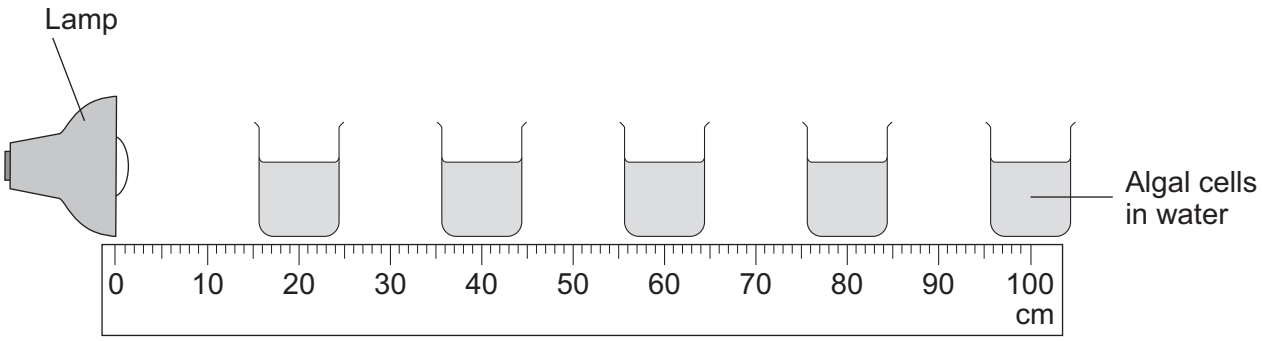
Turn over for the next question

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]

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]

Question 7 continues on the next page

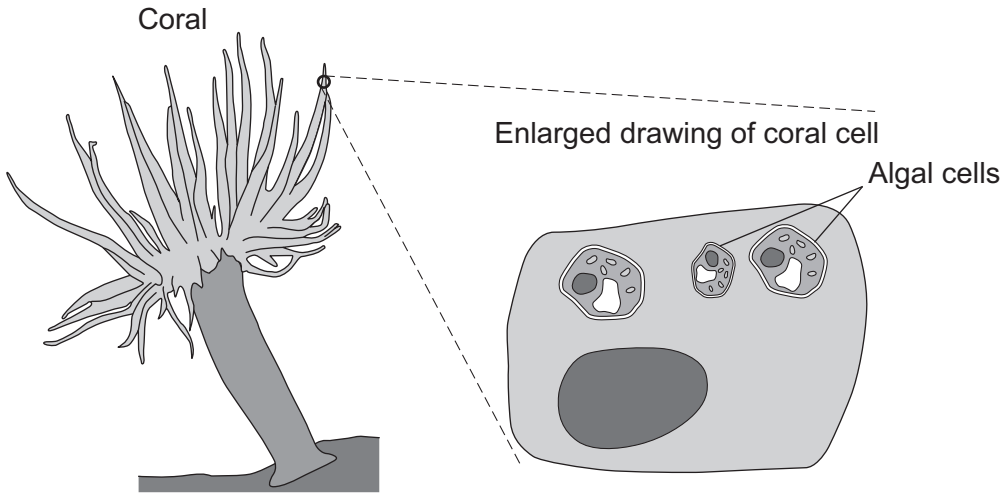
Corals are animals that live in the sea.

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]

_____ + _____ → _____ + _____

Do not write outside the box

0 7 . 4 Explain **one** way the algal cells use glucose for growth.

[2 marks]

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.

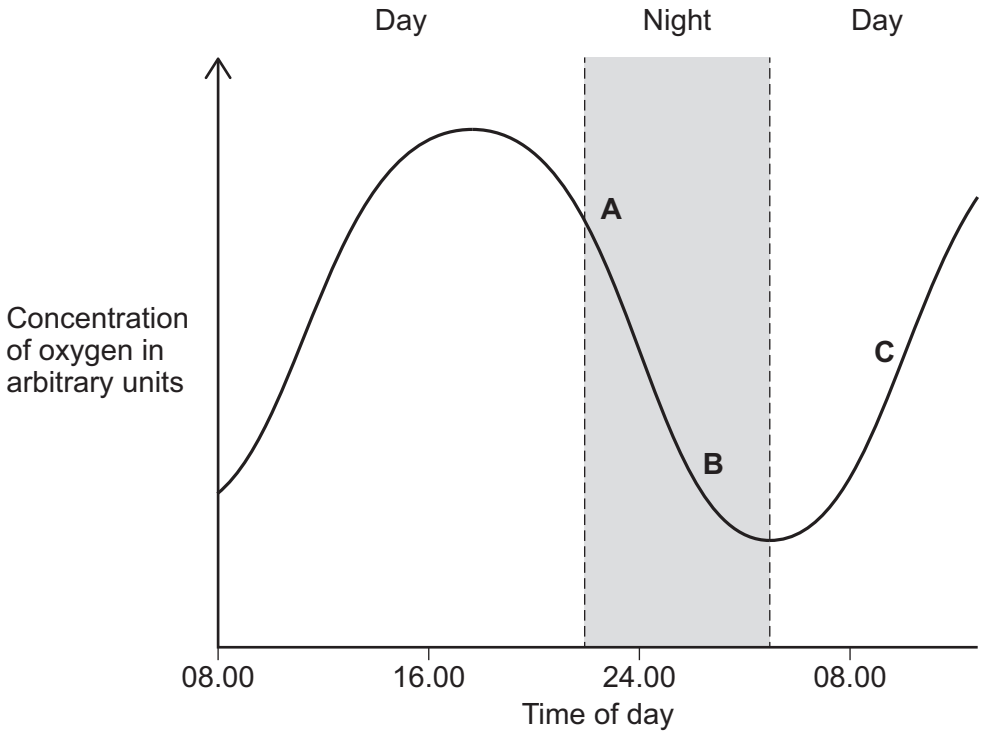
[1 mark]

Question 7 continues on the next page

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]

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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]

_____

_____

18

END OF QUESTIONS

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ANSWER IN THE SPACES PROVIDED

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

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