AQA GCSE Biology | 8461

SPECIFICATION POINT 4.4.1.1

Photosynthetic reaction

Past-paper questions

Tier	**Higher**
Question groups	**22**
Available paper years	**2008–2025**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

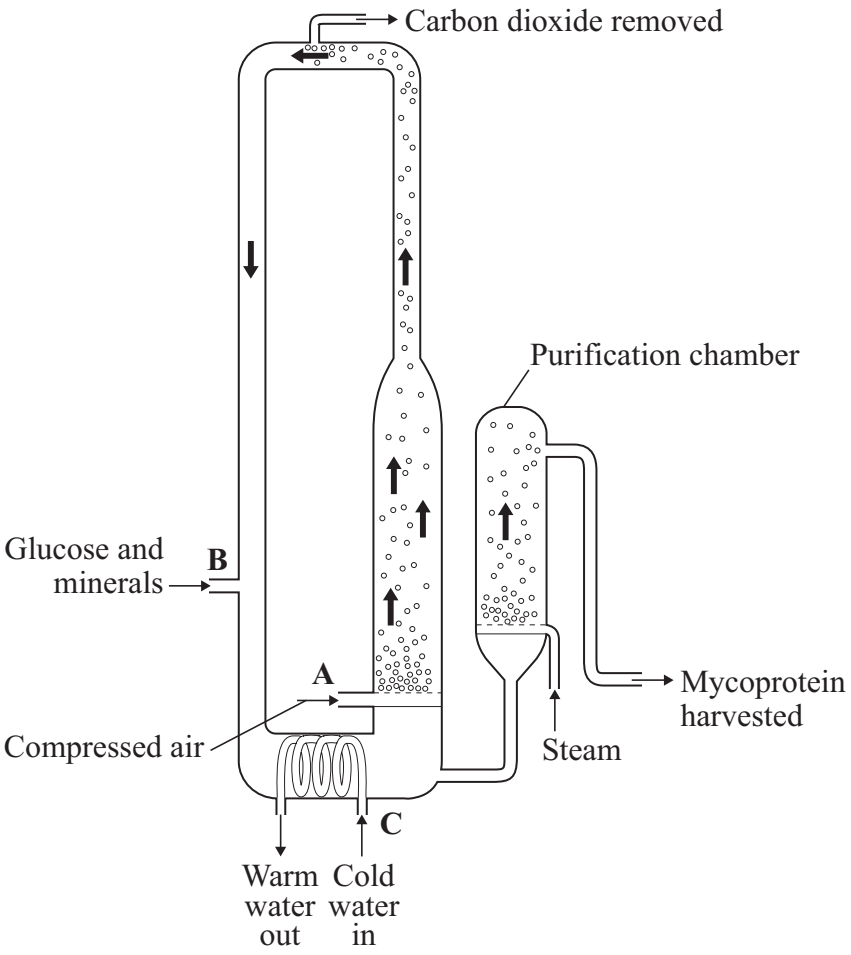
Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

4.4.1.1 Photosynthetic reaction

Question 01

June 2008 | BLY3H | Original Q7 | Legacy

7 The diagram shows a fermenter. This fermenter is used for growing the fungus *Fusarium* which is used to make mycoprotein.



7 (a) Bubbles of air enter the fermenter at **A**.

Give **two** functions of the air bubbles.

1 .....

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2 .....

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(2 marks)

4.4.1.1 Photosynthetic reaction

Question 01 · continued

for mark

7 (b) Glucose is added to the fermenter at **B**.

Explain why glucose is added.

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(1 mark)

7 (c) The fermenter is prevented from overheating by the cold water flowing in through the heat exchanger coils at **C**.

Explain what causes the fermenter to heat up.

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(1 mark)

7 (d) It is important to prevent microorganisms other than *Fusarium* from growing in the fermenter.

7 (d) (i) Why is this important?

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(1 mark)

7 (d) (ii) Suggest **two** ways in which contamination of the fermenter by microorganisms could be prevented.

1 .....

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2 .....

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(2 marks)

Question 7 continues on the next page

4.4.1.1 Photosynthetic reaction

Question 01 · continued

for mark

7 (e) Human cells cannot make some of the amino acids which we need. We must obtain these amino acids from our diet.

The table shows the amounts of four of these amino acids present in mycoprotein, in beef and in wheat.

Name of amino acid	Amount of amino acid per 100 g in mg			Daily amount needed by a 70 kg human in mg
	Mycoprotein	Beef	Wheat	
Lysine	910	1600	300	840
Methionine	230	500	220	910
Phenylalanine	540	760	680	980
Threonine	610	840	370	490

A diet book states that mycoprotein is the best source of amino acids for the human diet.

Evaluate this statement.

Remember to include a conclusion in your evaluation.

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(4 marks)

11

4.4.1.1 Photosynthetic reaction

Question 02

June 2009 | BLY2H | Original Q1 | Legacy

1 (a) (i) Complete the word equation for photosynthesis.

carbon dioxide + ... (+ light energy) → glucose + ...

(2 marks)

1 (a) (ii) Most of the carbon dioxide that a plant uses during photosynthesis is absorbed from the air.

Give **one** other source of carbon dioxide for a plant.

Draw a ring around your answer.

the soil **respiration in the plant** **osmosis in the plant** **water**

(1 mark)

A student investigated the conditions that plants need for photosynthesis.
The leaves of the plant he used had green and white parts.

Diagram 1 shows how part of one leaf was covered in black (opaque) card.
The plant was placed in a warm, sunny area and was watered well.
Eight hours later the leaf was removed from the plant and was tested for starch.

The results of the test are shown in **Diagram 2**, the shaded parts show where starch was present.

Diagram 1

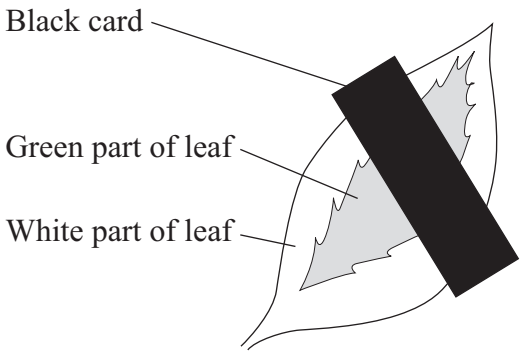
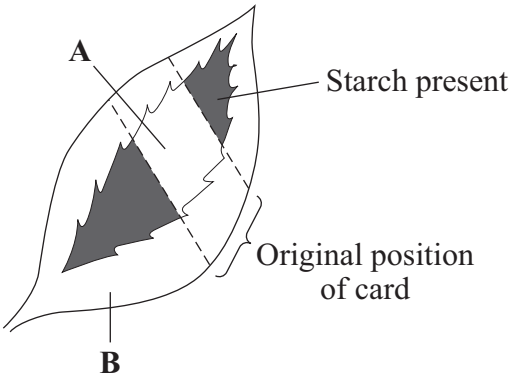


Diagram 2



4.4.1.1 Photosynthetic reaction

Question 02 · continued

for mark

1 (b) Name the **two** independent variables in this investigation.

1 .....

.....

2 .....

.....

(2 marks)

1 (c) Why was no starch found in:

1 (c) (i) the part of the leaf labelled **A**

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(1 mark)

1 (c) (ii) the part of the leaf labelled **B**?

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(1 mark)

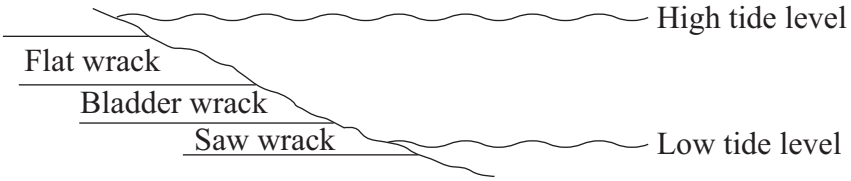
7

4.4.1.1 Photosynthetic reaction

Question 03

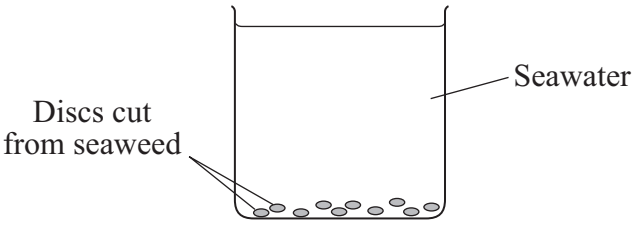
January 2010 | BLY2H | Original Q4 | Legacy

4 The diagram shows where three seaweeds live on a seashore.
As the tide moves in and out, these seaweeds are covered with seawater for different lengths of time.



Some students investigated the rate of photosynthesis in these seaweeds.

- They cut ten small discs from one seaweed.
- They dropped the discs into seawater in a beaker.
- They recorded the time taken for the fifth disc to float to the surface.
- They repeated this experiment with the other two seaweeds.



4 (a) (i) Suggest why the discs floated to the surface.

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(1 mark)

4 (a) (ii) Suggest the advantage of recording the time taken for the fifth disc to reach the surface, rather than for the tenth disc.

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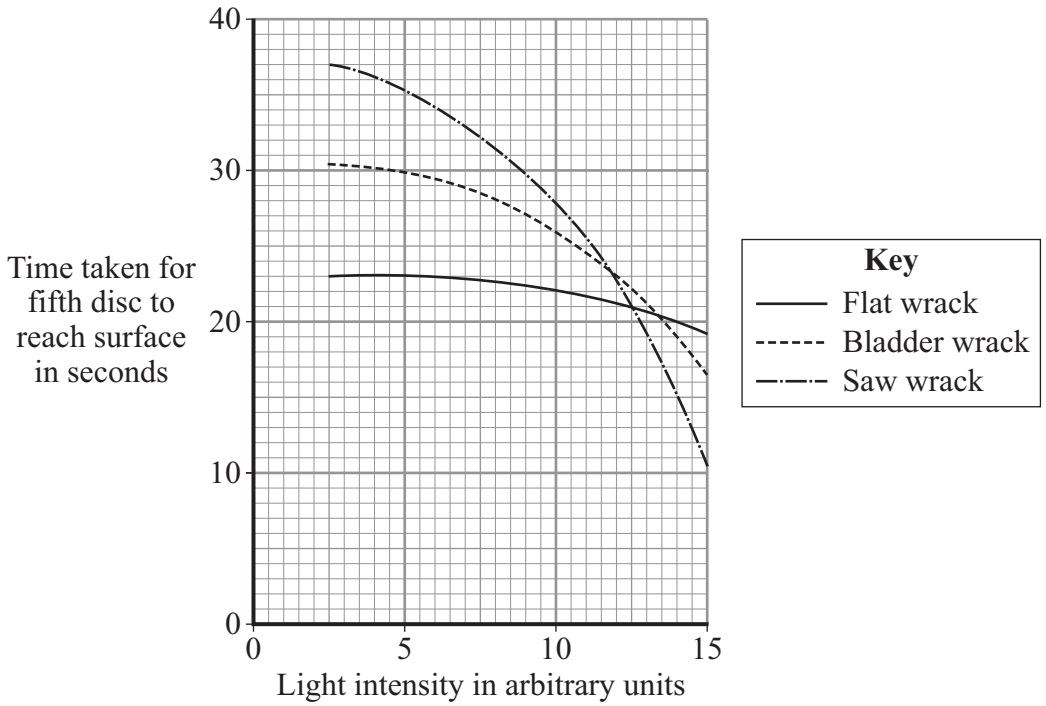
(1 mark)

4.4.1.1 Photosynthetic reaction

Question 03 · continued

for mark

4 (b) The students carried out their experiments at different light intensities.
The graph shows the results they collected.



4 (b) (i) Compare the rate of photosynthesis for flat wrack with the rate for saw wrack at different light intensities.

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(2 marks)

4 (b) (ii) Seawater absorbs light.

The growth rate of saw wrack is less than the growth rate of bladder wrack.

Suggest why.

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(2 marks)

6

4.4.1.1 Photosynthetic reaction

Question 04

June 2010 | BLY2H | Original Q1 | Legacy

1 This question is about photosynthesis.

1 (a) Plants make glucose during photosynthesis. Some of the glucose is changed into insoluble starch.

What happens to this starch?

Tick (✓) **one** box.

The starch is converted into oxygen. ☐

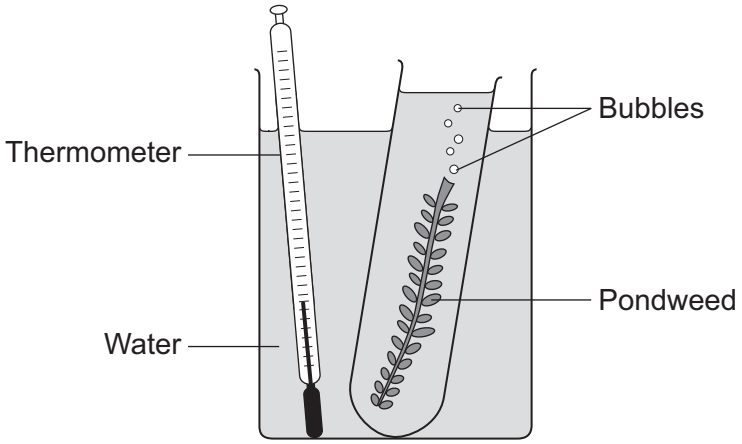
The starch is stored for later use. ☐

The starch is used to make the leaf green. ☐

(1 mark)

1 (b) A student investigated the effect of temperature on the rate of photosynthesis in pondweed.

The diagram shows the way the experiment was set up.



1 (b) (i) The student needed to control some variables to make the investigation fair.

State **two** of these variables.

1 .....

2 .....

(2 marks)

4.4.1.1 Photosynthetic reaction

Question 04 · continued

1 (b) (ii) The bubbles of gas are produced only while photosynthesis is taking place.

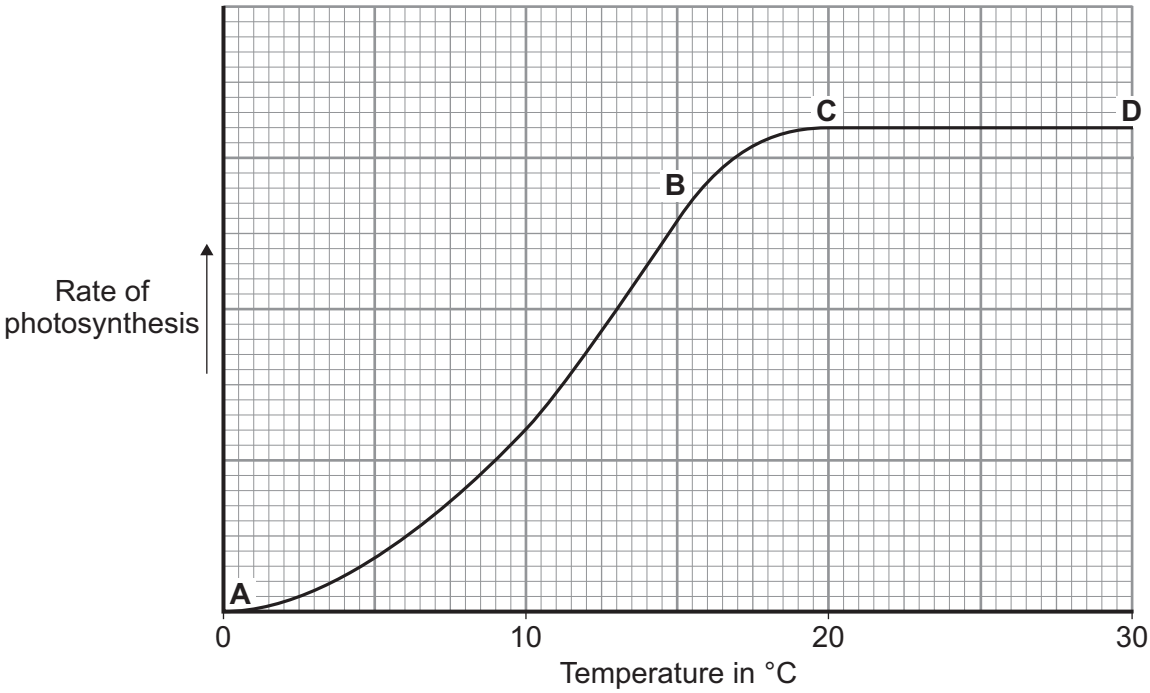
What **two** measurements would the student make to calculate the rate of photosynthesis?

1 .....

2 .....

(2 marks)

1 (c) The graph shows the effect of temperature on the rate of photosynthesis.



1 (c) (i) Name the factor that limits the rate of photosynthesis between the points labelled **A** and **B** on the graph.

.....

(1 mark)

1 (c) (ii) Suggest which factor, carbon dioxide, oxygen or water, might limit the rate of photosynthesis between the points labelled **C** and **D** on the graph.

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(1 mark)

7

4.4.1.1 Photosynthetic reaction

Question 05

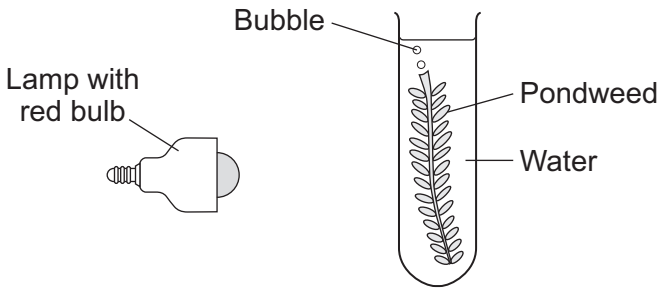
January 2011 | BLY2H | Original Q1 | Legacy

1 A group of pupils investigated the way in which the colour of light affects photosynthesis.

The pupils:

- put a piece of pondweed into a test tube of water
- shone light from a lamp with a red light bulb onto the pondweed
- counted the bubbles of gas produced by the pondweed every minute for three minutes.

The diagram shows the experiment.



The pupils repeated their experiment using a yellow light bulb, a green light bulb and a blue light bulb.

1 (a) (i) What was the independent variable in the investigation?

.....

(1 mark)

1 (a) (ii) To make the investigation fair the pupils needed to control some variables.

Suggest **one** variable that the pupils should have controlled during their investigation.

.....

(1 mark)

1 (a) (iii) It is better to count the bubbles every minute for three minutes than to count all the bubbles in three minutes.

Why?

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.....

(1 mark)

4.4.1.1 Photosynthetic reaction

Question 05 · continued

1 (b) The table shows the pupils' results.

Colour of bulb	Number of bubbles produced in one minute			
	1st minute	2nd minute	3rd minute	Mean
Red	24	19	21	21
Yellow	18	14	15	16
Green	6	4	3	4
Blue	32	34	32	33

Algae are tiny organisms that photosynthesise.
In natural light algae grow very quickly on the sides of a fish tank.
The algae make it difficult to see the fish.

1 (b) (i) What would be the best colour of light bulb to illuminate the fish tank to reduce the growth of algae?

Use the results in the table to help you to decide.

Draw a ring around **one** answer.

red **yellow** **green** **blue**

(1 mark)

1 (b) (ii) Explain why the colour you have chosen is the best.

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(2 marks)

6

4.4.1.1 Photosynthetic reaction

Question 06

4 (a) Ethanol can be produced from glucose.
The glucose is often made by the digestion of maize starch.

The equation shows the digestion of starch.

$$\text{starch} + \text{water} \xrightarrow{\text{enzymes}} \text{glucose}$$

4 (a) (i) Name the type of enzyme that can be used to digest starch.

.....

(1 mark)

4 (a) (ii) The glucose can then be used by yeast in the following process.

$$\text{glucose} \xrightarrow{\text{enzymes}} \text{ethanol} + \text{carbon dioxide} (+ \text{energy})$$

Name this process.

.....

(1 mark)

4 (b) Ethanol, produced as described in part (a)(ii), can be used in car engines.

This is more environmentally friendly than using petrol.

Explain why.

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(3 marks)

5

4.4.1.1 Photosynthetic reaction

Question 07

March 2011 | BLY1BP | Original Q7 | Legacy

QUESTION SEVEN

Algae are small plants that live in water. Algae photosynthesise to gain energy to grow. An alga that grows off the coast of Hawaii makes a high proportion of vegetable oils in its cells.

A fuel company is planning to farm this alga to produce biodiesel fuel from the vegetable oils. The company says that the plans will result in sustainable development.

7A What does the company mean by *sustainable development* (for producing biodiesel)?

1 The algae will always grow in the sea around Hawaii.

2 The biodiesel will be produced using fossil fuels.

3 The biodiesel will be produced without affecting future generations.

4 The company can keep making the biodiesel for a long time.

7B Which of the following statements is the most important reason for promoting the algae as a sustainable source of biodiesel?

1 The trial growth project is in the sea around Hawaii where conditions are best for the algae farming.

2 The cost of the biodiesel produced is 8 times greater than diesel produced from fossil fuels.

3 The algae absorb carbon dioxide from the atmosphere, which increases the 'greenhouse effect'.

4 Using food crops to produce biodiesel may lead to starvation in some poor countries.

7C Some people say that burning fossil fuels adds to global warming.

Why does burning fossil fuels add to global warming?

1 Burning fossil fuels releases heat.

2 Burning fossil fuels releases carbon dioxide.

3 Fossil fuels are easily available.

4 Carbon in fossil fuels did not come from plants.

4.4.1.1 Photosynthetic reaction

Question 07 · continued

7D Methane contributes to global warming because methane . . .

1 traps heat radiation from the Earth and re-radiates it out to space.

2 traps heat radiation from the Earth and re-radiates it back to the Earth.

3 traps heat radiation directly from the Sun and re-radiates it back to the Earth.

4 reflects heat radiation from the Sun back out to space.

Turn over for the next question

4.4.1.1 Photosynthetic reaction

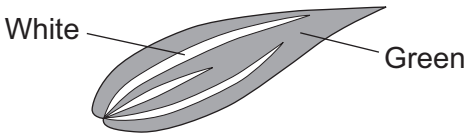
Question 08

June 2011 | BLY2H | Original Q5 | Legacy

5 Students investigated the effect of changing the carbon dioxide concentration on the rate of photosynthesis in pieces of leaf.

Diagram 1 shows the type of leaf used by the students.

Diagram 1

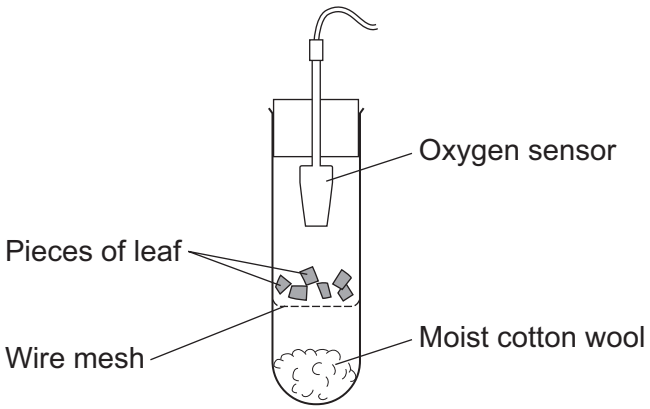


The students:

- cut pieces of leaf from the green region
- put the pieces into tubes
- added different concentrations of carbon dioxide to each tube
- shone lights on the tubes with either high or low light intensity
- recorded the concentration of oxygen in the tubes after 5 hours.

Diagram 2 shows how each experiment was set up.

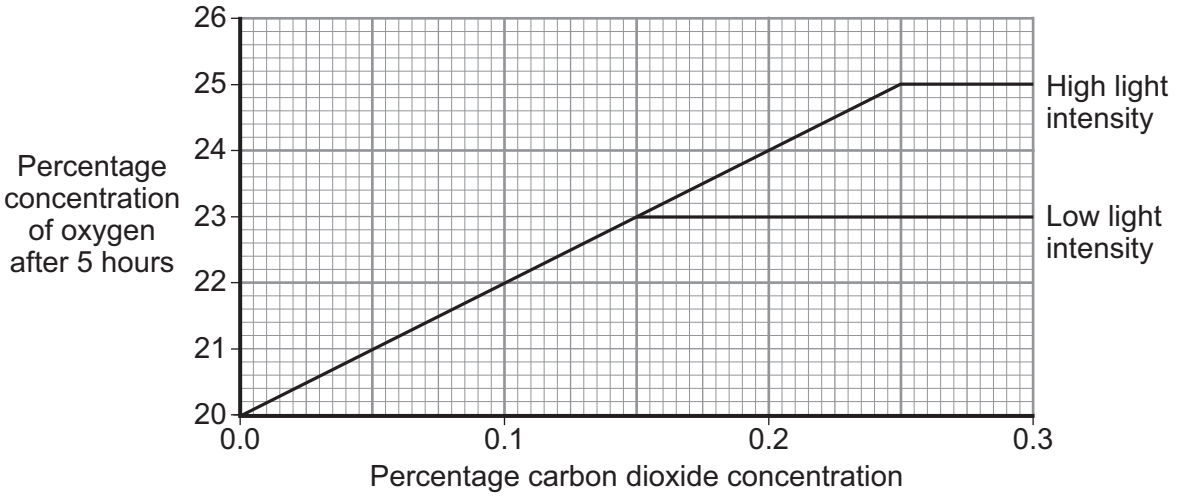
Diagram 2



4.4.1.1 Photosynthetic reaction

Question 08 · continued

The graph shows the results of the investigation.



5 (a) (i) Describe the effect of increasing carbon dioxide concentration on the rate of photosynthesis at low light intensity.

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(1 mark)

5 (a) (ii) Explain the effect that you have described.

In your answer you should refer to limiting factors.

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(2 marks)

5 (b) What would have been the effect on oxygen concentration over the five-hour period if a white region of the leaf had been used, instead of a green region?

Effect.....

Explain your answer.

Explanation .....

.....

.....

(2 marks)

Question 5 continues on the next page

4.4.1.1 Photosynthetic reaction

Question 08 · continued

5 (c) Some people keep indoor plants which have variegated leaves (leaves with green and white regions).

If plants with variegated leaves are kept in dim light conditions the white areas of the leaves start to turn green.

This is an advantage to the plant.

Suggest why.

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(2 marks)

7

4.4.1.1 Photosynthetic reaction

Question 09

June 2012 | BL2HP | Original Q5 | Legacy

5 (a) Complete the equation for photosynthesis.

..... + ... $\xrightarrow{\text{light energy}}$ ..... + oxygen

(2 marks)

5 (b) Scientists investigated how temperature affects the rate of photosynthesis.
The scientists grew some orange trees in a greenhouse.
They used discs cut from the leaves of the young orange trees.

The scientists used the rate of oxygen production by the leaf discs to show the rate of photosynthesis.

5 (b) (i) The leaf discs did not produce any oxygen in the dark.

Why?

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(1 mark)

5 (b) (ii) The leaf discs took in oxygen in the dark.

Explain why.

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(2 marks)

Question 5 continues on the next page

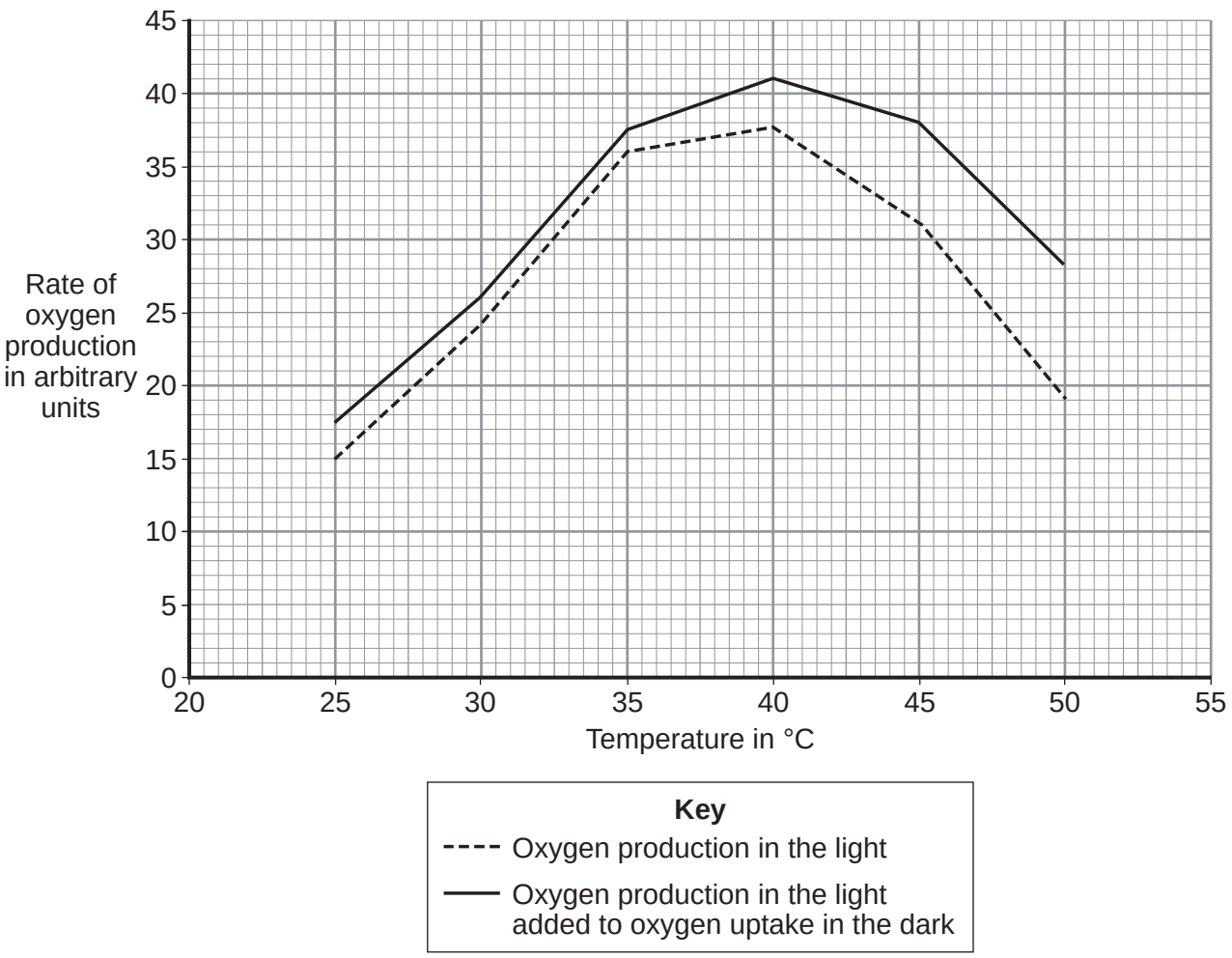
4.4.1.1 Photosynthetic reaction

Question 09 · continued

5 (c) In their investigation, the scientists measured the rate of oxygen release by the leaf discs in the light. The scientists then measured the rate of oxygen uptake by the leaf discs in the dark.

The graph shows the effect of temperature on

- oxygen production in the light
- oxygen production in the light added to oxygen uptake in the dark.



Use the information from the graph to answer each of the following questions.

5 (c) (i) Describe the effect of temperature on oxygen production in the light.

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(2 marks)

4.4.1.1 Photosynthetic reaction

Question 09 · continued

5 (c) (ii) Explain the effect of temperature on oxygen production in the light when the temperature is increased:

from 25 °C to 35 °C

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.....

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from 40 °C to 50 °C.

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(2 marks)

5 (d) A farmer in the UK wants to grow orange trees in a greenhouse. He wants to sell the oranges he produces at a local market.
He decides to heat the greenhouse to 35 °C.

Explain why he should **not** heat the greenhouse to a temperature higher than 35 °C.
Use information from the graph in your answer.

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(3 marks)

12

4.4.1.1 Photosynthetic reaction

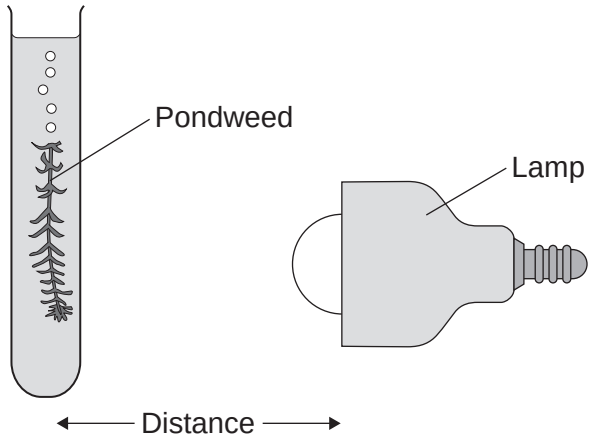
Question 10

January 2013 | BL2HP | Original Q1 | Legacy

1 Some students investigated the effect of light intensity on the rate of photosynthesis.

They used the apparatus shown in **Diagram 1**.

Diagram 1



The students:

- placed the lamp 10 cm from the pondweed
- counted the number of bubbles of gas released from the pondweed in 1 minute
- repeated this for different distances between the lamp and the pondweed.

1 (a) The lamp gives out heat as well as light.

What could the students do to make sure that heat from the lamp did **not** affect the rate of photosynthesis?

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(1 mark)

4.4.1.1 Photosynthetic reaction

Question 10 · continued

1 (b) The table shows the students' results.

Distance in cm	Number of bubbles per minute
10	84
15	84
20	76
40	52
50	26

1 (b) (i) At distances between 15cm and 50cm, light was a limiting factor for photosynthesis.

What evidence is there for this in the table?

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(1 mark)

1 (b) (ii) Give **one** factor that could have limited the rate of photosynthesis when the distance was between 10cm and 15cm.

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(1 mark)

Question 1 continues on the next page

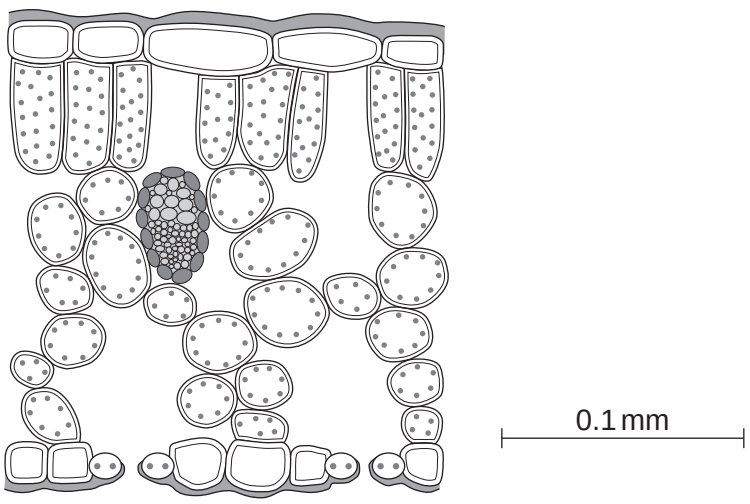
4.4.1.1 Photosynthetic reaction

Question 10 · continued

1 (c) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

Diagram 2 shows a section through a plant leaf.

Diagram 2



Describe the structure of the leaf and the functions of the tissues in the leaf.

You should use the names of the tissues in your answer.

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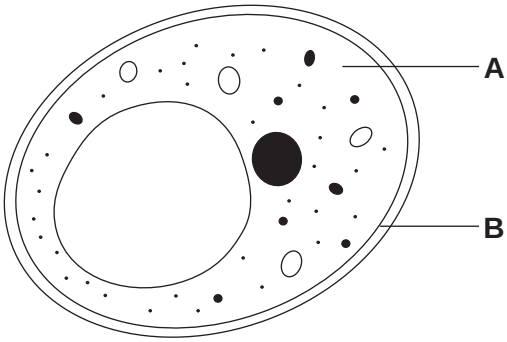
4.4.1.1 Photosynthetic reaction

Question 11

June 2013 | BL2HP | Original Q4 | Legacy

4 **Diagram 1** shows a yeast cell.

Diagram 1



4 (a) Name structures **A** and **B**.

A .....

B .....

(2 marks)

4 (b) Yeast cells can respire anaerobically.

The equation for anaerobic respiration in yeast is:

glucose ⟶ alcohol + carbon dioxide (+ energy)

Give **one** way in which anaerobic respiration in yeast cells is different from anaerobic respiration in human muscle cells.

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(1 mark)

4.4.1.1 Photosynthetic reaction

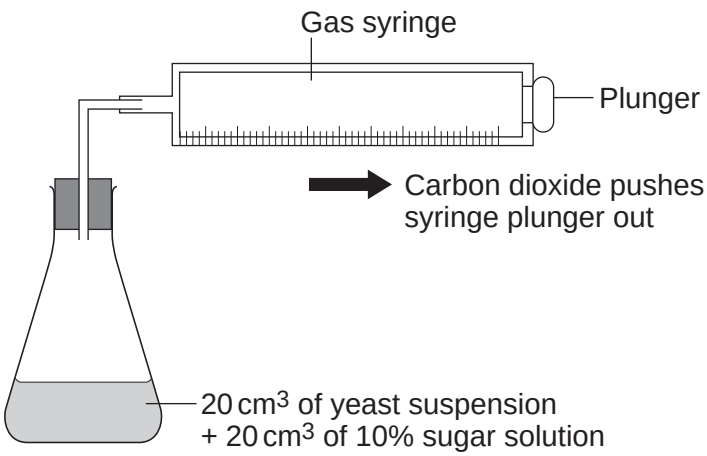
Question 11 · continued

4 (c) Yeast can use other types of sugar instead of glucose.
Some scientists investigated the effect of three different types of sugar on the rate of anaerobic respiration in yeast.

The scientists:

- used the apparatus shown in **Diagram 2** with glucose sugar
- kept the apparatus at 20 °C
- repeated the investigation with fructose sugar and then with mannose sugar
- repeated the investigation with water instead of the sugar solution.

Diagram 2



4 (c) (i) Give **two** control variables the scientists used in this investigation.

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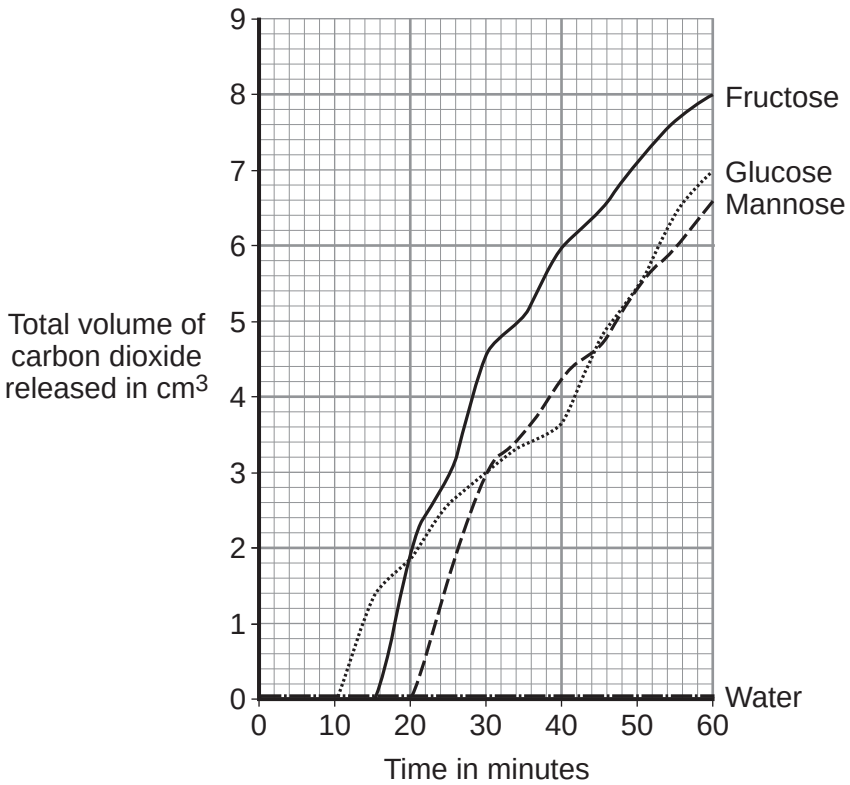
(2 marks)

Question 4 continues on the next page

4.4.1.1 Photosynthetic reaction

Question 11 · continued

4 (c) (ii) The graph shows the scientists' results.



From this information, a company decided to use fructose to produce alcohol and **not** mannose or glucose.

Explain the reason for the company's choice.

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(2 marks)

7

4.4.1.1 Photosynthetic reaction

Question 12

June 2013 | BL2HP | Original Q5 | Legacy

5 (a) Complete the equation for photosynthesis.

..... + water $\xrightarrow{\text{light energy}}$ ..... + ...

(3 marks)

5 (b) The rate of photosynthesis in a plant depends on several factors in the environment. These factors include light intensity and the availability of water.

Describe and explain the effects of **two other** factors that affect the rate of photosynthesis.

You may include one or more sketch graphs in your answer.

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(5 marks)

8

4.4.1.1 Photosynthetic reaction

Question 13

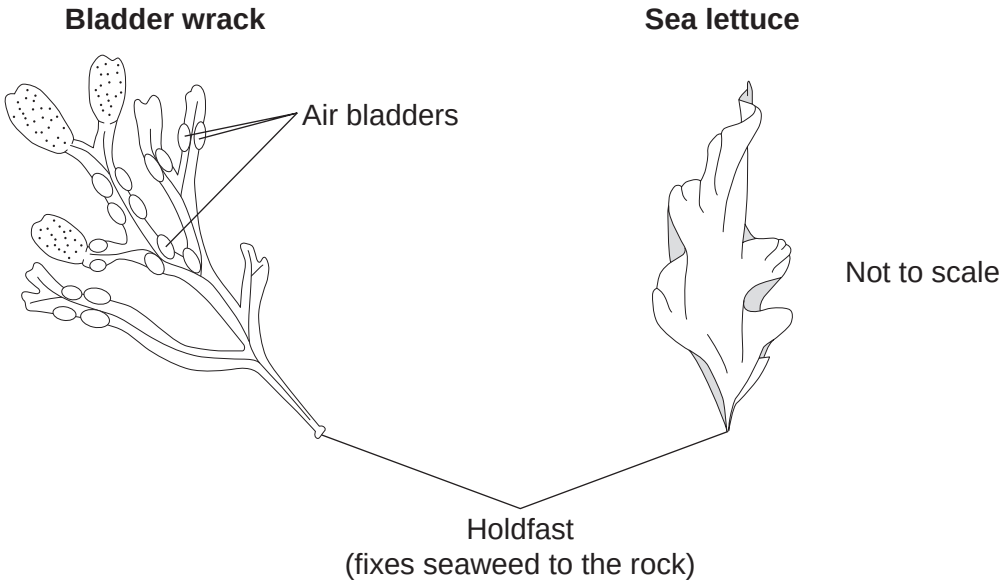
June 2014 | BL2HP | Original Q5 | Legacy

5 At the seashore, the tide comes in and goes out twice each day.

Some students investigated whether two different species of seaweed could live only at certain positions on a rocky shore.
Seaweeds are plant-like organisms that make their food by photosynthesis.

Figure 6 shows the two species of seaweed that the students investigated.

Figure 6



5 (a) The students:

1 placed a 50-metre tape measure on the rocks at right angles to the sea

2 placed a quadrat next to the tape measure

3 recorded whether each species was present or not.

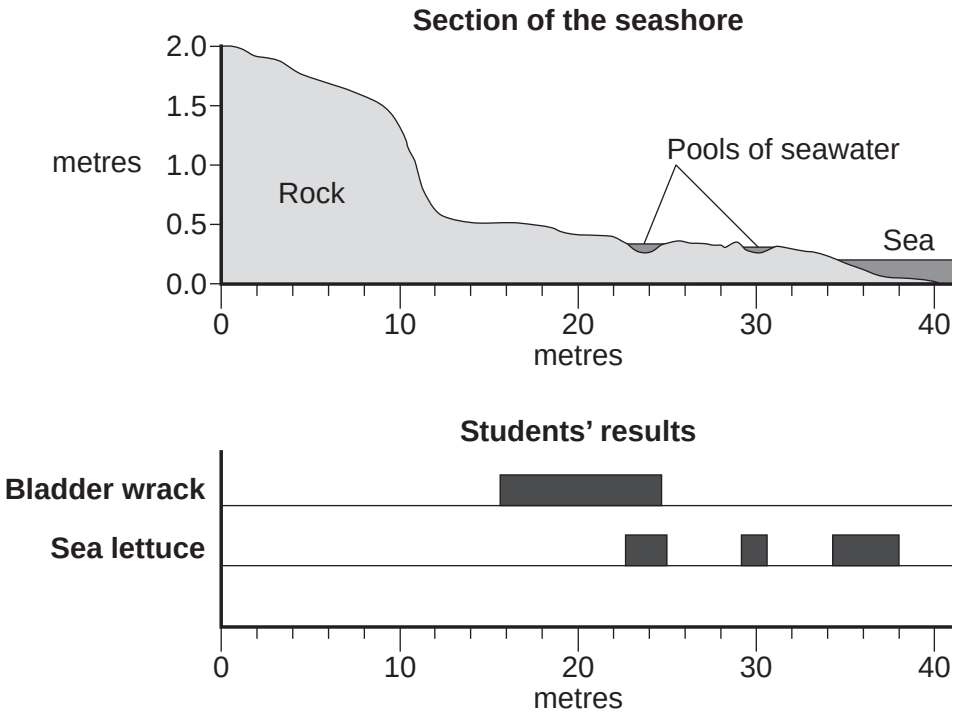
The students repeated steps 2 and 3 every metre down the shore.

Figure 7 shows a section of the seashore and the students' results.

4.4.1.1 Photosynthetic reaction

Question 13 · continued

Figure 7



5 (a) (i) The students placed the quadrat at regular intervals along a transect line rather than placing the quadrat at random positions anywhere on the rocky shore.

Explain why.

[2 marks]

.....

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.....

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5 (a) (ii) How could the students have improved their investigation to ensure that they produced valid data?

[2 marks]

.....

.....

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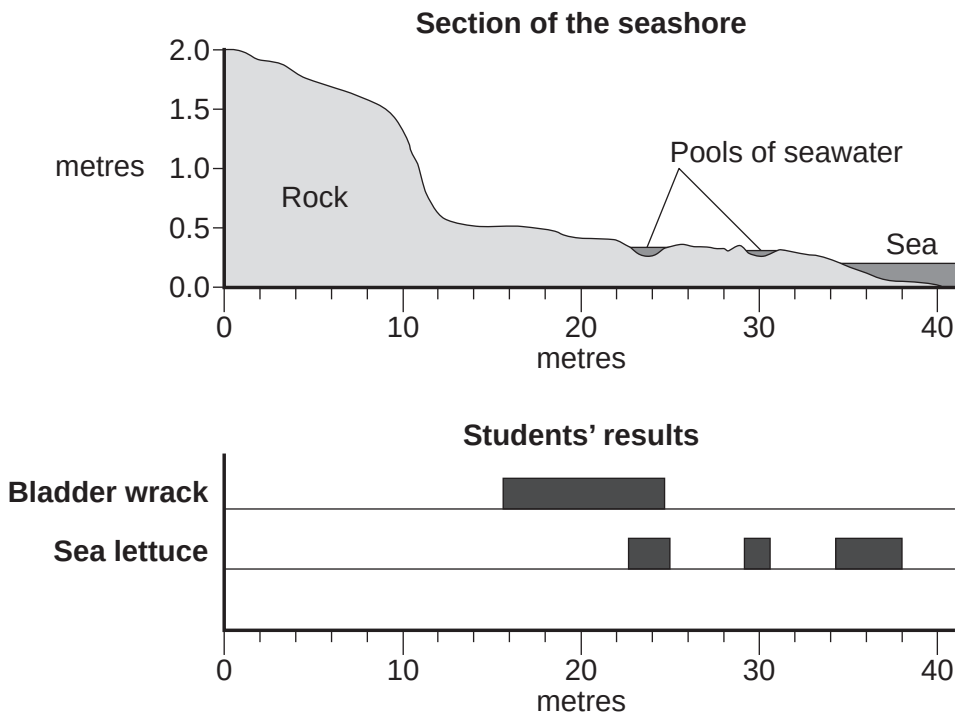
Question 5 continues on the next page

4.4.1.1 Photosynthetic reaction

Question 13 · continued

5 (a) (iii) **Figure 7** is repeated here to help you answer this question.

Figure 7



The students concluded that bladder wrack is better adapted than sea lettuce to survive in dry conditions.

What is the evidence for this conclusion?

Use information from **Figure 7**.

[2 marks]

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4.4.1.1 Photosynthetic reaction

Question 13 · continued

5 (b) The bladder wrack has many air bladders.
The air bladders help the bladder wrack to float upwards when the sea covers it.

Suggest how this helps the bladder wrack to survive.

[2 marks]

.....

.....

.....

.....

8

Turn over for the next question

4.4.1.1 Photosynthetic reaction

Question 14

June 2015 | BL3HP | Original Q4 | Legacy

4 In many areas of the world the mass of household waste produced each year is increasing.

4 (a) Give **two** reasons why the mass of household waste is increasing each year.

[2 marks]

1 .....

.....

2 .....

.....

4 (b) **Table 1** shows how the mass of household waste in the UK has changed from 2004 to 2012.

Table 1

Year	Total mass of household waste in thousands of tonnes (including total household recycling)	Total mass of household recycling in thousands of tonnes	Percentage of household waste recycled
2004	25 658	5785	22.5
2006	25 775	7976	30.9
2008	24 334	9398	38.6
2010	23 454	9733	
2012	22 643	9782	43.2

4 (b) (i) Calculate the percentage of household waste recycled in 2010.

[2 marks]

.....

.....

.....

.....

..... %

4.4.1.1 Photosynthetic reaction

Question 14 · continued

4 (b) (ii) The UK government has been encouraging a 'zero waste economy'.

In a 'zero waste economy', we reduce, reuse and recycle as much waste as possible.

A newspaper concluded that: **'The government's 'zero waste economy' has been successful.'**

Use information from **Table 1** to describe the reasons for and against the newspaper's conclusion.

[4 marks]

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4 (c) (i) Some waste releases carbon dioxide and methane into the atmosphere.
An increase in carbon dioxide and methane contributes to global warming.

Global warming can cause sea levels to rise.

Describe **two** other possible effects of global warming on our environment.

[2 marks]

1 .....

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2 .....

.....

4 (c) (ii) Storing the carbon dioxide helps to prevent more global warming.
Carbon dioxide can be stored (sequestered) in trees when they photosynthesise.

Give **one** different way in which carbon dioxide is sequestered in our environment.

[1 mark]

.....

.....

11

4.4.1.1 Photosynthetic reaction

Question 15

June 2016 | BL2HP | Original Q2 | Legacy

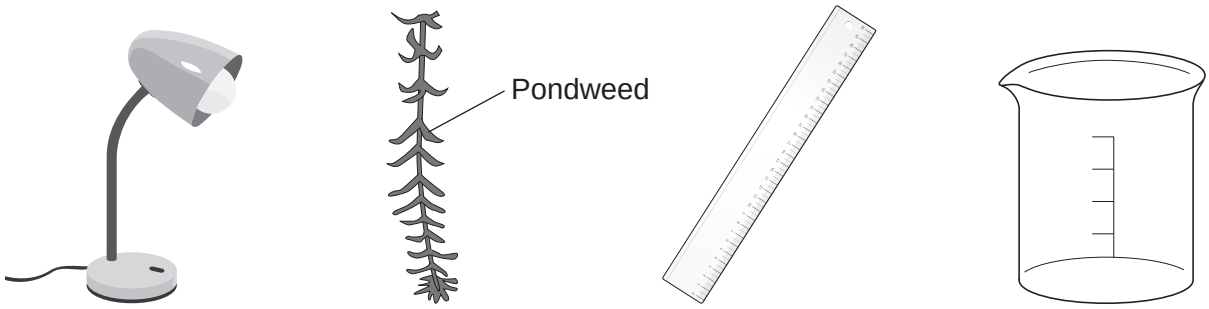
2 **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Light intensity, carbon dioxide concentration and temperature are three factors that affect the rate of photosynthesis.

How would you investigate the effect of **light intensity** on the rate of photosynthesis?

Figure 3 shows some of the apparatus you might use.

Figure 3



Not to scale

You should include details of:

- how you would set up the apparatus and the materials you would use
- the measurements you would make
- how you could make this a fair test.

[6 marks]

4.4.1.1 Photosynthetic reaction

Question 16

June 2017 | BL2HP | Original Q4 | Legacy

4 Plants use carbon dioxide from the air in photosynthesis.

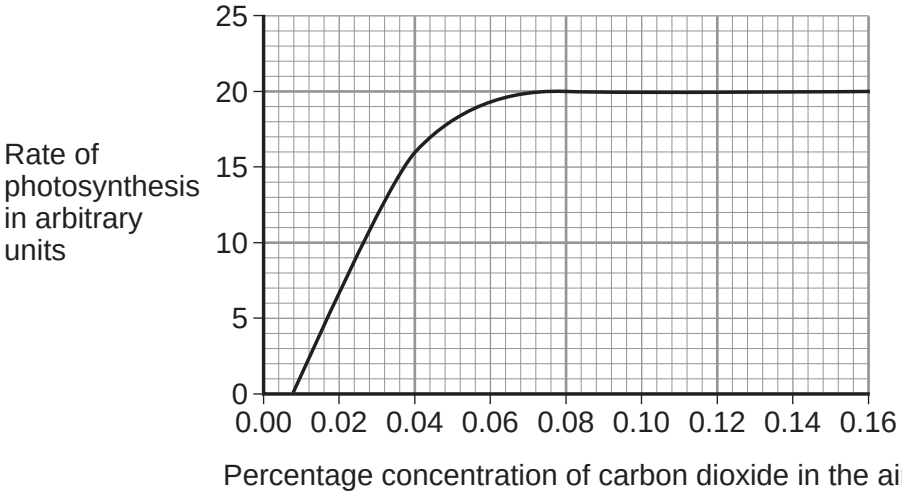
4 (a) Write the word equation for the process of photosynthesis.

[2 marks]

_____

4 (b) **Figure 5** shows the effect of the concentration of carbon dioxide on the rate of photosynthesis in tomato plants at 20 °C.

Figure 5



4 (b) (i) The concentration of carbon dioxide in the air is normally 0.04%.

What is the rate of photosynthesis in the tomato plants at 0.04% carbon dioxide?

[1 mark]

Rate = _____ arbitrary units

4 (b) (ii) A farmer grows tomato plants in a large greenhouse.

He plans to increase the carbon dioxide concentration in the air in his greenhouse to 0.08%.

Calculate the **percentage** increase in the rate of photosynthesis of the tomato plants when the carbon dioxide concentration is increased from 0.04% to 0.08%.

[1 mark]

Use information from **Figure 5**.

_____

_____

Percentage increase = _____ %

4.4.1.1 Photosynthetic reaction

Question 16 · continued

4 (b) (iii) Explain why the farmer would **not** use a concentration of carbon dioxide higher than 0.08%.

[2 marks]

4 (b) (iv) The farmer increases the concentration of carbon dioxide in the air.

Give **two** other ways that the farmer could increase the rate of photosynthesis of the tomato plants.

[2 marks]

1

2

8

4.4.1.1 Photosynthetic reaction

Question 17

June 2019 | 8461/1H | Original Q3

0 3 This question is about photosynthesis.

0 3 . 1 Complete the word equation for photosynthesis:

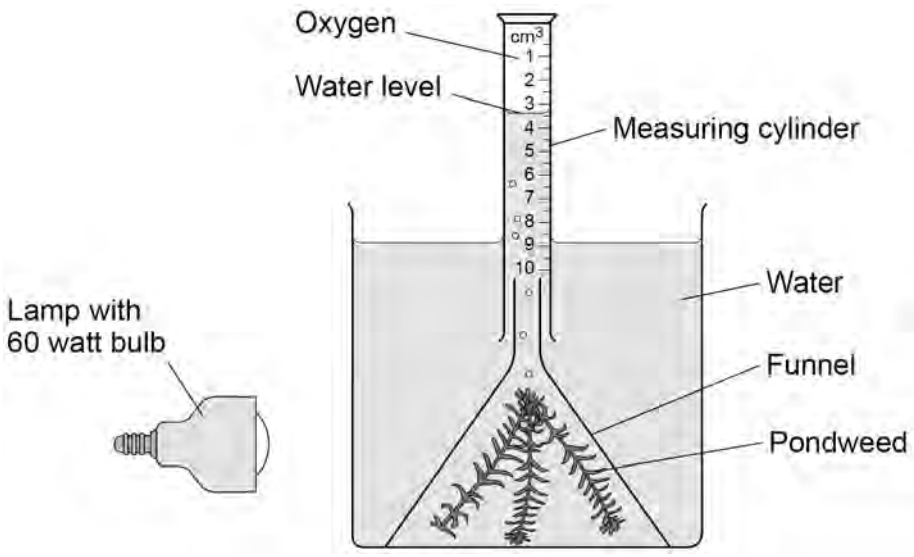
[2 marks]

_____ + _____ ⟶ _____ + oxygen

A student investigated photosynthesis using pondweed.

Figure 3 shows the apparatus the student used.

Figure 3



This is the method used.

1. Set up the apparatus as shown in **Figure 3**.
2. Switch on the lamp.
3. After 20 minutes, record the volume of oxygen collected in the measuring cylinder.
4. Repeat steps 1–3 using bulbs of different power output.

4.4.1.1 Photosynthetic reaction

Question 17 · continued

0 3 . 2 What was the independent variable in the investigation?

[1 mark]

Tick (✓) **one** box.

- Power output of bulb ☐
- Rate of photosynthesis ☐
- Time to collect oxygen ☐
- Volume of oxygen collected ☐

0 3 . 3 Suggest **two** ways the method could be improved so the results would be more valid.

[2 marks]

1 _____

_____

2 _____

_____

Question 3 continues on the next page

4.4.1.1 Photosynthetic reaction

Question 17 · continued

Table 3 shows the student's results.

Table 3

Power output of bulb in watts	Volume of oxygen collected in 20 minutes in cm^3	Rate of photosynthesis in cm^3/hour
60	0.5	1.5
100	0.8	2.4
150	1.1	**X**
200	1.2	3.6
250	1.2	3.6

0 3 . 4 Calculate value **X** in **Table 3**.

[1 mark]

X = _____ cm^3/hour

4.4.1.1 Photosynthetic reaction

Question 17 · continued

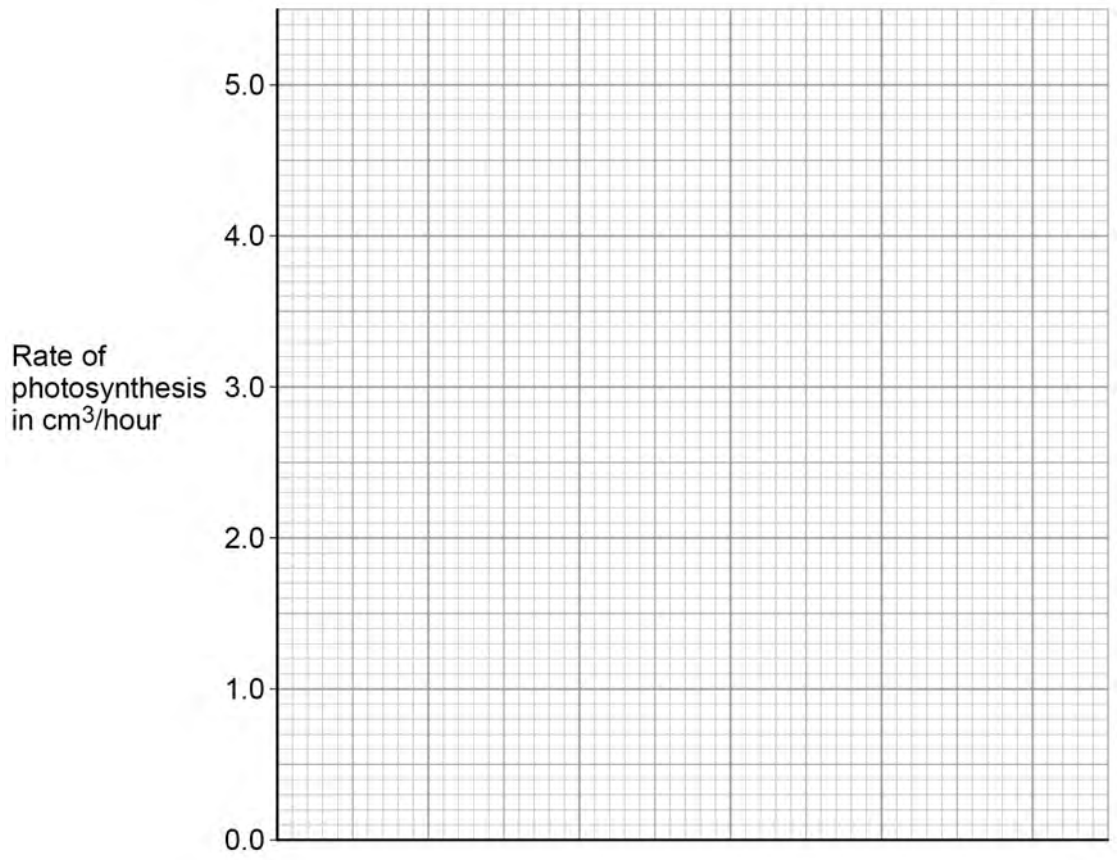
0 3 . 5 Complete **Figure 4**.

[4 marks]

You should:

- label the x-axis
- use a suitable scale
- plot the data from **Table 3** and your answer to Question **03.4**
- draw a line of best fit.

Figure 4



0 3 . 6 Determine the expected rate of photosynthesis with a bulb of power output 75 watts.

Use **Figure 4**.

[1 mark]

Rate of photosynthesis at 75 watts = _____ cm^3/hour

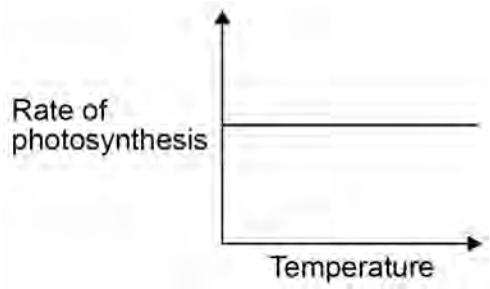
4.4.1.1 Photosynthetic reaction

Question 17 · continued

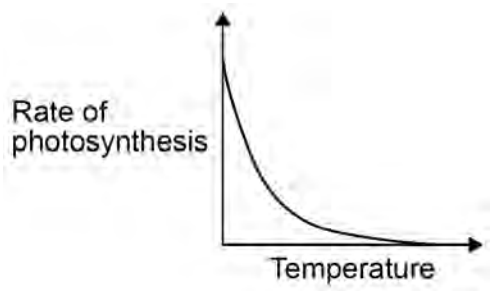
0 3 . 7 Which graph shows the effect of temperature on the rate of photosynthesis?

[1 mark]

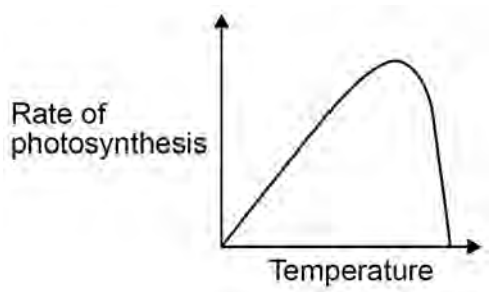
Tick (✓) **one** box.



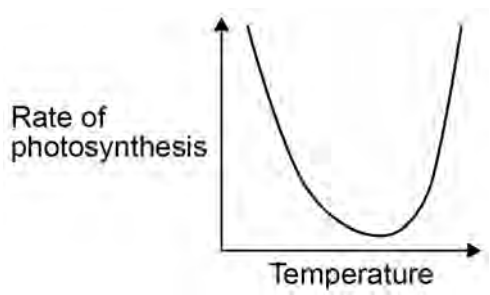
☐



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12

4.4.1.1 Photosynthetic reaction

Question 18

November 2020 | 8461/1H | Original Q1

0 1 This question is about photosynthesis.

0 1 . 1 Complete the word equation for photosynthesis.

[2 marks]

_____ + _____ → _____ + oxygen

0 1 . 2 Describe how energy for the photosynthesis reaction is gained by plants.

[2 marks]

Students investigated the effect of temperature on the rate of photosynthesis.

The students shone light from a lamp onto pondweed and measured the volume of oxygen produced per hour.

Table 1 shows the results.

Table 1

Temperature in °C	Rate of photosynthesis in cm^3/hour			
	Test 1	Test 2	Test 3	Mean
20	18.5	19.3	19.5	**X**
25	32.6	34.1	32.9	33.2
30	41.9	45.2	44.9	44.0
35	38.6	39.8	44.0	40.8
40	23.1	20.5	22.4	22.0
45	1.9	14.2	2.2	2.1

4.4.1.1 Photosynthetic reaction

Question 18 · continued

0 1 . 3 Calculate mean value **X**.

[2 marks]

X = _____ cm^3/hour

The students identified one anomalous result in **Table 1**.

0 1 . 4 Draw a ring around the anomalous result in **Table 1**.

[1 mark]

0 1 . 5 Suggest **one** possible cause of the anomalous result.

[1 mark]

0 1 . 6 How did the students deal with the anomalous result?

[1 mark]

0 1 . 7 Give **one** factor the students should have kept constant in this investigation.

[1 mark]

4.4.1.1 Photosynthetic reaction

Question 18 · continued

Table 1 is repeated below.

Table 1

Temperature in °C	Rate of photosynthesis in cm^3/hour			
	Test 1	Test 2	Test 3	Mean
20	18.5	19.3	19.5	**X**
25	32.6	34.1	32.9	33.2
30	41.9	45.2	44.9	44.0
35	38.6	39.8	44.0	40.8
40	23.1	20.5	22.4	22.0
45	1.9	14.2	2.2	2.1

0 1 . 8 Why did the rate of photosynthesis decrease from 35 °C to 45 °C?

[1 mark]

4.4.1.1 Photosynthetic reaction

Question 18 · continued

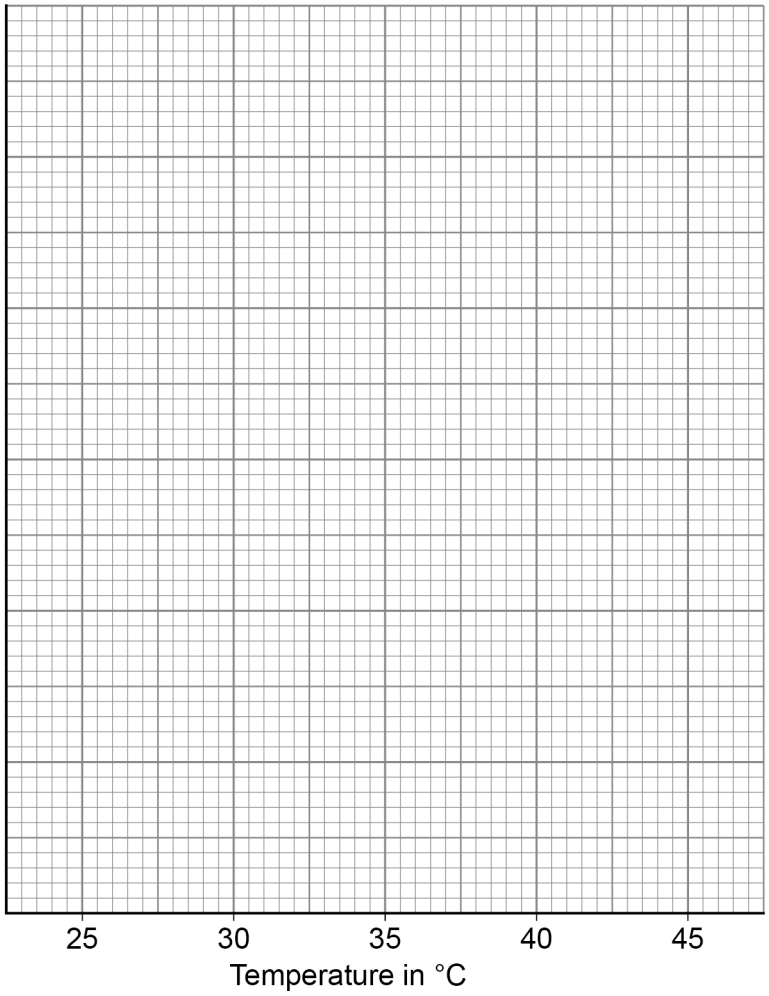
0 1 . 9 Complete **Figure 1** using data from **Table 1**.

You should:

- label the y-axis
- use a suitable scale for the y-axis
- plot the mean data from **Table 1** for temperatures from 25 °C to 45 °C
- draw a line of best fit.

[5 marks]

Figure 1



16

4.4.1.1 Photosynthetic reaction

Question 19

June 2023 | 8461/1H | Original Q6

0 6 This question is about photosynthesis.

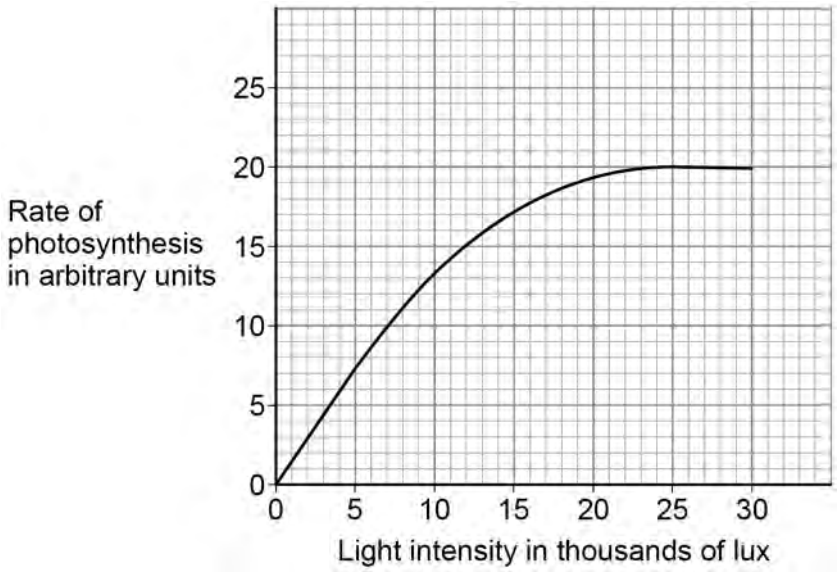
0 6 . 1 Complete the symbol equation for photosynthesis.

[1 mark]

6 _____ + 6 _____ → $C_6H_{12}O_6$ + 6 _____

Figure 8 shows how the rate of photosynthesis changes with light intensity.

Figure 8



4.4.1.1 Photosynthetic reaction

Question 19 · continued

0 6 . 2 Which part of the graph could be represented by the equation $y = mx + c$?

[1 mark]

Tick (✓) **one** box.

From 0 to 5 000 lux ☐

From 10 000 to 15 000 lux ☐

From 15 000 to 20 000 lux ☐

From 20 000 to 25 000 lux ☐

Question 6 continues on the next page

4.4.1.1 Photosynthetic reaction

Question 19 · continued

A student investigated the effect of colour of light on the rate of photosynthesis in leaves.

Figure 9 shows how the investigation was set up.

Figure 9

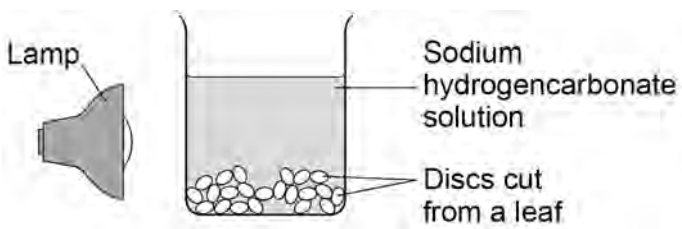


Table 5 shows the results.

Table 5

Colour of light	Time taken for 10 leaf discs to reach the surface of the solution in seconds
Blue	115
Green	831
Red	397

0 6 . 3 Give **one** way the student could change the colour of the light shining on the leaf discs.

[1 mark]

4.4.1.1 Photosynthetic reaction

Question 19 · continued

0 6 . 4 Give the independent variable and the dependent variable in this investigation.

[2 marks]

Independent variable _____

Dependent variable _____

0 6 . 5 All of the air had to be removed from the leaf discs before placing them in the beaker.

Suggest **one** reason why.

[1 mark]

0 6 . 6 The leaf discs were placed in a beaker of sodium hydrogencarbonate ($NaHCO_3$) solution.

Explain why sodium hydrogencarbonate solution was used instead of water.

[2 marks]

0 6 . 7 Explain why the leaf discs moved to the surface of the solution during the investigation.

[2 marks]

Question 19 · continued

There are two types of chlorophyll in leaves.

Figure 10 shows the percentage of different wavelengths of light that the two types of chlorophyll absorb.

Figure 10

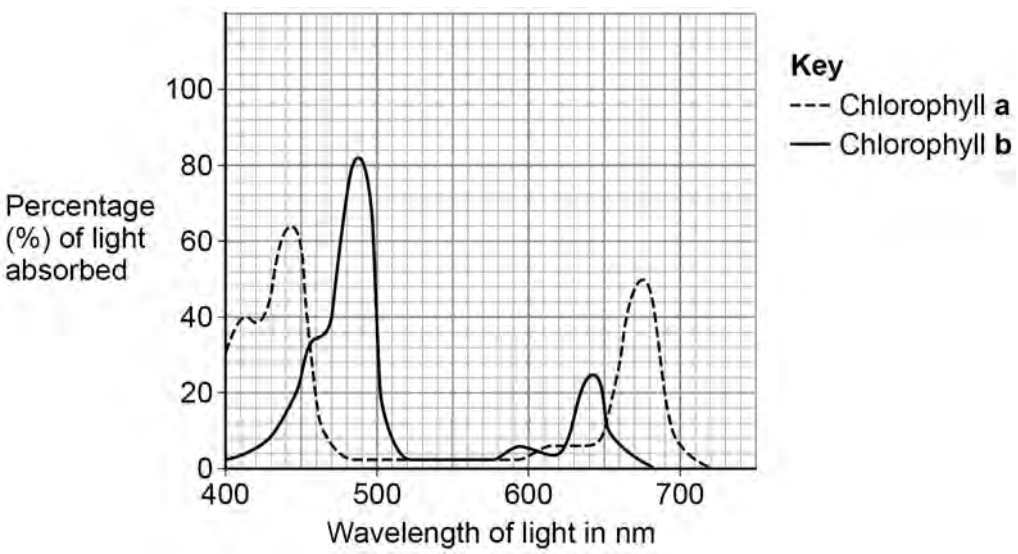


Table 6 shows the colour of different wavelengths of light.

Table 6

Range of wavelength of light in nm	380 − 435	450 − 499	500 − 570	571 − 590	620 − 720
Colour of light	violet	blue	green	yellow	red

0 6 . 8 Suggest the advantage to a plant of having two types of chlorophyll.

[1 mark]

4.4.1.1 Photosynthetic reaction

Question 19 · continued

0 6 . 9 **Table 5** is repeated below.

Table 5

Colour of light	Time taken for 10 leaf discs to reach the surface of the solution in seconds
Blue	115
Green	831
Red	397

The leaf discs in the investigation are green.

Explain the results in **Table 5** for blue light and for green light.

Use data from **Figure 10** and **Table 6**.

[4 marks]

15

4.4.1.1 Photosynthetic reaction

Question 20

June 2023 | 8461/2H | Original Q6

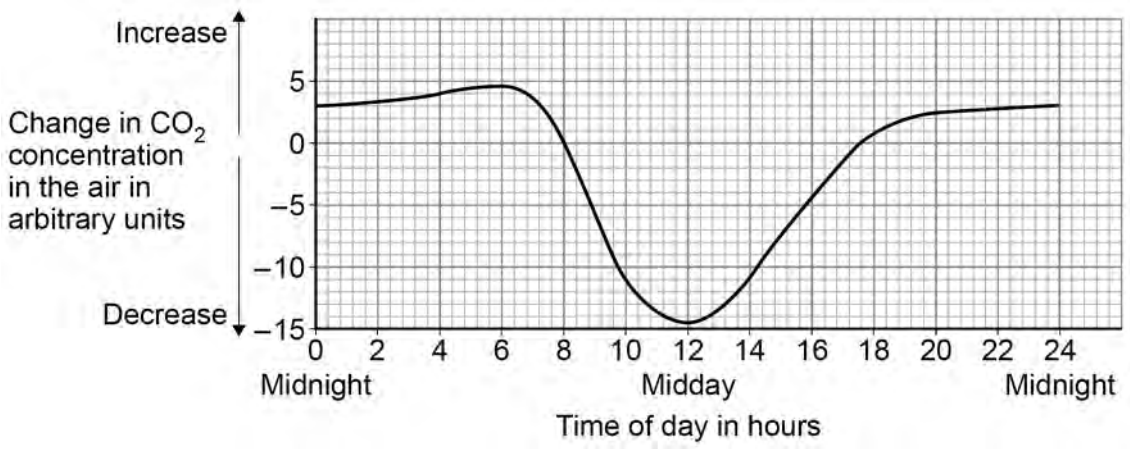
0 6 This question is about the effects of deforestation and agriculture.

The processes of photosynthesis and respiration affect the carbon dioxide concentration in the air.

Figure 9 shows the changes in the carbon dioxide concentration in the air in a tropical rainforest during one day.

The data are mean daily values over a whole year.

Figure 9



0 6 . 1 Explain what causes the changes in the carbon dioxide concentration in the air:

- from 0 to 6 hours
- from 8 to 12 hours.

Use information from **Figure 9**.

[4 marks]

0 to 6 hours _____

_____

_____

_____

8 to 12 hours _____

_____

_____

_____

Question 20 · continued

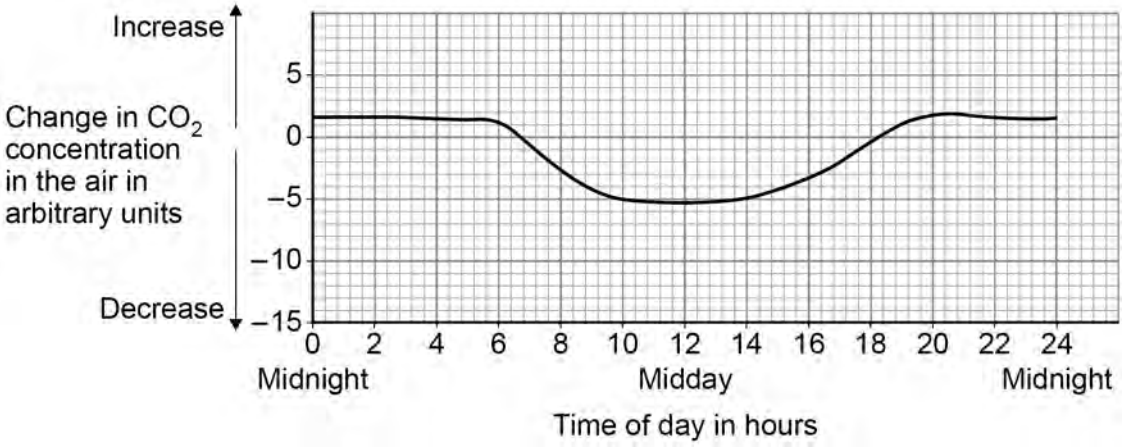
0 6 . 2 An area of rainforest is cut down and replaced with a field of maize plants.

Only one crop of maize is grown each year.

Figure 10 shows the changes in the carbon dioxide concentration in the air in the field of maize during one day.

The data are mean daily values over the 6-month growing period.

Figure 10



The maize grows for only 6 months of the year.

Explain why replacing rainforest with maize will increase the carbon dioxide concentration in the air after one year.

Use information from **Figure 9** and **Figure 10**.

[2 marks]

Question 6 continues on the next page

4.4.1.1 Photosynthetic reaction

Question 20 · continued

A tropical rainforest can contain over 1000 different tree species.

Large areas of tropical rainforest have been cut down during the last 100 years so crops can be grown.

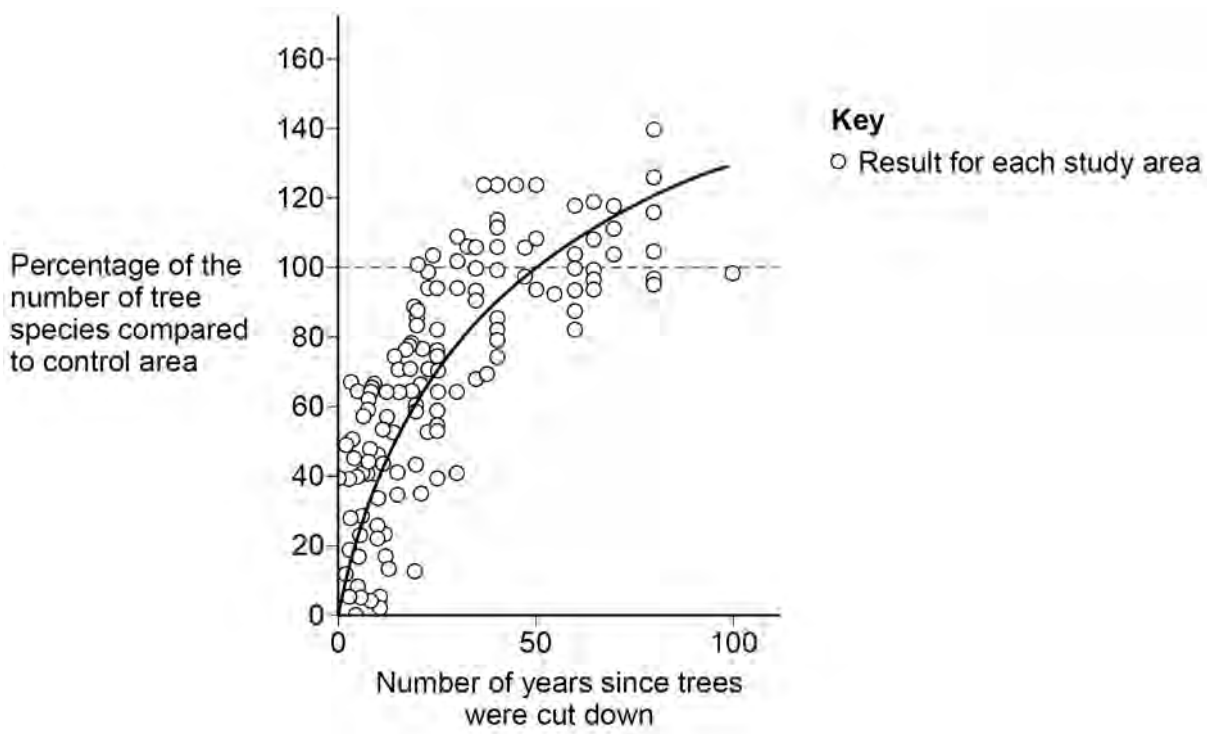
Scientists studied the regeneration of different areas of tropical rainforest.

The scientists:

- investigated areas of rainforest that had been cut down at different times during the previous 100 years
- recorded the number of tree species that re-grew in each area
- compared each area with a control area next to it. The control areas were undisturbed rainforest which had never been cut down.

Figure 11 shows the scientists' results.

Figure 11



4.4.1.1 Photosynthetic reaction

Question 20 · continued

0 6 . 3 The values plotted in **Figure 11** are percentages of the results for the control areas.

Explain why the scientists presented their results as **percentages**.

[2 marks]

During the 100 years, the biodiversity of trees in the regenerating rainforest increases.

0 6 . 4 Give **one** other conclusion you can make from **Figure 11**.

[1 mark]

0 6 . 5 Give **two** reasons why an increase in the diversity of trees in the rainforest leads to an increase in animal diversity.

[2 marks]

1

2

11

4.4.1.1 Photosynthetic reaction

Question 21

June 2024 | 8461/1H | Original Q7

0 7 A student investigated the effect of different factors on photosynthesis.

The student used three leaves growing on the same plant.

Each leaf was treated in a different way.

After 48 hours the student tested each leaf for starch.

Table 3 shows the results.

Table 3

Leaf tested	Treatment	Result after 48 hours
1	Upper and lower surfaces covered with black paper	No starch present
2	Upper and lower surfaces covered and sealed with transparent plastic	No starch present
3	**Not** covered	Starch present

0 7 . 1 Explain the results for the three leaves.

[5 marks]

Question 7 continues on the next page

4.4.1.1 Photosynthetic reaction

Question 21 · continued

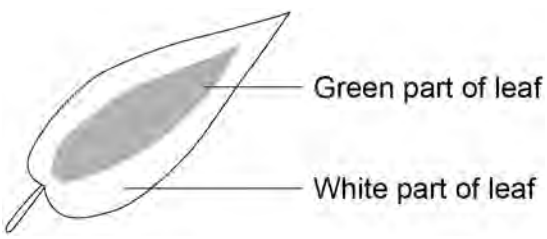
In another investigation the student used a different type of plant.

The plant was left uncovered in the light for 48 hours.

After 48 hours the student tested a leaf from the plant for starch.

Figure 6 shows the leaf before it was tested for starch.

Figure 6



0 7 . 2 Complete **Table 4** to show the results you would expect for the starch test on the leaf in **Figure 6**.

[1 mark]

Table 4

Part of leaf tested	Result after 48 hours
Green	
White	

0 7 . 3 Explain the results you gave in Question **07.2**.

[2 marks]

4.4.1.1 Photosynthetic reaction

Question 21 · continued

In some leaves, the green parts become yellow because of an ion deficiency.

0 7 . 4 Which ion is deficient in a plant with yellow leaves?

[1 mark]

0 7 . 5 Give the scientific term that describes the yellow colour of the leaves.

[1 mark]

0 7 . 6 The rate of photosynthesis is affected by different factors.

How could the oxygen produced during photosynthesis be used to measure the **rate** of photosynthesis?

[1 mark]

Question 7 continues on the next page

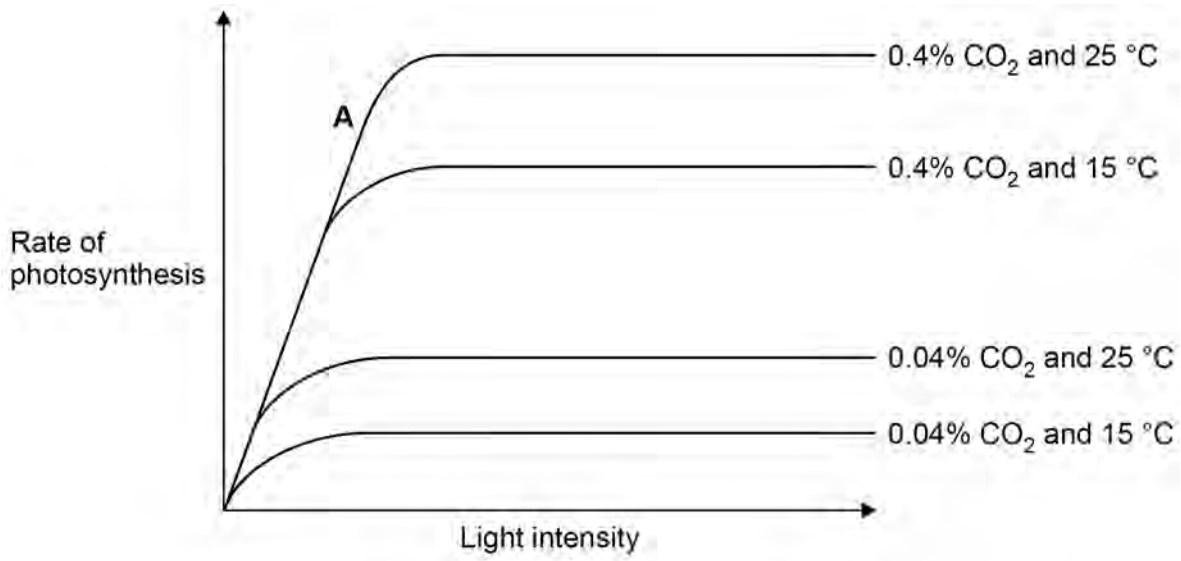
4.4.1.1 Photosynthetic reaction

Question 21 · continued

Light, carbon dioxide and temperature are limiting factors of photosynthesis.

Figure 7 shows how the rate of photosynthesis is affected by light, carbon dioxide and temperature.

Figure 7



0 7 . 7 At point **A** on **Figure 7**, light is a limiting factor.

What is meant by a 'limiting factor'?

[1 mark]

4.4.1.1 Photosynthetic reaction

Question 21 · continued

0 7 . 8 Explain the effect of increasing temperature and increasing carbon dioxide concentration on the rate of photosynthesis shown in **Figure 7**.

[4 marks]

0 7 . 9 Photosynthesis investigations often use a light source.

The spreading out of light from a source obeys the inverse square law.

The inverse square law links light intensity to distance from the light source.

Which of the following shows the inverse square law?

[1 mark]

Tick (✓) **one** box.

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

$\text{light intensity} \propto \text{distance}^2$ ☐

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

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

17

4.4.1.1 Photosynthetic reaction

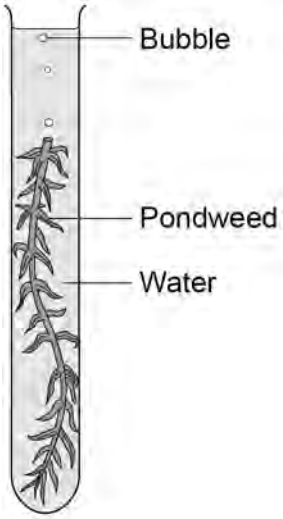
Question 22

June 2025 | 8461/1H | Original Q4

0 4 A student investigated the effect of temperature on the rate of photosynthesis in pondweed.

Figure 4 shows how the student set up the apparatus.

Figure 4



This is the method used.

1. Prepare five tubes of pondweed as shown in **Figure 4**.
2. Place one tube into each of five water baths set at different temperatures.
3. Wait two minutes.
4. Measure the time taken for each piece of pondweed to release 10 bubbles.

0 4 . 1 What is the independent variable in the investigation?

[1 mark]

Question 4 continues on the next page

4.4.1.1 Photosynthetic reaction

Question 22 · continued

Table 4 shows the results.

Table 4

Temperature in °C	Time taken for pondweed to release 10 bubbles in seconds
10	84
20	43
30	27
40	25
50	33

0 4 . 2 Calculate the rate of photosynthesis at **20 °C**.

Give your answer to 3 significant figures.

Give the unit.

[4 marks]

Rate (3 significant figures) = _____

Unit = _____

4.4.1.1 Photosynthetic reaction

Question 22 · continued

0 4 . 3 Explain the difference in the rate of photosynthesis at 40 °C compared with the rate of photosynthesis at 10 °C.

[3 marks]

0 4 . 4 Give **two** other factors that affect the rate of photosynthesis.

Do **not** refer to temperature in your answer.

[2 marks]

1

2

0 4 . 5 Describe **one** way the method could be changed to obtain more accurate results for the rate of photosynthesis.

[1 mark]

Question 4 continues on the next page

4.4.1.1 Photosynthetic reaction

Question 22 · continued

A gardener noticed that some plants were not growing as well as usual.

0 4 . 6 Describe **two** ways the gardener could identify a plant disease.

[2 marks]

1 _____

_____

2 _____

_____

0 4 . 7 One of the plants had purple spots on its leaves and the leaves fell off.

What disease is the plant most likely to have?

[1 mark]

_____

0 4 . 8 A different plant had yellow leaves, but no spots.

Explain why plants may develop yellow leaves.

[2 marks]

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16