Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International GCSE (9–1)

Time 1 hour 15 minutes

Paper reference **4BI1/2B**

Biology

UNIT: 4BI1
PAPER: 2B

You must have:
Calculator, ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- Show all the steps in any calculations and state the units.

Information

- The total mark for this paper is 70.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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Q:1/1/1/1/1/1/

Pearson

Answer ALL questions.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Read the passage below. Use the information in the passage and your own knowledge to answer the questions that follow.

Supercharging plants to reduce global warming

The proportion of carbon dioxide in the atmosphere has increased in the last 100 years. In 2020, a mass of 727 gigatonnes of carbon dioxide was released into the atmosphere from natural processes, along with a mass of 37 gigatonnes from human activities. Scientists have estimated that plants naturally remove a mass of 746 gigatonnes of carbon dioxide from the atmosphere every year. The difference between what is removed and what is released causes atmospheric carbon dioxide to rise every year. Carbon dioxide is a greenhouse gas, and a significant rise will cause global warming.

To help solve the problem of rising concentrations of atmospheric carbon dioxide, scientists are planning to produce transgenic, supercharged plants that can remove atmospheric carbon dioxide and store it in their roots. The scientists estimate that if these plants can be developed, the plants could remove a mass of carbon dioxide equivalent to 50% of the emissions from human activities.

Coastal plants that have their roots in seawater contain a substance called suberin in the cell walls of the outer layer of the roots. Suberin is a waterproof substance that contains a high proportion of carbon atoms. Suberin is decomposed very slowly so remains in the soil for a long time.

The photograph shows a coastal plant called a mangrove.

(Source: © Snow At Night/Shutterstock)

To produce the supercharged plants, scientists intend to take the gene that codes for high suberin production from a coastal plant and insert it into crop plants. The crop plants used are perennial plants. Perennial plants live for many years rather than dying each winter. The transgenic crops would take in large amounts of carbon dioxide and use the carbon atoms to make suberin. The carbon would then be locked up and stored as suberin in the roots. After successfully producing one plant, they will use micropropagation rather than pollination to produce others.

These supercharged crop plants may have other uses. Suberin in roots helps to make them tolerant to soil with a high salt concentration, helping to produce higher crop yields in areas that have difficult growing conditions.

(a) (i) Carbon dioxide is a greenhouse gas.

State the name of another greenhouse gas (line 7).

(1)

(ii) Calculate the increase in mass, in kg, of atmospheric carbon dioxide in 2020 (lines 2 to 7).

Give your answer in standard form.

[1 gigatonne = 1 000 000 000 000 kg]

(3)

Increase in mass = kg

(iii) State two consequences of global warming for the environment.

(2)

1

2

DO NOT WRITE IN THIS AREA

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DO NOT WRITE IN THIS AREA

(b) Explain why producing genetically engineered plants with additional suberin in their roots could reduce atmospheric carbon dioxide (lines 14 to 17 and lines 19 to 24).

(4)

(c) Which enzyme is used to remove a gene from a section of DNA?

(1)

- ☒ **A** amylase
- ☒ **B** ligase
- ☒ **C** lipase
- ☒ **D** restriction

(d) Explain why the additional suberin in the cell walls of the roots will make the transgenic plants tolerant to soil with a high salt concentration (lines 26 to 28).

(2)

Link to passage

(e) Give three reasons why the scientists use micropropagation to reproduce the transgenic crop plants (lines 24 to 25).

(3)

1

2

3

(Total for Question 1 = 16 marks)

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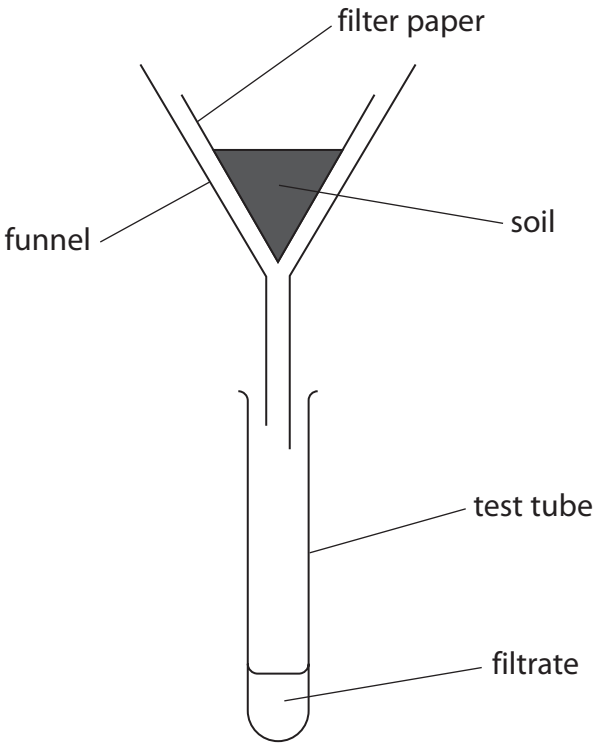
2 A student uses this method to investigate the nitrogen cycle.

- take two samples of soil, each of mass 100 g
- sterilise one sample of soil by heating at 100 °C for one hour
- place the sterilised and unsterilised samples into separate filter funnels
- pour 25 cm^3 of water through each soil sample and collect the filtrate in a test tube
- test each filtrate for nitrates
- pour water through each soil sample for 5 minutes
- pour another 25 cm^3 of water through each soil sample and collect the filtrate in a test tube
- test each filtrate for nitrates
- add 1 cm^3 of a solution of ammonium salts to each soil and leave for three days
- pour 25 cm^3 of water through each soil sample again and collect the filtrate in a test tube
- test each filtrate for nitrates

The diagram shows the student's apparatus.



The table shows the student's results.

Soil sample	Result of test for nitrates		
	At start of investigation	**After water has passed through for five minutes**	**Three days after adding ammonium salts**
unsterilised	present	absent	present
sterilised	present	absent	absent

(a) Give the independent variable in the investigation.

(1)

(b) (i) Suggest why the student poured water through the soil samples for five minutes before adding the ammonium salts.

(2)

(ii) Comment on the results of the nitrate tests on the two soil samples three days after adding ammonium salts.

(4)

(Total for Question 2 = 7 marks)

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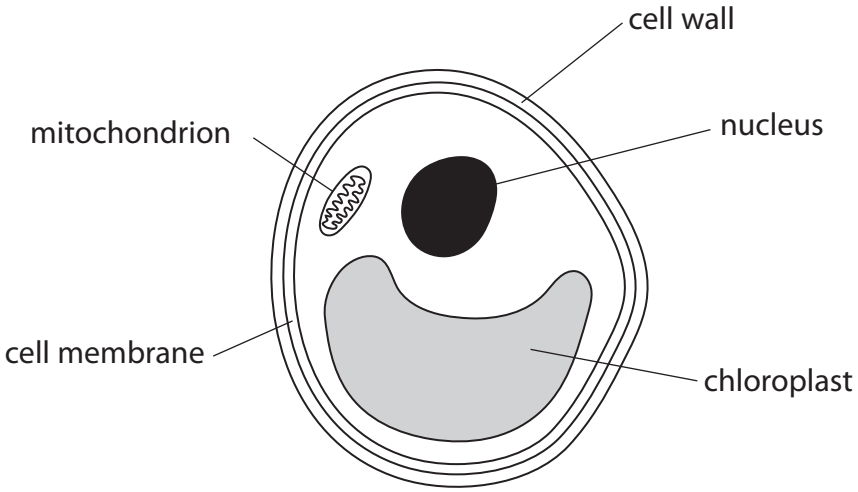
3 The diagram shows a single-celled organism called *Chlorella* that lives in fresh water.

Chlorella has a chloroplast and can photosynthesise.



(a) (i) Which of these groups of organisms contains *Chlorella*?

(1)

- ☒ **A** animals
- ☒ **B** bacteria
- ☒ **C** plants
- ☒ **D** protoctists

(ii) Which of these labelled structures would also be present in an animal cell?

(1)

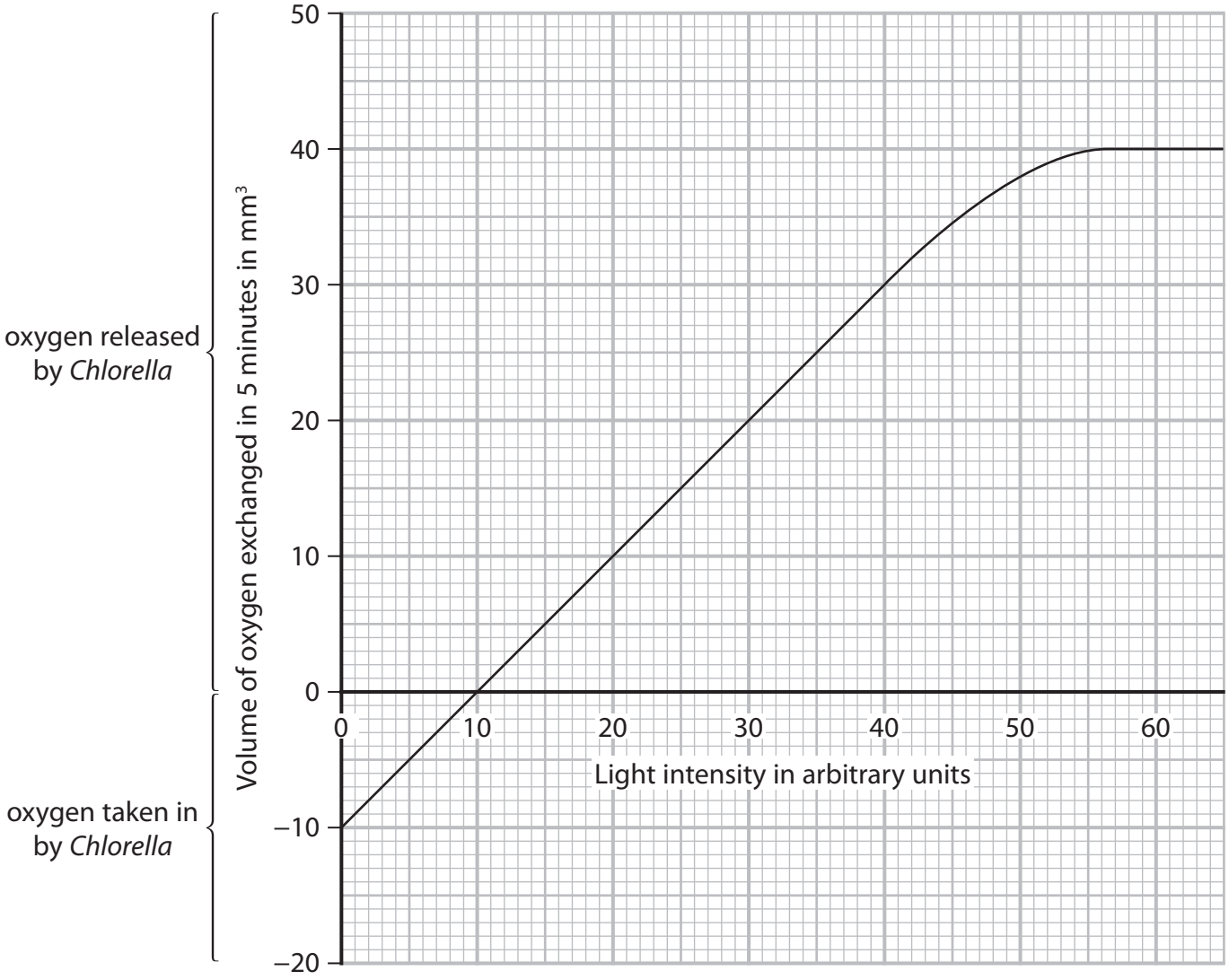
- ☒ **A** cell membrane and chloroplast
- ☒ **B** cell membrane and mitochondrion
- ☒ **C** cell wall and chloroplast
- ☒ **D** cell wall and mitochondrion

(b) Complete the balanced chemical symbol equation for photosynthesis.

(2)

$$+ \longrightarrow + 6O_2$$

(c) The graph shows the effect of light intensity on gas exchange by *Chlorella*.



(i) Explain why *Chlorella* takes in oxygen at light intensities below 10 arbitrary units.

(2)

(ii) Explain the changes in the volume of oxygen released as the light intensity increases from 10 arbitrary units.

(3)

(iii) The volume of oxygen released by *Chlorella* is the difference between the oxygen produced by photosynthesis and the oxygen taken in.

Use the graph to calculate the volume of oxygen produced in five minutes by photosynthesis at a light intensity of 50 arbitrary units.

(2)

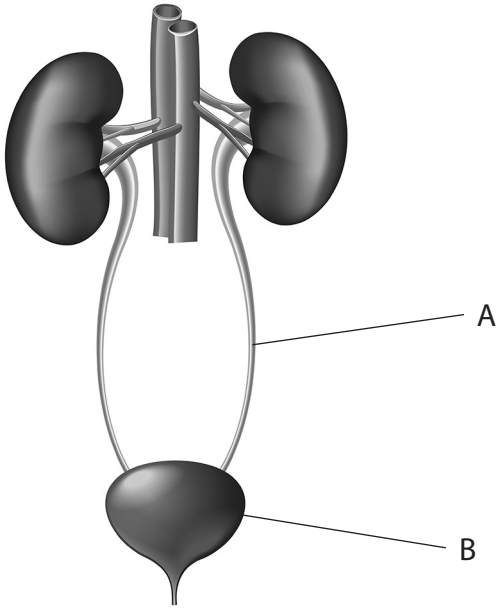
volume of oxygen = mm^3

(d) Describe how hydrogen-carbonate indicator could be used to investigate the effect of light intensity on carbon dioxide exchange by *Chlorella*.

(3)

(Total for Question 3 = 14 marks)

4 The diagram shows part of the human urinary system.



(Source: © La Gorda/Shutterstock)

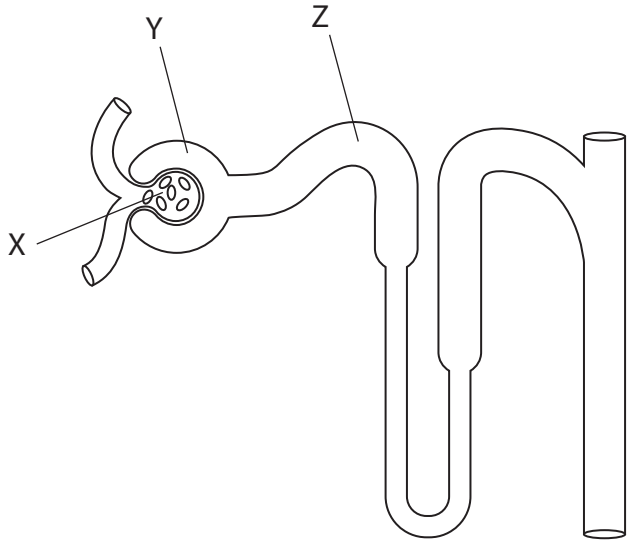
(a) Name the structures labelled A and B.

(2)

A

B

(b) The diagram shows a kidney nephron.



The table shows the relative concentrations of glucose and protein in the areas labelled X, Y and Z on the diagram.

Substance	Relative concentration of substance in arbitrary units		
	Area X	Area Y	Area Z
protein	100	0	0
glucose	100	50	0

(i) Explain the difference between the concentration of protein in area X and the concentration of protein in area Y.

(2)

(ii) Explain the difference between the concentration of glucose in area Y and the concentration of glucose in area Z.

(2)

(c) When the body becomes dehydrated, the concentration of urine increases.

Explain the changes that occur in the body that lead to the production of concentrated urine.

(4)

(Total for Question 4 = 10 marks)

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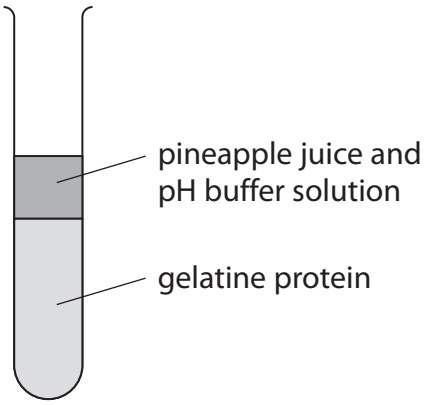
5 Pineapple juice contains a protease called bromelain.

A student uses this method to investigate the digestion of solid gelatine protein by bromelain.

- place solid gelatine protein into a test tube up to a height of 5 cm
- mix 5 cm^3 pineapple juice with 1 cm^3 of pH 4 buffer
- place 1 cm^3 of the pineapple juice and buffer solution on top of the gelatine
- leave for one hour in a water bath set to 37 °C
- measure the height of the solid gelatine and use it to calculate the volume of gelatine that has been digested

Repeat the method three more times.

The diagram shows part of the student's method.



(a) The table shows the student's results for the volumes of gelatine digested at pH 4.

Tube number	Volume of gelatine digested in cm^3
1	0.55
2	1.89
3	0.54
4	0.61

(i) Calculate the mean volume of gelatine digested in cm^3.

Give your answer to two decimal places.

(3)

mean volume = cm^3

(ii) State what substances are produced when the gelatine protein is digested.

(1)

(b) The student repeats the investigation with different pH buffers.

The table shows their results.

pH	Mean volume of gelatine digested in cm^3
3	0.32
5	0.98
7	0.51
9	0.33
11	0.01

(i) Give two variables the student should control.

(2)

1

2

(ii) Explain the effect of changing the pH on the mean volume of gelatine digested.

(3)

(c) Describe how to test for the presence of protein.

(2)

(Total for Question 5 = 11 marks)

6 Beta thalassaemia is a genetic condition caused by a mutation in a gene for haemoglobin.
People with beta thalassaemia produce less haemoglobin and fewer red blood cells than people without the condition.

(a) Explain why people with beta thalassaemia may experience severe tiredness.

(2)

(b) A new treatment for beta thalassaemia has been developed that edits the haemoglobin gene. These are the steps in the treatment.

- remove blood stem cells from a patient's bone marrow
- put a strand of RNA and an enzyme into the blood stem cells to correct the haemoglobin gene
- use drugs to destroy the patient's remaining bone marrow cells
- replace the patient's bone marrow cells with the modified stem cells

The modified stem cells that are in the bone marrow now produce red blood cells containing sufficient haemoglobin.

(i) The strand of RNA used in this treatment is complementary to one strand of the DNA in the haemoglobin gene.

Give the base sequence of RNA that is complementary to this sequence of DNA.

(2)

DNA strand A A T G G C G G C T C A

RNA strand

(ii) Protein synthesis of the modified gene will produce haemoglobin.

Describe the stages of this protein synthesis.

(4)

(iii) The standard treatment for beta thalassaemia is a weekly blood transfusion.

The new treatment has so far been tested on two patients, with these results.

- both patients started making large numbers of red blood cells with sufficient haemoglobin
- both patients experienced serious side effects from the drugs used, needing to spend several months in isolation in hospital before recovering
- 15 months after the treatment, neither patient required further blood transfusions
- both patients were able to exercise normally without feeling tired

Evaluate the use of the new treatment compared to weekly blood transfusions.

(4)

(Total for Question 6 = 12 marks)

TOTAL FOR PAPER = 70 MARKS

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