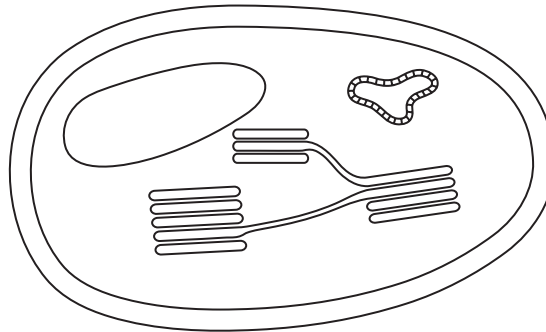


1 Cells that photosynthesise contain many chloroplasts.

The diagram below shows a chloroplast.



(a) (i) Draw a line on the diagram to show where photophosphorylation takes place.

Label the line P.

(1)

(ii) Place a cross in the box next to the molecule produced by photophosphorylation.

(1)

- A** ATP
- B** NADP
- C** oxygen
- D** water

(b) (i) State where carbon fixation takes place in a chloroplast.

(1)

(ii) The equation for carbon fixation is shown below.



Name the molecules Y and Z.

(2)

molecule Y

molecule Z

(iii) Name the enzyme involved in carbon fixation.

(1)

2 Photosynthesis can be divided into two main stages, the light-dependent stage and the light-independent stage.

(a) Explain why the light-independent stage cannot take place without the light-dependent stage.

(3)

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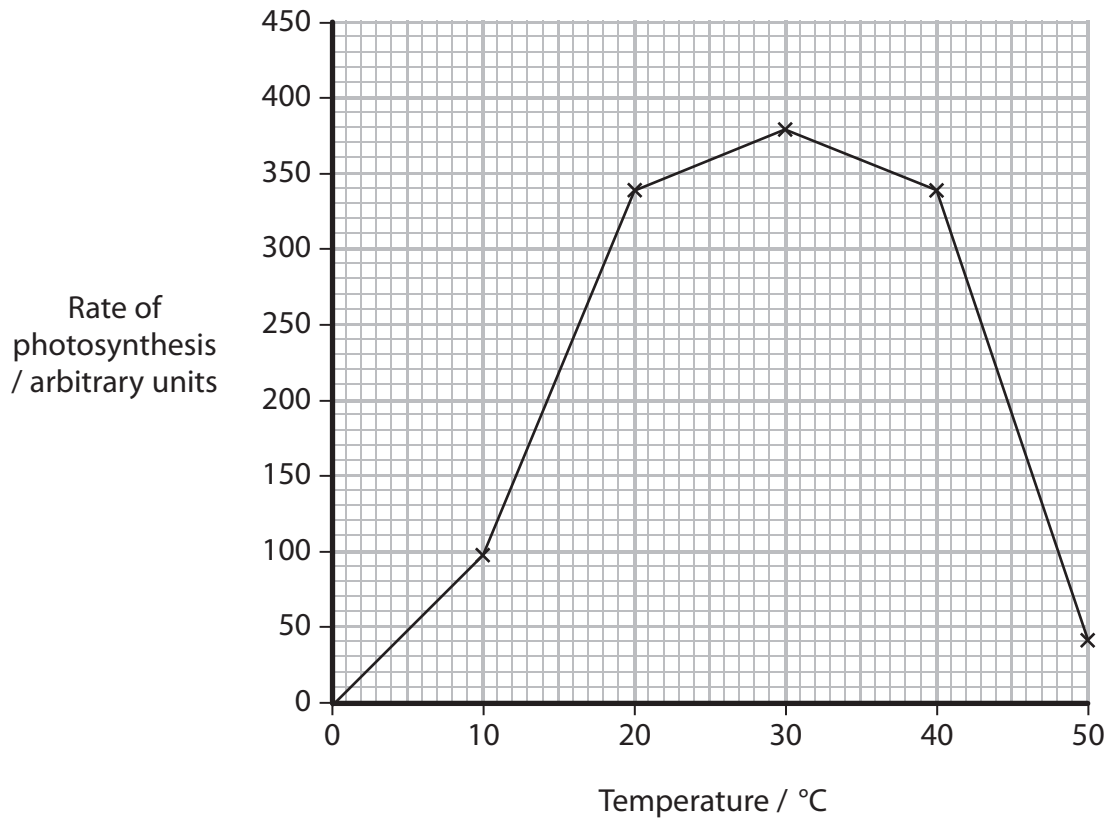
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- (b) An investigation was carried out by a student, to find the effect of temperature on the rate of photosynthesis in *Elodea canadensis* (Canadian pondweed).

The rate of photosynthesis was measured over a period of two hours at a fixed temperature. This was repeated at different temperatures.

All other abiotic factors were controlled.

The results of this investigation are shown in the graph below.



- (i) Place a cross (☒) in the box next to the statement that describes what could be measured to find the rate of photosynthesis in this investigation.

(1)

- A** increase in mass of *Elodea*
- B** mass of nitrate absorbed
- C** volume of carbon dioxide produced
- D** volume of oxygen produced

- (ii) The temperatures used in this investigation were 0°C, 10°C, 20°C, 30°C, 40°C and 50°C.

Suggest what the results of the investigation show about the minimum temperature required for photosynthesis in *Elodea*.
Give a reason for your answer.

(2)

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- (iii) Explain the meaning of the following statement.

“All other abiotic factors were controlled.”

(2)

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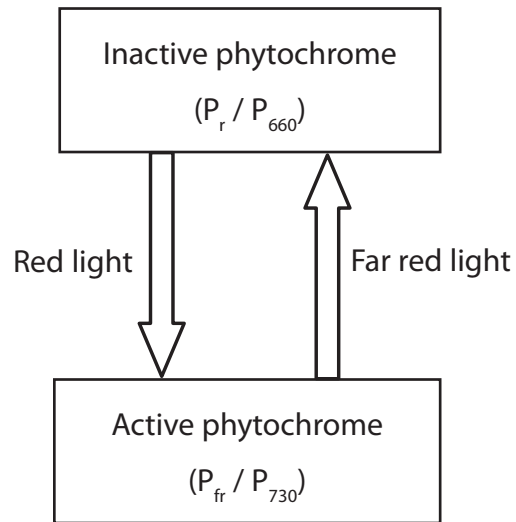
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3 Phytochromes are photoreceptors found in many plants.

(a) The diagram below shows the interconversion of inactive phytochrome (P_r / P_{660}) and active phytochrome (P_{fr} / P_{730}).



State **one** way in which the active form of phytochrome can be converted back to the inactive form, other than by exposing it to far red light.

(1)

(b) A study was carried out to investigate the effect of red light and far red light on sunflower plants.



A sunflower
Magnification $\times 0.5$

One group of sunflower seedlings, group A, was grown under a lamp that emitted red light and far red light of the same intensity.

Another group of sunflower seedlings, group B, was grown in the same way, except that the lamp emitted a lower intensity of red light. The intensity of far red light was unchanged.

When the plants were fully grown, the mean dry mass of the flowers produced and the mean length of the plant stems were recorded.

This study was repeated using new groups of sunflower seedlings.

The results are shown in the table below.

Study	Mean dry mass of the flowers / g		Mean stem length / cm	
	Group A	Group B	Group A	Group B
Original	58	45	125	148
Repeat	43	38	124	142

(i) Using the mean dry mass of the flowers shown in the table, compare the results of group A with group B for both the original and repeat studies.

(3)

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(ii) The light conditions experienced by group B were similar to those found near ground level in woodland.

Using the mean stem lengths shown in the table, suggest the importance of these light conditions for a young seedling in the woodland.

(3)

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(iii) A statistical analysis of the data for mean stem length was carried out.

The analysis showed that there was a significant difference between the mean stem length data for groups A and B.

However, there was no significant difference between the data from the original study and the repeat study.

Suggest a conclusion for the effect of light on mean stem length and use the results of this statistical analysis to comment on the reliability of the data.

(3)

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(Total for Question 3 = 10 marks)

4 Photosynthesis involves the fixation of carbon dioxide in chloroplasts.

(a) Place a cross ☒ in the box next to the region of the chloroplast that would be involved in the fixation of carbon dioxide.

(1)

- A crista
- B granum
- C matrix
- D stroma

(b) An investigation was carried out into the effect of reducing the carbon dioxide available for photosynthesis. Cells of a unicellular alga were suspended in a solution containing 1.0% carbon dioxide. After 250 seconds, the carbon dioxide in the solution was reduced to 0.003%.

The cells were illuminated with a bright light and some were removed at regular time intervals for 500 seconds. The concentrations of ribulose biphosphate (RuBP) and glycerate 3-phosphate (GP) in the cells were measured.

(i) Suggest **two** reasons why a suspension of cells of a unicellular alga, in a solution, is more suitable for this investigation than using leaves.

(2)

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(ii) Suggest why it would be advisable to illuminate the cells at a high light intensity during this investigation.

(3)

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- 5 The table below shows some statements relating to photoreceptors (phytochromes) in plants.

Complete the table with a tick (✓) if the statement is correct or a cross (×) if the statement is not correct.

(4)

Statement	Tick (✓) or cross (×)
Cause cell depolarisation	
Affected by all wavelengths of light	
Involved in plant growth and development	
Affected by darkness	

(Total for Question 5 = 4 marks)