

2.8 Photosynthesis

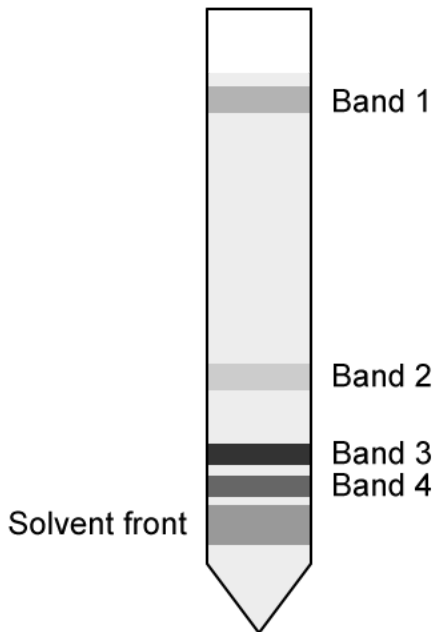
Question Paper

Course	DP IB Biology
Section	2. Molecular Biology
Topic	2.8 Photosynthesis
Difficulty	Hard

Time allowed: 60
Score: /47
Percentage: /100

Question 1a

a)
Paper chromatography can be used to separate photosynthetic pigments obtained from chloroplasts. The chromatography strip below shows distinct pigment bands.



The teacher explains that the four bands represent four pigments: chlorophyll a, chlorophyll b, xanthophylls and carotenes (but not necessarily in that order). The teacher asks a student to suggest which bands most likely represent the two chlorophyll pigments. The student suggests bands 3 and 4.

Explain why this is the correct choice.

[2 marks]

[2 marks]

Question 1b

b)
Describe how someone could accurately identify the pigments in the chromatogram shown in part a).

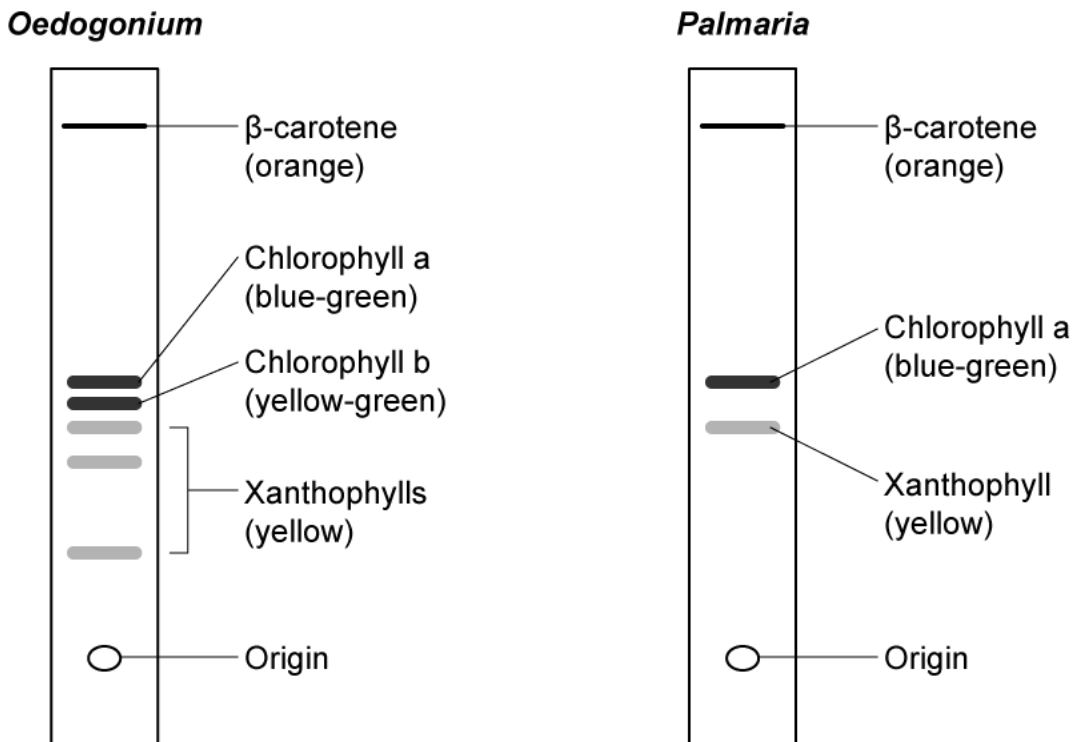
[3 marks]

[3 marks]

Question 1c

c)

The photosynthetic pigments from two aquatic algae, green alga genus *Oedogonium* and red alga genus *Palmaria*, were separated by thin layer chromatography. The chromatograms are shown below.



Palmaria also contain a red pigment known as phycoerythrin. The pigment appears red because it absorbs blue light and reflects red light. The pigment phycoerythrin is absent from the chromatogram above.

Suggest why this might be.

[1 mark]

[1 mark]

Question 1d

d)
Light of shorter wavelengths penetrates water to greater depths than light of longer wavelengths.

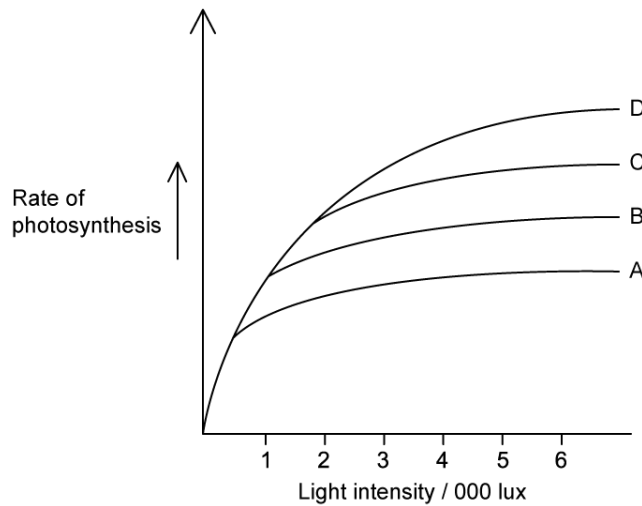
Using information here and from part c), suggest why red algae such as *Palmaria* can live at greater depths than many other aquatic algae.

[2 marks]

[2 marks]

Question 2a

a)
The graph below shows the effect of light intensity, carbon dioxide, and temperature on the rate of photosynthesis.



- A - 0.04 % carbon dioxide at 15 °C
- B - 0.04 % carbon dioxide at 25 °C
- C - 0.04 % carbon dioxide at 35 °C
- D - 0.1 % carbon dioxide at 25 °C

State **three** factors that could be measured to allow an estimate of the **rate** of photosynthesis in this experiment.

[3 marks]

[3 marks]

Question 2b

b)

A commercial farmer growing peppers keeps her greenhouses at 25 °C and circulates air around the greenhouses. Air has a CO₂ concentration of 0.04 % and the ambient light intensity is 3 000 lux.

i)

Use the graph in part a) to state whether the farmer would be more likely to achieve higher pepper yields by raising the carbon dioxide concentration to 0.1% **or** by raising the temperature to 35 °C.

[1 mark]

ii)

Explain your answer to part i).

[2 mark]

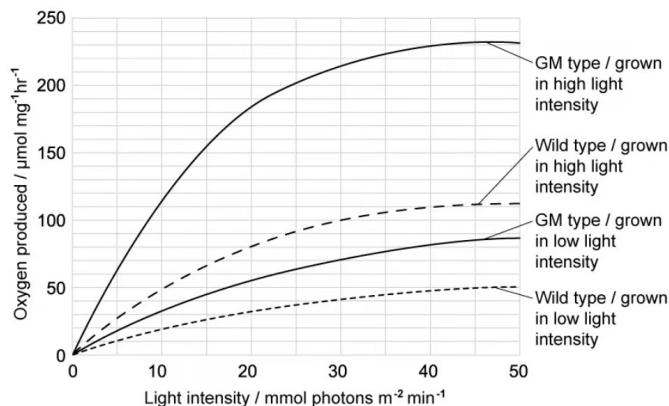
[3 marks]

Question 2c

c)

There are two types of chlorophyll in chloroplasts, chlorophyll a and chlorophyll b. Researchers created a genetically-modified (GM) vine plant with an allele that caused them to synthesise higher levels of chlorophyll b than wild-type vine plants. They investigated the effect of this new allele on the rate of plant growth.

The researchers grew wild-type and GM vines. They grew some of each in low light intensity and grew others in high light intensity. They extracted chloroplasts from mature plants of both types. Finally, they measured oxygen production at different light intensities by the chloroplasts they had extracted from the plants.



i)

Oxygen production here is used as a measure of the rate of photosynthesis.

State why this is possible.

[1 mark]

ii)

Calculate the percentage improvement in oxygen production caused by the genetic modification for vines grown at high light intensity at an experimental light intensity of 20 mmol photons m⁻² min⁻¹. Give your answer to 3 significant figures.

[2 marks]

[3 marks]

Question 2d

d)
The researchers suggested that GM plants producing more chlorophyll b would grow faster than wild-type plants in all light intensities.

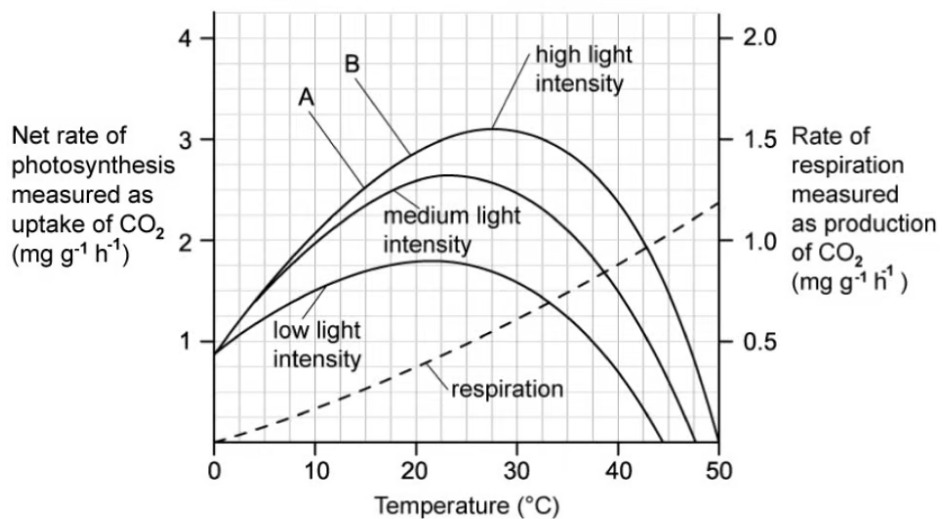
Explain how the data in part c) support this suggestion.

[3 marks]

[3 marks]

Question 3a

a)
Lab technicians wanted to determine the effects of light intensity and temperature on the rate of photosynthesis in rhododendron plants growing in parks and gardens. They recorded the effect of different temperatures on the net rate of photosynthesis at various light intensities. Their experiment also recorded the rate of respiration at the different temperatures. The graph below shows the results from their experiment.



Explain the increase in the net rate of photosynthesis between points A and B on the graph.

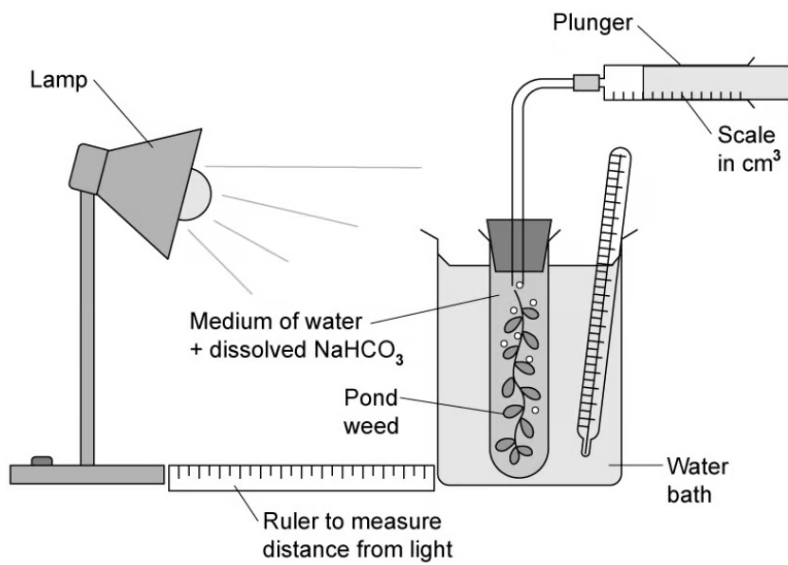
[3 marks]

[3 marks]

Question 3b

b)

In another experiment a student looked at the effect of light intensity on the rate of photosynthesis in pond weed. They set up the investigation as shown below and altered the light intensity by changing the distance between the lamp and the pondweed.



Identify **four** variables that need to be controlled in this investigation.

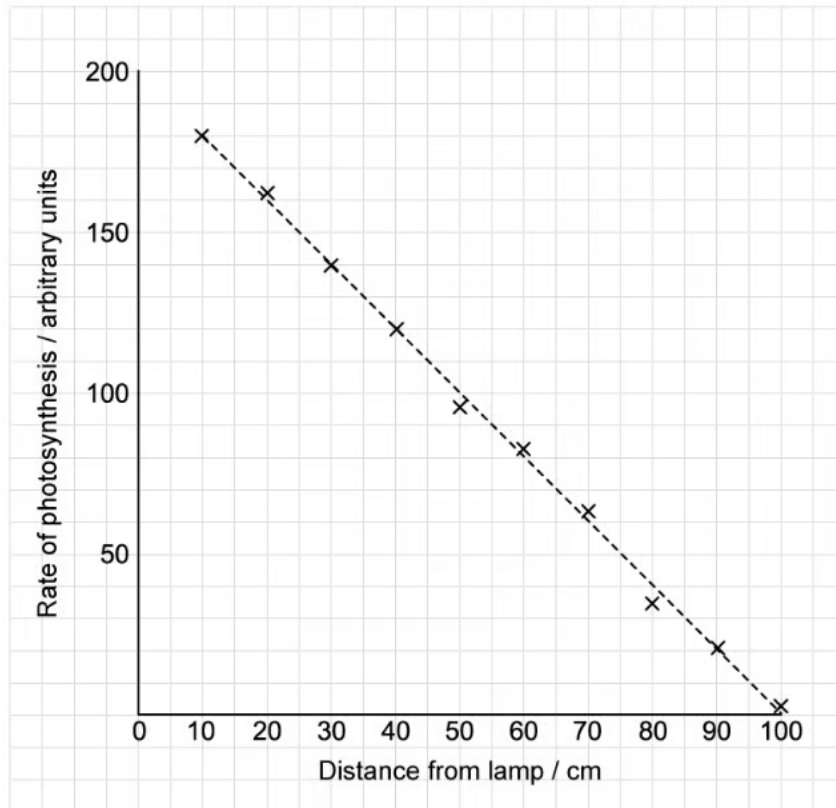
[4 marks]

[4 marks]

Question 3c

c)

The graph below shows the student's results from their investigation in part b).



Calculate the percentage decrease in the rate of photosynthesis that takes place when the distance from the lamp is 10 cm compared to when it is 90 cm. Show your working.

[2 marks]

[2 marks]

Question 3d

d)
Identify, with a reason, **one** challenge that would be faced by the technicians in a) that would not be faced by the student in part b) when carrying out their experiments.

[2 marks]

[2 marks]

Question 4a

a)
A variegated plant was grown in a laboratory by a student. One of its leaves is shown below (Fig. 1). The student left the whole plant in the dark for 12 hours to inhibit photosynthesis. After this time they covered part of the leaf with a rectangle of black card (Fig. 2). Following the exposure of the plant to sunlight for a further 3 hours the student removed the black card and then removed the leaf from the plant before testing the whole leaf for starch (Fig. 3).



Fig. 1

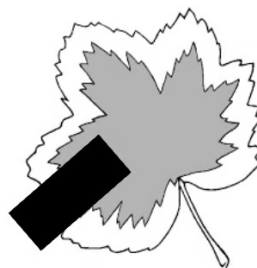


Fig. 2

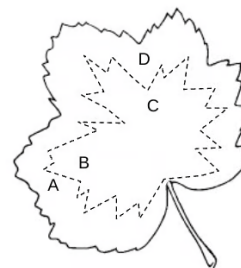


Fig. 3

Suggest why photosynthesis was inhibited for 12 hours.

[1 mark]

[1 mark]

Question 4b

b)

From Fig. 3 in part a) identify the following:

i)

The **two** areas of the leaf from **A–D** that the student could use to show that light is required for photosynthesis.

[1 mark]

ii)

The **two** areas of the leaf from **A–D** that the student could use to show that chlorophyll is required for photosynthesis.

[1 mark]

[2 marks]

Question 4c

c)

The student concluded that the detection of starch was proof that photosynthesis had occurred in the leaf during the experiment.

Suggest why this conclusion may not be correct.

[2 marks]

[2 marks]

Question 5a

One mark will be awarded for clarity of communication throughout this question.

a)

Explain how researchers could prepare an initial concentrated solution containing photosynthetic pigments for separation during thin layer chromatography.

[6 marks]

[6 marks]

Question 5b

b)

In a woodland the concentration of carbon dioxide gas in the air changes during a 24-hour period. It can also vary depending on the height above the ground at which a gas measurement is taken.

Explain the variation in carbon dioxide concentration in a woodland over time and at different heights. Assume that there is no air movement caused by wind throughout the 24-hour period.

[5 marks]

[5 marks]