1. Nov/2019/Paper_41/No.5

(a) Fig. 5.1 shows the seaweed *Laminaria hyperborea*. This is a photosynthetic protoctist found in the coastal waters around Norway.

The seaweed is grown commercially to obtain the glucose polysaccharide called alginate. This is used in certain food products.

Fig. 5.1

An increase in carbon dioxide concentration in the atmosphere has resulted in higher concentrations of carbon dioxide in the ocean. This has caused a decrease in the pH of the ocean and has resulted in ocean acidification.

Scientists are studying seaweeds such as *L. hyperborea* because they absorb a large quantity of carbon dioxide during photosynthesis. This may help to increase the pH of the ocean and reverse ocean acidification.

(i) State where light absorption occurs in the chloroplasts of *L. hyperborea*.

..... [1]

(ii) Name **one** product of the light dependent stage of photosynthesis.

..... [1]

(iii) Outline the reactions occurring in the stroma that lead to the production of a polysaccharide, such as alginate.

The first sentence has been completed for you.

Carbon dioxide binds to RuBP.

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..... [4]

(b) Laboratory experiments were carried out to investigate the effect of day length on the rate of photosynthesis in another marine autotroph, *Zostera marina*.

- The temperature was controlled at 4 °C.
- A low concentration of carbon dioxide dissolved in the water was used.
- The light exposure period (day length) was different for five groups of *Z. marina*.
- This was maintained for 10 days to allow *Z. marina* to adapt to these conditions.
- After 10 days, the rate of photosynthesis was measured for each group under the **same** controlled conditions.
- The experiment was repeated using five groups of *Z. marina* with a high concentration of carbon dioxide dissolved in water.

Table 5.1 shows the rate of photosynthesis for each group.

Table 5.1

day length /hours	rate of photosynthesis /arbitrary units	
	low carbon dioxide concentration	high carbon dioxide concentration
12	2.0	2.5
14	3.0	5.0
16	4.0	7.0
18	5.5	11.0
20	7.5	18.0

(i) With reference to Table 5.1, explain the difference in the rate of photosynthesis at high carbon dioxide concentration compared to low carbon dioxide concentration.

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..... [2]

(ii) With reference to Table 5.1, describe **and** explain the effect of increasing day length on the rate of photosynthesis for the *Z. marina* in high carbon dioxide concentration.

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(c) In the laboratory, a seaweed was grown in water with different pH values. All other variables, including temperature and light, were standardised.

The mean rate of photosynthesis was calculated over a 24 hour period for each pH value.

The results are shown in Fig 5.2.

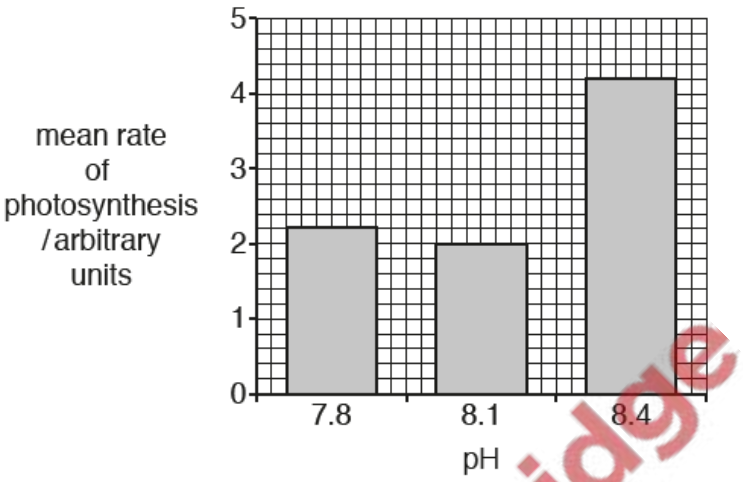

Fig. 5.2

(i) With reference to Fig. 5.2, explain the effect on the rate of photosynthesis when the pH increases from 8.1 to 8.4.

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..... [2]

(ii) The lower pH values on Fig. 5.2 represent ocean acidification.

Suggest why the results for the lower pH values do **not** fully support the idea that seaweeds can help to reduce ocean acidification.

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..... [1]

[Total: 14]

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.....

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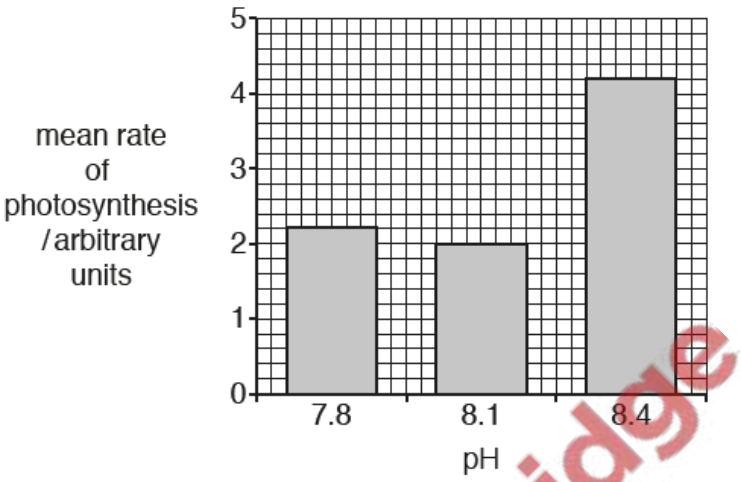

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.....

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..... [2]

(ii) The lower pH values on Fig. 5.2 represent ocean acidification.

Suggest why the results for the lower pH values do **not** fully support the idea that seaweeds can help to reduce ocean acidification.

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..... [1]

[Total: 14]

3. Nov/2019/Paper_43/No.6

Mining may result in the release of heavy metal ions, causing pollution of lakes and rivers.

High concentrations of these heavy metal ions, such as cadmium (Cd^{2+}) and copper (Cu^{2+}), decrease the rate of photosynthesis in plants.

(a) Cadmium ions disrupt the function of photosystem II in chloroplasts.

(i) Name the part of the chloroplast where photosystem II is located.

..... [1]

(ii) Describe the role of photosystem II in the absorption of light.

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..... [3]

(b) An investigation was carried out into the effect of cadmium ion concentration on the aquatic, single-celled, photosynthetic protoctist, *Chlamydomonas reinhardtii*.

The activity of photosystem II was measured at different concentrations of cadmium ions.

- Four different concentrations of cadmium ions were used, 0, 1, 10 and 100 $\mu mol\,dm^{-3}$.
- *C. reinhardtii* was allowed to acclimatise in the dark before the experiment started.
- At time 0 min the light was switched on and the cadmium ions were added.
- At each concentration, the activity of photosystem II was measured over a period of 60 minutes.
- Each experiment was carried out under the same controlled conditions.

The results are shown in Fig. 6.1.

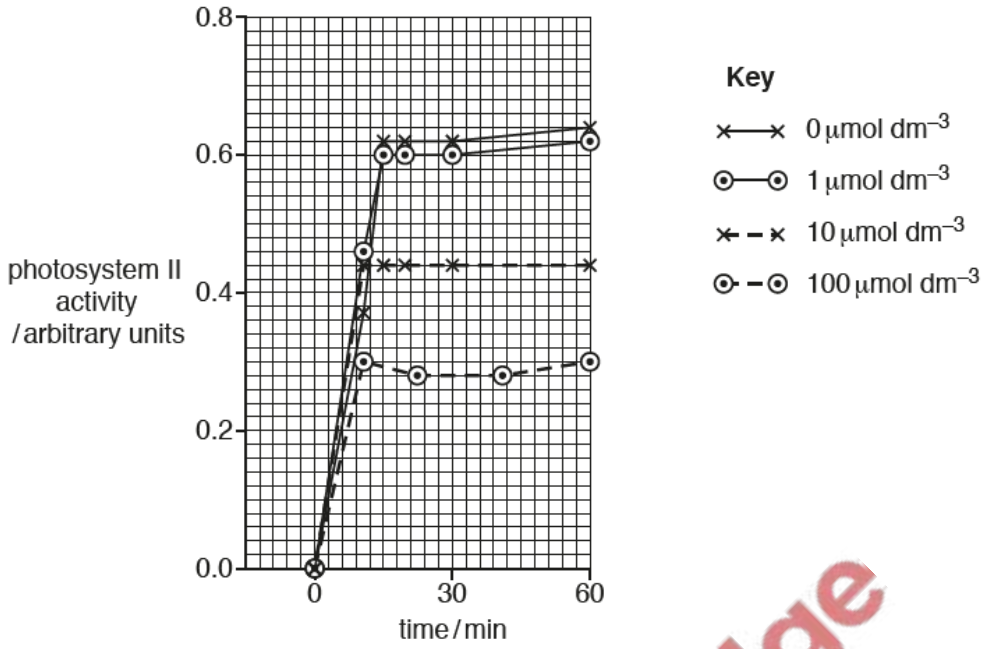

Fig. 6.1

Describe the effects of cadmium ion concentration on the activity of photosystem II, as shown in Fig. 6.1.

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..... [2]

(c) Copper(II) ions (Cu^{2+}) inhibit the function of a proportion of the chlorophyll a present in single-celled, photosynthetic protoctists.

The concentration of functional chlorophyll a in these organisms was measured in two different months of the same year in an unpolluted lake and in a lake polluted with copper ions.

The results are shown in Table 6.1.

Table 6.1

lake	concentration of functional chlorophyll a / μg dm^{-3}	
	month **A**	month **B**
unpolluted	3.45	0.24
polluted with copper ions	1.79	0.24

(i) Describe **and** suggest explanations for the results shown in Table 6.1.

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..... [4]

(ii) Copper ions can replace other metal ions present in organic molecules.

Suggest how copper ions change the structure of chlorophyll a.

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..... [1]

(d) Chromatography is a method that can be used to separate and identify different photosynthetic pigments in a chloroplast extract.

Describe how chromatography is used to identify chlorophyll a in an extract from chloroplasts.

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..... [4]

[Total: 15]

4. June/2019/Paper_41/No.9(a)

(a) Explain what is meant by the term limiting factor **and** explain how knowledge of limiting factors is used to increase crop yields in glasshouses. [7]

5. June/2019/Paper_41/No.10(b)

(b) Describe how you would carry out an investigation into the effect of wavelength of light on the rate of photosynthesis of a plant, using a redox indicator such as DCPIP. [8]

6. June/2019/Paper_43/No.9

(a) Describe how the structure of a chloroplast is related to its functions. [8]

(b) Describe how you would separate chloroplast pigments using chromatography. [7]

[Total: 15]

7. Feb/2019/Paper_42/No.1

(a) The effect of light intensity on the rate of photosynthesis can be investigated using a cut shoot of a pond plant.

The apparatus used in the investigation is shown in Fig. 1.1.

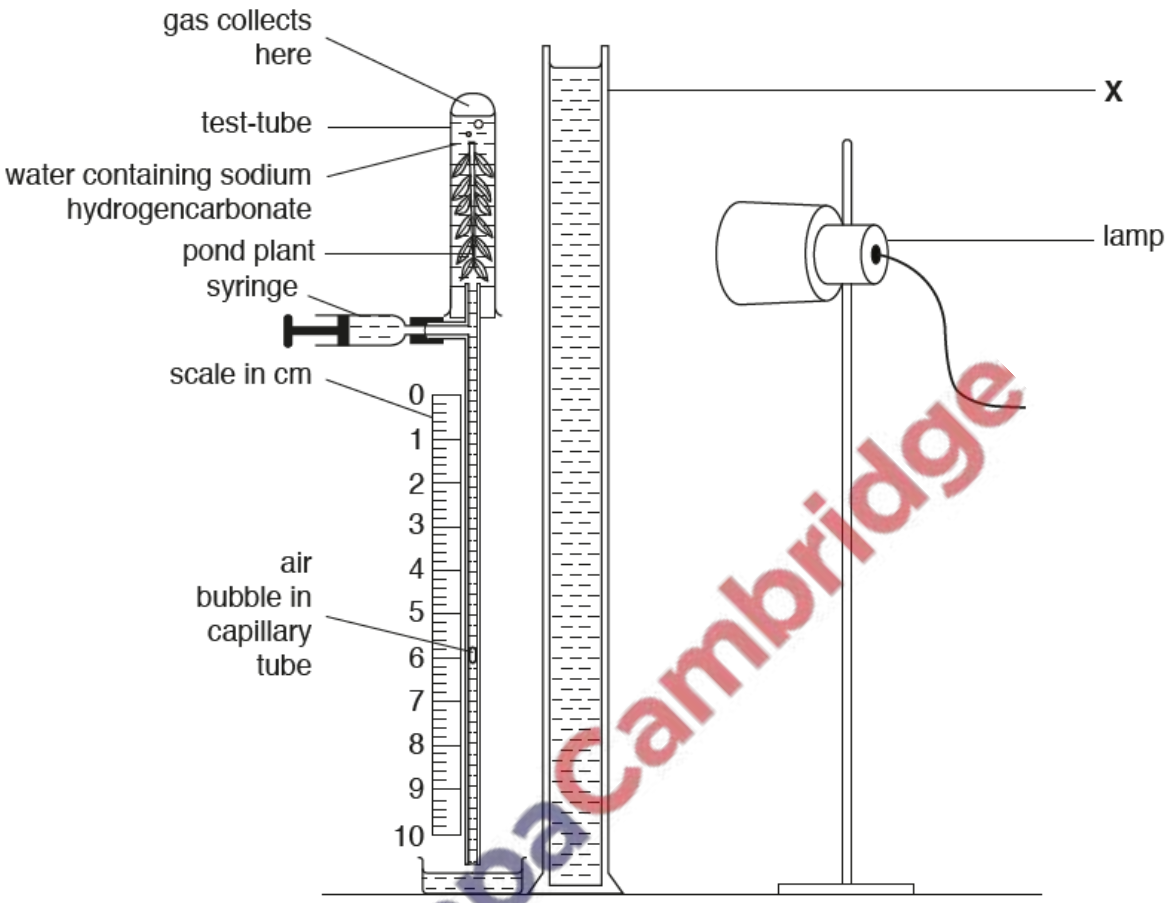

Fig. 1.1

The light intensity can be changed by placing the lamp at different distances from the pond plant.

(i) Apparatus **X**, shown in Fig. 1.1, is a thin glass container filled with water.

Explain the function of apparatus **X**.

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..... [2]

(ii) Before completing the assembly of the apparatus shown in Fig. 1.1, sodium hydrogencarbonate is added to the water surrounding the pond plant in the test-tube.

Explain why sodium hydrogencarbonate is added to the water surrounding the pond plant in the test-tube.

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..... [1]

(iii) Name the gas collected in the test-tube.

..... [1]

(b) The investigation was carried out with the lamp at distances of 10, 20, 30, 40 and 50 cm from the pond plant. For each of these distances, the air bubble in the capillary tube was initially positioned at 0 cm on the scale and, after 5 minutes, the distance moved by the air bubble was measured. The rate of movement of the air bubble was then calculated.

The results are shown in Fig. 1.2.

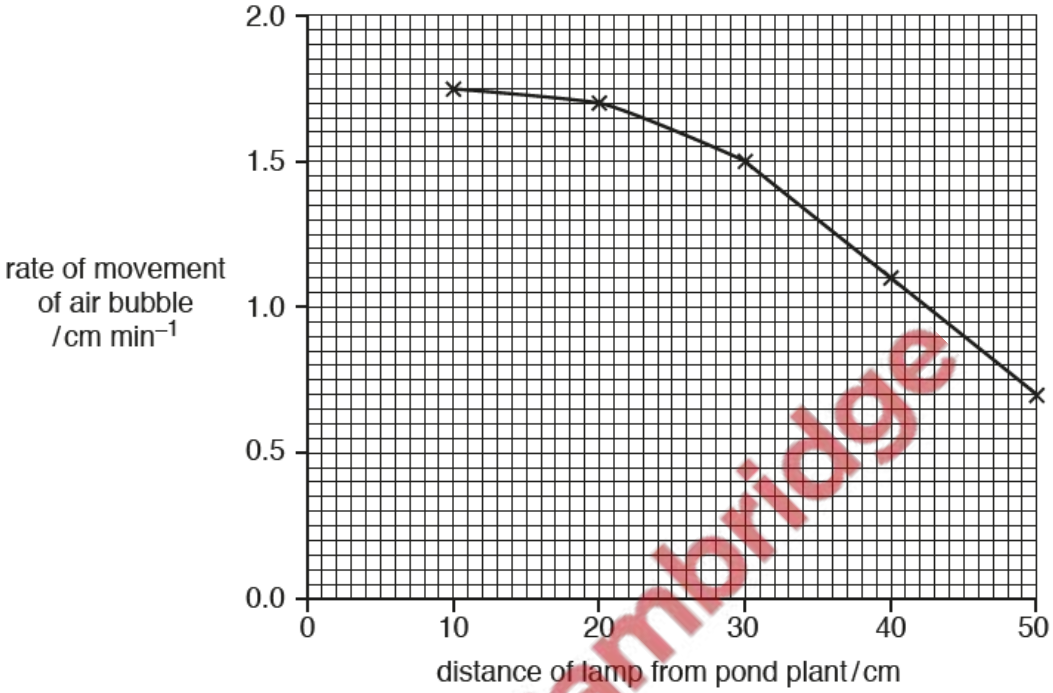

Fig. 1.2

(i) With reference to Fig. 1.2, describe the relationship between the rate of photosynthesis and **light intensity**.

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..... [2]

(ii) Further investigations showed that at distances of less than 10 cm, the rate of movement of the air bubble was the same as at 10 cm.

Explain why there was no change in the rate of movement of the air bubble at distances less than 10 cm.

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..... [2]

(c) Some of the light energy absorbed by the pond plant is used in cyclic photophosphorylation.

Outline the process of cyclic photophosphorylation.

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..... [5]

[Total: 13]