Write your name, centre number and candidate number in the boxes below.

Surname	Other names

Centre number | | | | | |

Candidate number | | | | |

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Limiting factors of photosynthesis

Time allowed: 1 hour 10 minutes

Subject code **0610**

Biology

Questions from Paper 3, Paper 4 and Paper 6

You must have: a ruler marked in centimetres and millimetres, a protractor, compasses, a pen, an HB pencil and an eraser.

Total marks

/ 66

Instructions

- Answer every question in the space provided on this paper.
- Write in black or dark blue ink. Pencil may be used for diagrams and graphs.
- Fill in your name, centre number and candidate number above.
- Show your working: a correct method can earn marks even if the answer is wrong.

Information

- This paper has 7 questions worth 66 marks in total.
- The marks for each question or part are shown in brackets, for example [3].

Advice

- Read every question through once before you write anything.
- Use the marks in brackets to judge how long to spend on each part.
- If you finish early, go back and check your working.

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Print at 100% (Actual size) so diagrams keep their real measurements.

1 Plan an investigation to determine the effect of light intensity on photosynthesis in an aquatic plant.

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..... [6]

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2 Hydrogencarbonate indicator can be used to determine the concentration of carbon dioxide in a solution. The table shows the colour of the indicator at different concentrations of carbon dioxide.

carbon dioxide concentration	hydrogencarbonate indicator colour
high	yellow
medium	red
low	purple

Aquatic plants photosynthesise and use up carbon dioxide when in the light. Aquatic plants respire and produce carbon dioxide in the light and in the dark.

When the carbon dioxide produced is equal to carbon dioxide used, hydrogencarbonate indicator is red.

Using an aquatic plant, plan an investigation to determine the light intensity at which the rate of photosynthesis is equal to the rate of respiration.

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..... [6]

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3 In an investigation, the carbon dioxide concentration in the air above a crop of maize plants was measured for 24 hours.

There was no wind blowing during the 24 hours of the investigation.

The results of this investigation are shown in Fig. 9.1.

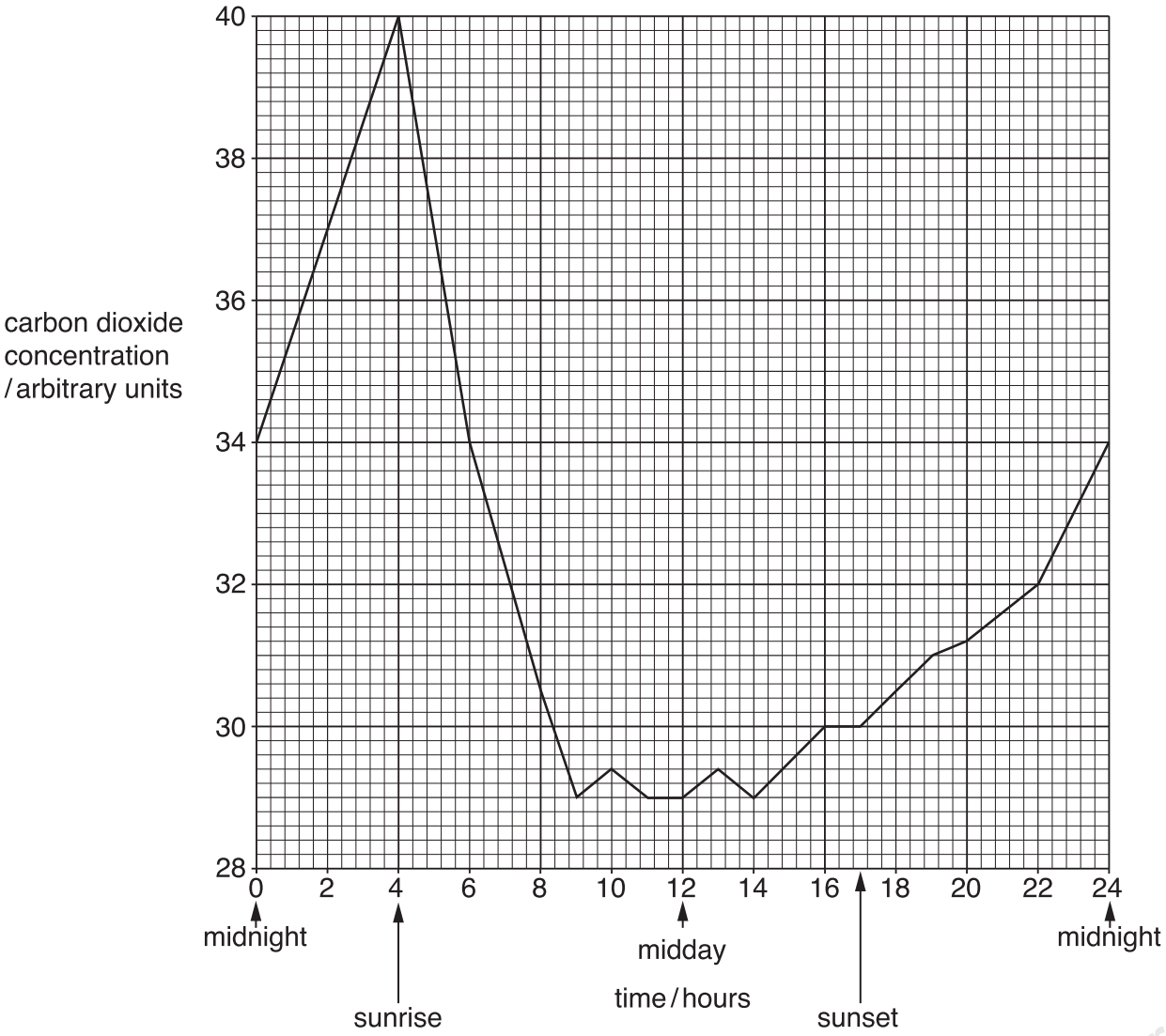


Fig. 9.1

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(a) **(i)** State the **two** times, on Fig. 9.1, at which the carbon dioxide concentration in the air was 37 arbitrary units.

..... [1]

(ii) Calculate the difference in the carbon dioxide concentration in the air between 04:00 (sunrise) and 12:00 (midday) on Fig. 9.1.

Space for working.

..... arbitrary units [1]

(iii) Explain why the concentration of carbon dioxide decreases between 04:00 and 09:00.

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..... [3]

(b) State **two** environmental factors that would affect the results of this investigation.

1 .....

2 .....

[2]

[Total: 7]

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4 Many growers of crops in glasshouses use carbon dioxide enrichment to improve yields.

(a) Explain the advantages of carbon dioxide enrichment of glasshouses.

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..... [2]

Fig. 3.1 shows the carbon dioxide concentrations inside three glasshouses, **D**, **E** and **F**, on a hot day with bright sunlight.

- Glasshouses **D** and **E** received carbon dioxide enrichment and were ventilated by opening the windows.
- Glasshouse **F** did not receive any extra carbon dioxide and the windows were closed.

The carbon dioxide concentrations in the glasshouses and in the atmosphere were measured. The concentration in the atmosphere was 0.039 %.

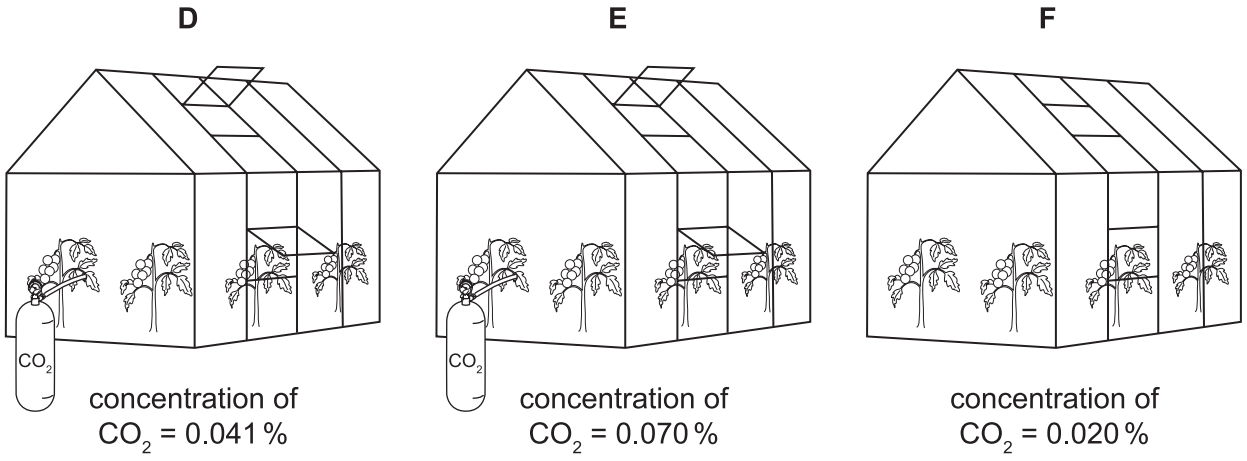


Fig. 3.1

The rate of uptake of carbon dioxide by the crop plants was measured in grams of carbon dioxide absorbed per square metre of glasshouse per hour. These results are shown in Table 3.1.

Table 3.1

glasshouse	rate of uptake of carbon dioxide by crop plants / g per m^2 per hour
D	2.5
E	5.7
F	1.0

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(b) Suggest why it may **not** be cost effective to maintain a high concentration of carbon dioxide in glasshouse **E** compared to the concentration of carbon dioxide in the atmosphere.

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..... [2]

(c) **(i)** Concentrations of carbon dioxide in all three glasshouses in Fig. 3.1 increased at night. State why this happened.

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..... [1]

(ii) Explain why it is important to ventilate glasshouses by opening the windows.

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..... [4]

[Total: 9]

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5 A scientist investigated the effect of temperature on the rate of photosynthesis in one species of plant.

Photosynthesis involves enzyme-controlled reactions.

Discs were cut from a leaf and kept at different temperatures.

The total surface area of the discs was kept the same for each temperature.

The volume of oxygen that was produced by the leaf discs was measured and used to estimate the rate of photosynthesis.

The results are shown in Fig. 4.1.

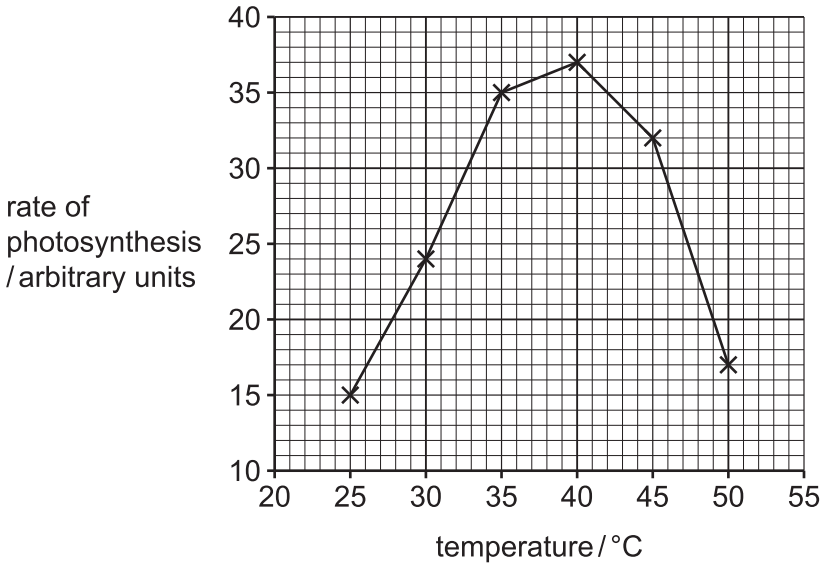


Fig. 4.1

(a) Identify the optimum temperature for photosynthesis in Fig. 4.1.

..... °C [1]

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(b) Explain the results shown in Fig. 4.1.

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..... [6]

(c) Carbon dioxide was supplied in excess at each temperature during the investigation.

Explain why.

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..... [2]

(d) Suggest why not all of the oxygen produced by the leaf is released.

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..... [1]

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(e) Describe the role of chlorophyll in photosynthesis.

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..... [2]

[Total: 12]

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6 Researchers in Michigan investigated the rate of photosynthesis in leaves of big-tooth aspen trees, *Populus grandidentata*, by placing some of the growing leaves inside transparent boxes.

The researchers measured the uptake of carbon dioxide by the leaves over a range of temperatures from 10–40 °C. They carried out their measurements at two different concentrations of carbon dioxide:

H – 325 ppm carbon dioxide which is close to the concentration in the atmosphere;

J – 1935 ppm carbon dioxide which is a very high concentration.

The results are shown in Fig. 3.1.

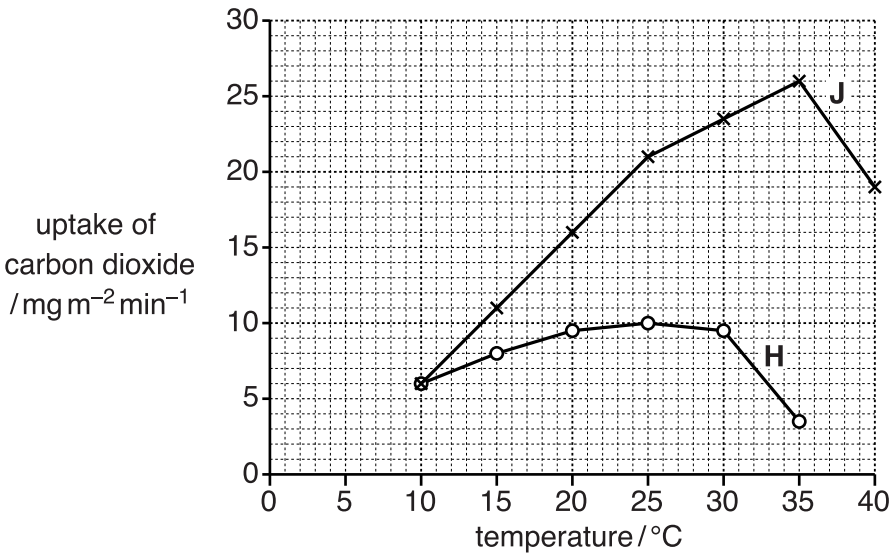


Fig. 3.1

(a) Describe how the results for the aspen leaves in batch **J** differ from the results for the aspen leaves in batch **H**. Use data from Fig. 3.1 in your answer.

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.....[3]

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(b) Explain why the rate of photosynthesis in the leaves in batch **J**:

(i) increases with an increase in temperature from 15 °C to 35 °C

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.....[2]

(ii) decreases at temperatures above 35 °C.

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.....[2]

(c) Use the results in Fig. 3.1 to suggest **and** explain the likely effect on plant growth of an increase in carbon dioxide concentration in the atmosphere as a result of the combustion of fossil fuels.

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.....[5]

[Total: 12]

Photosynthesis and limiting factors Click for more variations

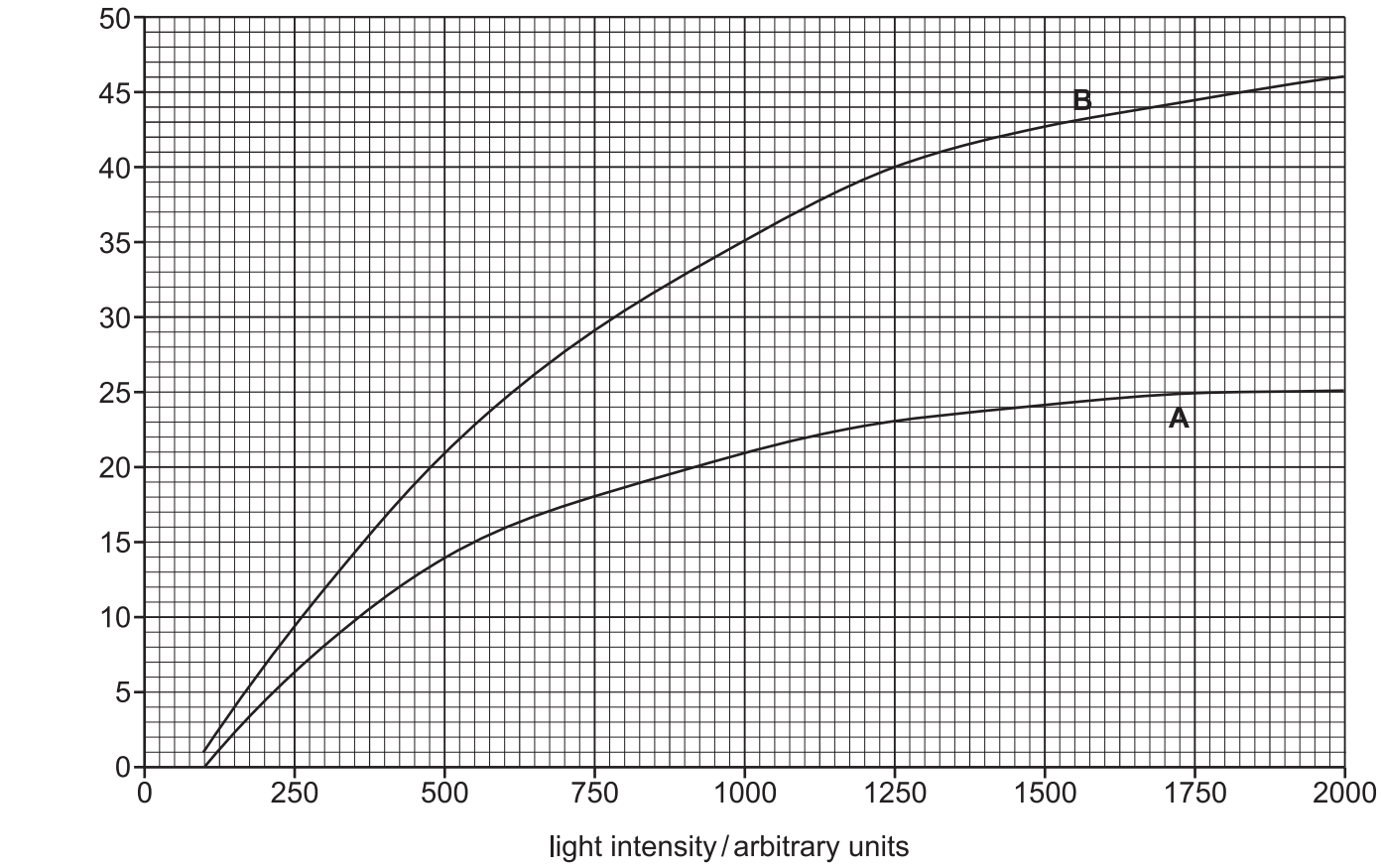
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7 **(a)** State the **word** equation for photosynthesis.

..... [2]

(b) Scientists investigated the effect of light intensity on the rate of photosynthesis in the leaves of eucalyptus trees at two different concentrations of carbon dioxide, **A** and **B**.

The results are shown in Fig. 2.1.



Key:

A carbon dioxide concentration 140 ppm

B carbon dioxide concentration 1000 ppm

Fig. 2.1

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(i) Suggest **and** explain why the scientists kept the temperature of the leaves at 20 °C while they recorded results.

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..... [2]

(ii) Calculate the percentage increase in the rate of photosynthesis at a light intensity of 1250 arbitrary units when the carbon dioxide concentration was increased from 140 ppm to 1000 ppm.

Show your working and give your answer to the nearest whole number.

..... %
[3]

(iii) Describe the effect of increasing light intensity on the rate of photosynthesis when the concentration of carbon dioxide was 140 ppm.

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..... [3]

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(iv) Explain the effect of increasing light intensity on the rate of photosynthesis when the concentration of carbon dioxide was 1000 ppm.

Use the term *limiting factor* in your answer.

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..... [4]

[Total: 14]

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