

13.2 Investigation of limiting factors

Name: _____ Class: _____ Date: _____

Total: 13 marks

KEY WORDS temperature • light intensity • concentration
 • limiting factor • indicator

Objective

Build the skills to answer exam questions on the **investigation of limiting factors** of photosynthesis – **light intensity**, **carbon dioxide concentration** and **temperature**.

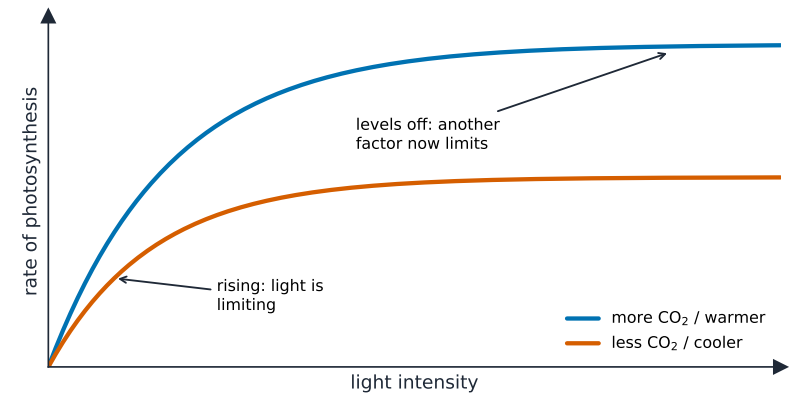
You must be able to:

- explain the effects of light intensity, carbon dioxide concentration and temperature on rate
- read a rate graph to identify which factor is limiting
- describe investigations using redox indicators and whole aquatic plants

1 Key knowledge and worked examples

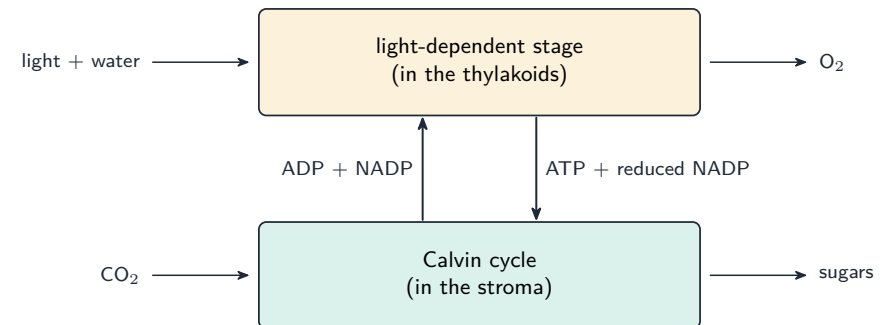
■ Limiting factors

A **limiting factor** is the one in shortest supply that holds back the rate.



the scarcest factor limits the rate · higher plateau: CO₂ or temperature was limiting

While the rate rises, light is limiting; where it levels off, another factor (CO₂ or temperature) is limiting



Limiting factors act on the two stages of photosynthesis

- raising **light intensity** speeds the rate until another factor becomes limiting.
- raising **CO₂ concentration** speeds the rate until another factor becomes limiting.
- raising **temperature** speeds the rate to an optimum; too high and the enzymes denature.

■ Investigations

- a redox **indicator** (DCPIP or methylene blue) with a chloroplast suspension loses colour as the light-dependent stage works – time the colour loss at different light intensities or wavelengths.
- with a whole **aquatic plant** (e.g. *Elodea*), count the oxygen bubbles per minute, or collect the gas, under different conditions. Use a control and repeat for reliability.

2 Practice

2.1 Name **three** factors that can limit the rate of photosynthesis. [3]

2.2 State how you could measure the rate of photosynthesis of pondweed. [1]

3 Exam-style questions

3.1 On a rate-against-light-intensity graph, the curve rises then levels off. At the levelled-off part, the limiting factor is: [1]

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A light intensity

B something other than light (e.g. CO₂ or temperature)

C the amount of chlorophyll only

D oxygen concentration

3.2 Why does the rate of photosynthesis fall at very high temperatures? [1]

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A too much CO₂ dissolves

B the enzymes denature

C light cannot reach the leaf

D water freezes

3.3 A student counts oxygen bubbles from pondweed at different distances from a lamp.

(a) Explain why moving the lamp closer increases the bubble rate (up to a point). [2]

(b) State **two** variables the student must control to make this a fair test. [2]

3.4 Explain how a redox indicator such as DCPIP can be used to measure the rate of the light-dependent stage. [3]
