

EB Education Revision Guide



How to work with Photosynthesis: Part 2

Investigating Photosynthesis

As photosynthesis is a chemical reaction, it can happen at different rates.

You need to be able to investigate practically the different factors that affect the rate of photosynthesis.

Canadian pondweed is an aquatic plant that can be used to measure the rate of photosynthesis.

The rate at which the plant produces oxygen corresponds to the rate at which the plant is photosynthesising. The faster oxygen bubbles are produced, the faster the rate of photosynthesis.

Factors affecting the rate of photosynthesis

Remember the following factors

(see 'How to work with Photosynthesis: Part 1' for more information)

- Temperature
- Light intensity
- Carbon dioxide
- The amount of chlorophyll (plants in darker conditions synthesise more chlorophyll, to absorb the light required. The effects of some plant diseases affect the amount of chlorophyll, and therefore the ability of a plant to photosynthesise).

Investigating Photosynthesis

Different factors:

There are several ways of measuring the rate of photosynthesis in the lab. These include:

- the rate of **oxygen** output
- the rate of **carbon dioxide** uptake
- the rate of **carbohydrate** production

The plant will also be respiring, which will use up some oxygen and carbohydrate and increase carbon dioxide output, so this will impact on the results.

How to do it:

You could investigate the effect of different **wavelengths** of light on photosynthesis.

- Use coloured acetate filters to investigate the effects of the blue, green and red parts of the spectrum on photosynthesis.

You could investigate the effect of the presence or absence of chlorophyll on photosynthesis by using a variegated plant. Variegated plants have regions of their leaves with, and without, chlorophyll.

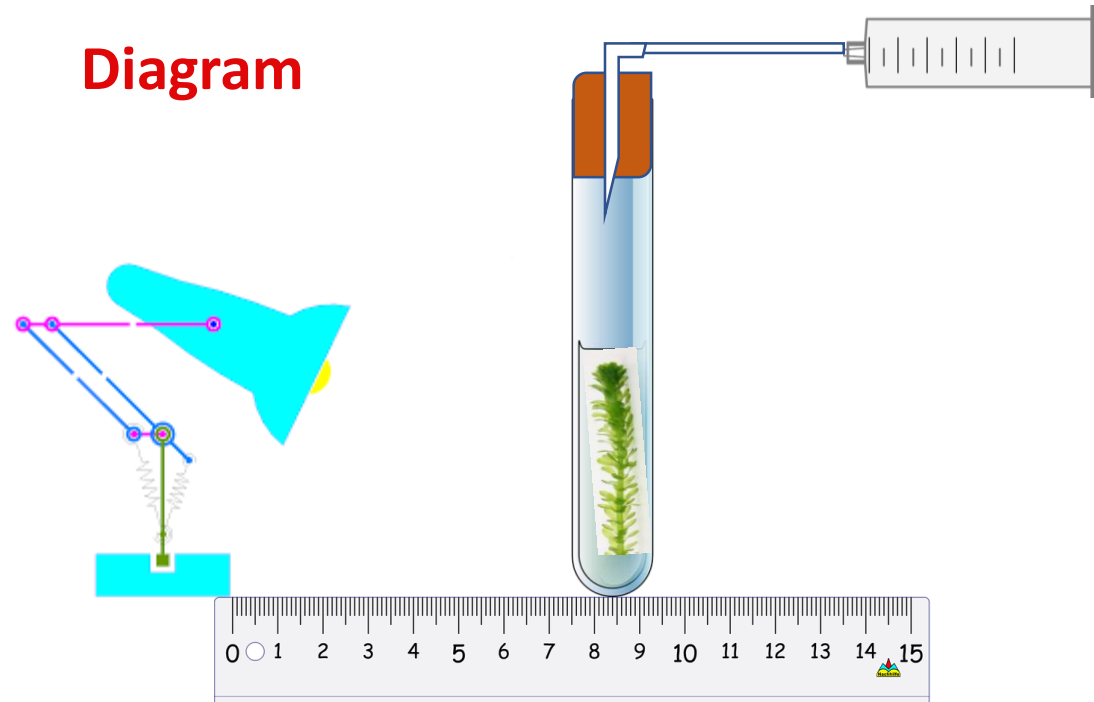
- Only those areas of the leaf with chlorophyll photosynthesise. They will test positive for starch, which is built up from the glucose produced.

Measuring the effect of light intensity

Sodium hydrogencarbonate is added to the water to provide the plant with carbon dioxide.

- Place a lamp at a specific distance from the pondweed.
- Leave for a set amount of time.
- Collect the oxygen produced in the gas syringe and measure the volume produced (counting the number of bubbles given off would provide a less accurate result).
- Repeat the experiment with the lamp at different distances from the pondweed.

Diagram



CONTROL VARIABLES: temperature (use a water bath), use a heat filter to eliminate heat from the lamp, carbon dioxide concentration (use set amount of hydrogencarbonate to set volume of water). ...helping everybody achieve Even Better

Calculating Light Intensity

Higher only

The light intensity is proportional to distance, it will decrease as the distance away from the bulb increases. There is an inverse square relationship between distance and light intensity, as the distance *increases*, the light intensity *decreases*.

This is because as the distance away from a light source increases, **photons** of light become spread over a wider area.

The light energy at twice the distance away is spread over four times the area. So as distance doubles the light intensity becomes $\frac{1}{4}$.

The light energy at three times the distance away is spread over nine times the area, so as distance trebles the light intensity becomes $\frac{1}{9}$ and so on.

The light intensity is inversely proportional to the square of the distance – this is the inverse square law.

$$\text{Light intensity} \propto \frac{1}{\text{distance } (d)^2}$$

Your turn:

1. A scientist was investigating the effect of light intensity on the rate of photosynthesis in an aquatic plant.

She placed the lamp at different distances from the plant, and counted the number of bubbles produced in 60 seconds.

She then used the number of bubbles produced to calculate the rate of photosynthesis.

The light intensity was calculated using the inverse square law.

$$\frac{1}{d^2}$$

The results are shown below.

Distance of lamp from plant (cm)	Light intensity	Bubbles produced in 60 seconds
5	0.04	83
10	0.01	24
15	0.0044	14
20		9
25	0.0016	6
30	0.0011	5

a) Calculate the light intensity when the lamp is 20cm away from the plant.

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b) Using the data in the table, describe the effect light intensity has on the rate of photosynthesis.

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Your turn:

c) Suggest another method to measure light intensity.

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d) Explain how the method could be improved to measure the volume of gas released more accurately.

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e) If the light intensity decreased to 0.0001 units, explain what would happen to the levels of gas produced.

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Answers:

1. A scientist was investigating the effect of light intensity on the rate of photosynthesis in an aquatic plant.

She placed the lamp at different distances from the plant, and counted the number of bubbles produced in 60 seconds.

She then used the number of bubbles produced to calculate the rate of photosynthesis.

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a) Calculate the light intensity when the lamp is 20cm away from the plant.

$$20 \times 20 = 400$$

$$1/400 = 0.0025$$

$$= 0.0025$$

b) Using the data in the table describe the effect light intensity has on the rate of photosynthesis.

As light intensity decreases the rate of photosynthesis decreases.

After 20 cm away, light intensity appears to have little effect on the rate of photosynthesis.

Answers:

c) Suggest another method to measure light intensity.

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Use a light meter
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d) Explain how the method could be improved to measure the volume of gas released more accurately.

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Collect the oxygen in a graduated gas syringe. This will
reduce the errors in counting bubbles which may be of
different sizes.
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e) If the light intensity decreased to 0.0001 units, explain what would happen to the levels of gas produced.

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The volume of gas produced would decrease to below 4
bubbles per 60 seconds, because light is needed for
photosynthesis.
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For more help and resources, or
to work with us as a tutor, please
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