

Aim: Investigate the effect of light intensity on rate of photosynthesis

Equipment

- Beaker
- Filter funnel
- 1 or 10cm³ measuring cylinder
- 10cm piece of pondweed
- Plasticine
- Stop clock
- Light source
- Metre ruler

Oxygen is a by-product of photosynthesis.
By using water plants, you can see and collect bubbles of colourless gas released to measure the rate of photosynthesis.

Hazard:

- Keep electrical equipment away from water
- Ensure hands are dry

Independent variable → Light intensity (distance from lamp)

Dependent variable → Rate of photosynthesis (rate of gas production)

Control variables →

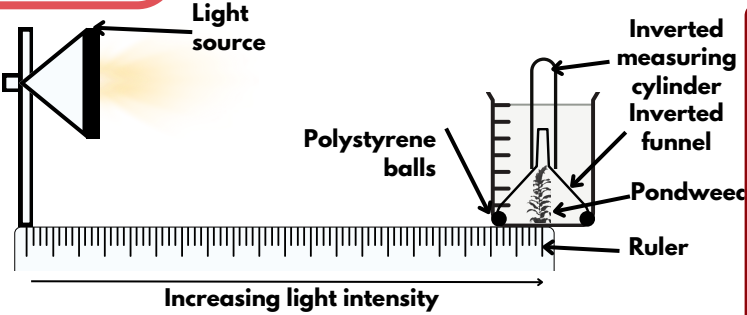
- Temperature
- Light colour
- Carbon dioxide concentration

Method:

Preparation

- 1) Place **10cm** piece of pondweed (cut edge at top) into a **beaker** of water.
- 2) Cover the pondweed with the **filter funnel**, **inverted**.
- 3) Fill measuring **cylinder** with water and **invert to top** the inverted filter.
- 4) Place the **light source 1m** from the beaker, using the 1m ruler to measure.

Raise filter from the bottom of the beaker with plasticine



What is happening?
The rate of photosynthesis increases as the light moves closer, demonstrating the light is the limiting factor. Eventually, no matter how close the light, the rate stays the same. Here, light is no longer the limiting factor (could be amount of chlorophyll temperature or CO2 concentration)

REQUIRED PRACTICAL 6 PHOTOSYNTHESIS

Procedure

- 5) When set up, start the stop watch and:
 - **Count** the number of bubbles released in 3minutes
 - Record the **volume of gas produced** and **collected** in the measuring cylinder during the **three minutes**
- 6) Move the light source to **80cm away** from the beaker.
- 7) **Refill** the measuring cylinder with water and carefully **reposition** all elements as you did in steps 1-4.
- 13) Repeat step 5 at **80cm**, then at **60, 40 and 20cm**. Record results after each distance:

Too slow? Increase rate of reaction with:

- Sodium hydrogen carbonate solution
- Warmer water

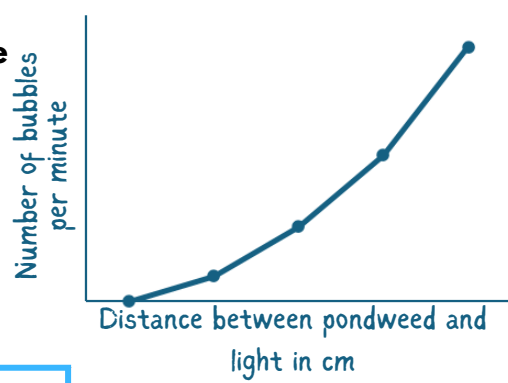
Inverse Square Law

As distance of light increases, light intensity decreases - an **inverse relationship**. However, this is not linear. The light intensity increases or decreases in inverse proportion to the **square of the distance**

Double (x2) the distance
Light intensity falls by a quarter (1/4)

$$\frac{1}{2^2} = \frac{1}{4}$$

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



Analysis of Results

"As distance decreases, light intensity increases and so the rate of photosynthesis increases. This is because energy transferred by light is needed for photosynthesis to take place."

	Increasing Light Intensity					
	120cm	100cm	80cm	60cm	40cm	20cm
Number of gas bubbles	0	1	4	8	11	11
Volume of gas cm ³	0.00	0.80	2.35	4.60	8.00	8.10

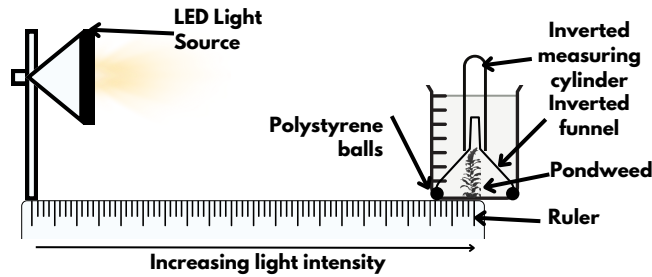
Measuring volume of gas is more accurate as some bubbles produced a too small or quick to come out to be counted accurately

Potential improvements?

- Use a gas syringe to collect volume of gas produced.
- Place a heat shield (glass tank) between lamp and plant to prevent the light source heating the plant
- Taking mean of several repeats at each distance.
- Use an LED bulb to minimise heat energy released.
- Monitor temperature of water with a thermometer to check for temperature rise.

Exam Style Questions - Photosynthesis

1) Students investigated the rate of photosynthesis in pondweed at different light intensities. They used the following set up:



They counted the number of oxygen gas bubbles produced in 3 minutes whilst the light source was placed at different distances from the pondweed.

Table 1 shows the results:

	Distance from pondweed					
	120cm	100cm	80cm	60cm	40cm	20cm
Number of gas bubbles	0	1	4	8	11	11

a) Describe the pattern shown in Table 1. (2 marks)

b) Suggest how the experiment could be modified to investigate the effect of carbon dioxide concentration instead of light intensity on the rate of photosynthesis? (1 mark)

c) The LED light source does not get hot. Why is this important? (1 mark)

d) What could be the limiting rate of photosynthesis when the light source is 40cm away from the pondweed? Give one factor. (1 mark)

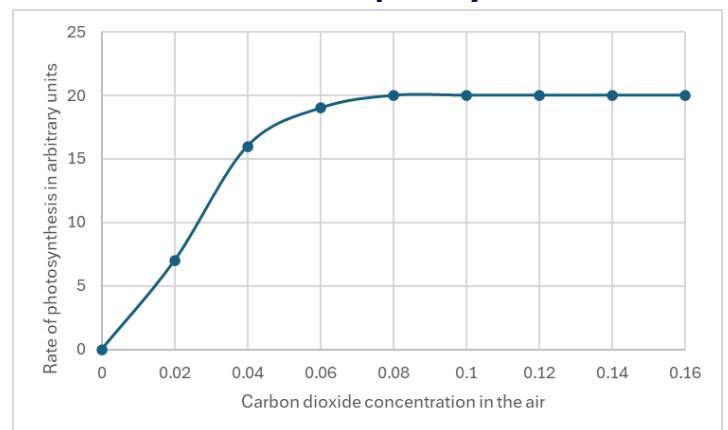
e) Suggest how the students could modify the apparatus to measure the rate of photosynthesis more accurately. (1 mark)

2) The graph shows the effect of the concentration of carbon dioxide on the rate of photosynthesis in tomato plants at 20°C.

a) What is the maximum rate of photosynthesis of the tomato plant shown in the graph? (1 mark)

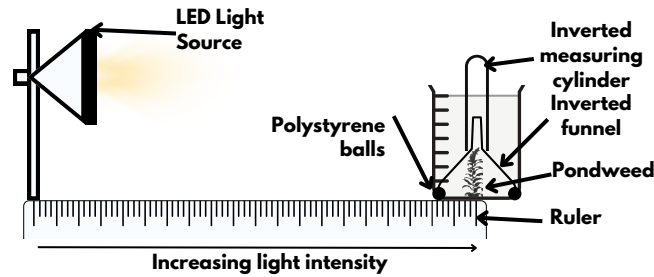
b) Describe the effect of increasing the concentration of carbon dioxide on the rate of photosynthesis.

You should include numbers from the graph in your description. (3 marks)



Exam Style Questions - Photosynthesis

1) Students investigated the rate of photosynthesis in pondweed at different light intensities. They used the following set up:



They counted the number of oxygen gas bubbles produced in 3 minutes whilst the light source was placed at different distances from the pondweed.

Table 1 shows the results:

	Distance from pondweed					
	120cm	100cm	80cm	60cm	40cm	20cm
Number of gas bubbles	0	1	4	8	11	11

a) Describe the pattern shown in Table 1. (2 marks)

One mark for each of the following:

- Number of bubbles per three minutes increases as the distance from pondweed decreases/light intensity increases
- The number of bubbles per three minutes levels off at 40cm.

b) Suggest how the experiment could be modified to investigate the effect of carbon dioxide concentration instead of light intensity on the rate of photosynthesis? (1 mark)

One mark for each of the following:

- Sodium hydrogen carbonate
- Different masses

c) The LED light source does not get hot. Why is this important? (1 mark)

One mark - Pondweed remains at a constant temperature

d) What could be the limiting rate of photosynthesis when the light source is 40cm away from the pondweed? Give one factor. (1 mark)

One mark for one of the following:

- Carbon dioxide concentration
- Amount of chlorophyll

e) Suggest how the students could modify the apparatus to measure the rate of photosynthesis more accurately. (1 mark)

One mark for one of the following:

- Syringe
- Scale on the side

2) The graph shows the effect of the concentration of carbon dioxide on the rate of photosynthesis in tomato plants at 20°C.

a) What is the maximum rate of photosynthesis of the tomato plant shown in the graph? (1 mark)

One mark - 20

b) Describe the effect of increasing the concentration of carbon dioxide on the rate of photosynthesis. You should include numbers from the graph in your description. (3 marks)

Mark one - Increases

Mark two - Levels off/reaches a maximum/ remains constant/stays the same/plateaus/stops increasing

Mark three - goes up to/reaches a maximum/levels off at 20 arbitrary units OR at 0.07-0.08 concentration

