Measuring the rate of photosynthesis

Canadian Pondweed Experiment

This test can specifically measure the effect of light intensity on photosynthesis. The rate of the plant's **oxygen production** is proportional to the rate of **photosynthesis**.

1. **Place the plant in a boiling tube.** Place the plant **underwater** in a boiling tube.
2. **Connect a gas syringe.** Place the boiling tube on a clamp and add a capillary tube and a gas syringe. There should be an air bubble in the capillary tube.
3. **Use a ruler to measure movement of the air bubble.** You can then use a ruler to see how much the air bubble moves. The amount the bubble moves is proportional to the **rate** of photosynthesis.
4. **Change the variables.** You can now vary the light intensity, temperature and CO_2 concentration and observe the effect on bubble displacement (and hence rate of photosynthesis).

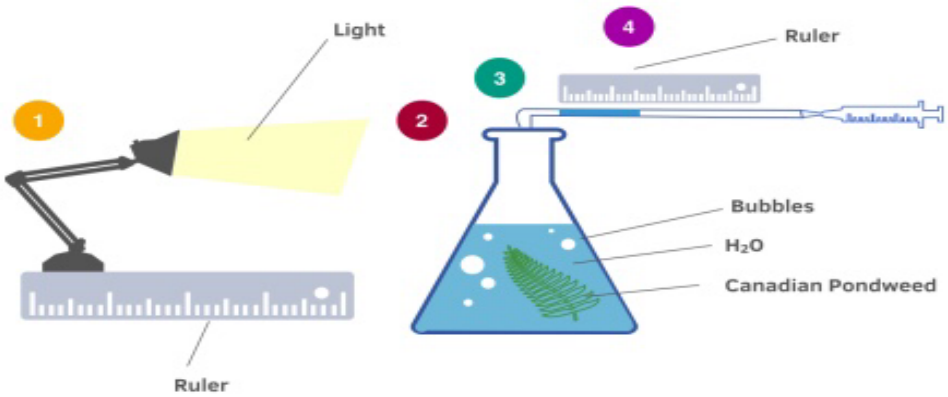

Fig 6. The Canadian Pondweed Experiment.

Investigating the Effect of Light Intensity

- **Vary light intensity:** Place a lamp at differing distances from the plant and observe the oxygen production through the movement of the bubble.
- **Control the other variables, and repeat for reliability:** Control the temperature of the room and the time taken for the experiment. Make sure to repeat the experiment three times at each distance, then take a mean value in order to attain more reliable results.

Fig 7. Investigating the Effect of Light Intensity.

Investigating the Effect of Temperature

- **Vary the temperature:** Place the boiling tube in different temperature water baths and observe the oxygen production through the movement of the bubble. This will give you an opportunity to see the effect of light intensity on the rate of photosynthesis
- **Control the other variables, and repeat for reliability.** Control the time taken for the experiment and the distance at which the lamp is placed. Make sure to repeat the experiment three times at each distance, then take a mean value in order to attain more reliable results.

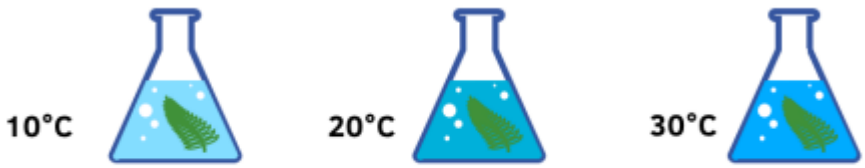

Fig 8. Investigating the Effect of Temperature.

Investigating the Effect of CO_2 Concentration

- **Vary the CO_2 concentration:** Dissolve different amounts of **sodium hydrogen-carbonate** in the boiling tube. This releases carbon dioxide in water. You can dissolve different amounts into different boiling tubes to see the effect of differing carbon dioxide concentration on the rate of photosynthesis
- **Control the other variables, and repeat for reliability.** Control the temperature, distance of the lamp and the time taken for the experiment. Make sure to repeat the experiment three times at each carbon dioxide concentration, then take a mean value in order to attain more reliable results.

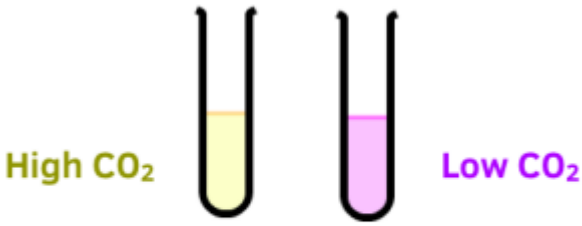

Fig 9. Investigating the Effect of CO_2 Concentration.

Inverse square Law

- The **inverse square law** shows the relationship between light intensity and distance.
- As the distance increases the light intensity decreases. This means that they are **inversely proportional** to each other.
- Light intensity and distance are inversely proportional to each other
- This means that as the distance doubles you decrease the intensity of the light will be four times less
- This is called the **inverse square law** and shown by the equation below:

$$\text{Light intensity} = \frac{1}{\text{Distance}^2}$$

Q: Calculate the light intensity when the distance of the plant is 10 cm from the lamp

Use the equation:

Light intensity = 1/d2

Fill in the values you know:

Light intensity = 1/102

Calculate the light intensity:

Light intensity = 0.001 au. **au stands for Arbitrary Units**