Aim: To investigate the effect of light intensity on the rate of photosynthesis, using pondweed (Elodea) as the plant.

Background Theory

- Photosynthesis: 6CO■ + 6H■O → C■H■■O■ + 6O■ (using light energy, in chloroplasts).
- Oxygen is produced as a by-product and can be counted as bubbles or measured by volume.
- Light intensity is a limiting factor — increasing it (up to a point) increases the rate.
- Adding NaHCO■ to the water ensures CO■ is not limiting throughout the experiment.

★ Light intensity is proportional to 1/distance² (inverse square law).

★ Above a certain light intensity, another factor (CO■ or temperature) becomes limiting — rate plateaus.

Equipment

- Pondweed (Elodea)
- Lamp (with variable distance or power)
- Ruler or metre rule
- Beaker / boiling tube
- Sodium hydrogen carbonate solution (NaHCO■) — 1%
- Stopwatch
- Thermometer
- Water bath (to control temperature)

Method

1. Cut a 5 cm length of healthy pondweed. Make the cut at an angle under water to avoid trapping air.
2. Place the pondweed in a boiling tube containing 1% NaHCO■ solution. The cut end should face upward.
3. Place the lamp at a distance of 5 cm from the boiling tube. Allow 2 minutes for the plant to adjust.
4. Count the number of oxygen bubbles produced in 1 minute. Record the result.
5. Repeat at distances of 10, 15, 20, 25 and 30 cm.
6. Repeat the whole experiment twice and calculate the mean number of bubbles per minute.
7. Keep a thermometer next to the tube to check temperature remains constant throughout.

Variables

Independent variable	Distance of lamp from pondweed (5, 10, 15, 20, 25, 30 cm) — used as a measure of light intensity
Dependent variable	Number of oxygen bubbles produced per minute (or volume of O■ collected)
Controlled variables	Temperature (water bath), CO■ concentration (NaHCO■), same pondweed, same lamp wattage

Results Table

Distance (cm)	Bubbles/min (1)	Bubbles/min (2)	Bubbles/min (3)	Mean bubbles/min

Analysis

- Plot a line graph: mean bubbles per minute (y-axis) vs distance from lamp (x-axis).
- As distance increases, light intensity decreases and the rate of photosynthesis decreases.
- Describe the shape: rate decreases as distance increases (curve, not straight line).
- ★ Calculate light intensity for each distance: relative intensity = 1 ÷ distance².
- ★ Plot rate vs 1/d² — this should give a straighter line as rate is proportional to light intensity.
- ★ If rate plateaus at low distances, suggest which other factor is now limiting the rate.

Exam Tip: NaHCO■ ensures CO■ is not a limiting factor. Always state this when explaining controls. Counting bubbles is less accurate than measuring O■ volume — mention this as a limitation.

Common Mistake: Do not confuse light intensity with light brightness — use the precise term "light intensity" in exam answers.