

This is the **Higher Separate** version — includes all Higher Tier content (marked ★) and all Separate Science content.

The rate of photosynthesis is controlled by limiting factors. The factor in shortest supply at any given time limits the rate, regardless of how much of the other factors are present.

Required Practical: Investigating effect of light intensity on photosynthesis using pondweed. Use different distances from lamp. Add NaHCO_3 to ensure CO_2 is not limiting. Control temperature with a water bath.

- Three main limiting factors: light intensity, CO_2 concentration, temperature.
- Light intensity: more light \rightarrow more energy available \rightarrow faster rate. Above a point, another factor becomes limiting.
- CO_2 concentration: CO_2 is a reactant. More CO_2 \rightarrow faster rate up to a limit.
- Temperature: higher temp \rightarrow enzymes more active \rightarrow faster reactions. But above $\sim 45^\circ\text{C}$, photosynthesis enzymes DENATURE \rightarrow rate drops sharply.
- ★ **HT Inverse square law:** light intensity $\propto 1/\text{distance}^2$. Double the distance \rightarrow quarter the light intensity.
- Greenhouse growers control all three factors: artificial lighting, CO_2 generators, heating — to maximise year-round yield.
- **Sep** Water can also limit photosynthesis if plants become water-stressed — stomata close to conserve water, reducing CO_2 entry.

Key Terms

Limiting factor	The factor in shortest supply that controls the rate of a reaction — increasing other factors has no effect
Light intensity	Amount of light per unit area — proportional to $1/\text{distance}^2$ from a light source

■ **Exam Tip:** In a graph where rate plateaus: the plateau means ANOTHER factor is now limiting, not the one being changed. You must identify what that other factor is. Common mistake: saying "maximum rate reached" without specifying the new limiting factor.