An Experiment Showing The Limiting Factors Of Photosynthesis

This experiment is going to show how light intensity affects the rate of photosynthesis in Canadian Pond Weed, ***Elodea***. ***Elodea*** has long been used in experiments to estimate the rate of photosynthesis. The first example was by Reinke in 1883. He counted the bubbles given off by ***Elodea*** in spring water with a little added carbon dioxide when it was exposed to lights of different intensities. ***Elodea*** is a green plant. It makes glucose from carbon dioxide and water, using light as energy. ***Elodea*** can only photosynthesise when light shines on it. ***Elodea*** produces oxygen during photosynthesis when light shines on the plant.
Glucose, made in photosynthesis, is a source of energy for ***Elodea***. It is used for the growth and repair of plant cells. Energy is transferred from glucose to the cells during aerobic respiration. ***Elodea*** respires at a steady rate all of the time; ***Elodea*** makes oxygen during aerobic respiration.

Planning Experimental Procedure:

Plants need certain amounts of Carbon Dioxide, light and an optimum temperature to produce glucose. I am going to attempt to find out how the rate of photosynthesis differs at dissimilar light intensities.

Factors affecting photosynthesis in Elodea:

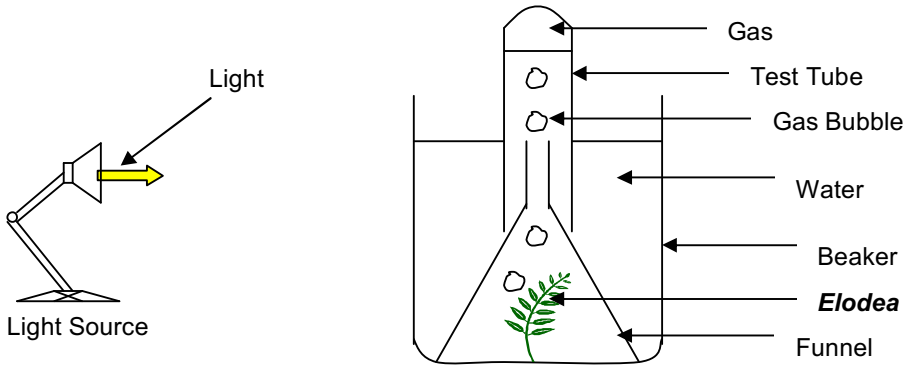
- Light intensity, as it increases, so does the rate of photosynthesis until no more increase happens, whatever the light intensity
- Carbon dioxide concentration, as the amount of carbon dioxide increases, so does the rate of photosynthesis
- Temperature, enzymes control the process, so up to an optimum temperature, the rate of photosynthesis will increase
- Water, photosynthesis cannot occur in the absence of water

Key Variables:

- The amount of CO_2 present in the water at the time of testing
- The intensity of the light on the plant
- The length of the experiment
- The temperature of the water and the surrounding air
- The amount of ***Elodea*** used in the experiment

I am going to measure the amount of gas bubbles given off by the ***Elodea*** in 15 minutes. All of the variables that can be altered by a human will be kept the same to provide a fair test. The amount of CO_2 in the water and the temperature will be kept the same by using water collected from the tap at as similar time as possible. The amount of ***Elodea*** used will be kept the same by using the same piece. The time the plant is tested upon will be 15 minutes every time.

Apparatus and Set-up:



Predictions:

I predict that the amount of bubbles of gas produced by the piece of pondweed will diminish as the plant is taken further from the light source. This is because the energy needed for a plant to photosynthesise is gained from the sun. We can replicate this in a laboratory using a lamp. Without light the plant is not able to photosynthesise therefore not producing bubbles of oxygen.

Plan of Action:

1. Collect equipment: - Beaker, Pondweed, Water, Funnel and Boiling/Test Tube.
2. Arrange equipment in format shown overleaf.
3. Extinguish all extinguishable light sources.
4. Turn on test lamp and start timing 15 minutes on a stopwatch.
5. Count the bubbles for 15 minutes.
6. Record results in a table.
7. Draw graph and conclude experiment.

Carry Out Experiment

Analysing Evidence and Drawing Conclusions:

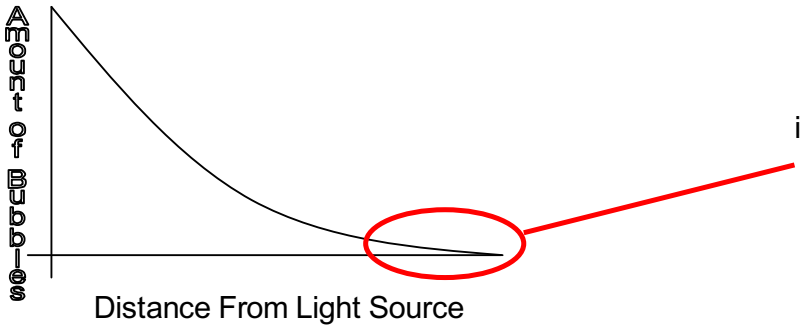
Plant Distance from Lamp (cm)	Number of Bubbles Counted
10	75
20	54
30	49
40	43
50	37
60	32
70	32
80	24
90	2
100	2

PLEASE SEE GRAPH ON SEPARATE SHEET

These are the results taken from my experiment. My previous prediction was correct. The amount of bubbles diminished as the plant got further away from the light source. This is because the chloroplasts in the leaf need light to provide energy to be able to convert carbon dioxide into glucose and oxygen. S hown by the formula: -

$$6H_2O + 6CO_2 \xrightarrow[\text{Chlorophyll}]{\text{Light}} C_6H_{12}O_6 + 6O_2$$

This experiment presented me with two anomalous results. The results for the plants that were 90 and 100cm away from the light source hardly photosynthesised at all. I think this is because the 'trigger-level' for photosynthesis is b etween 80 and 90 cm away from the light source and we measured just outside this.



This sketch graph shows the rough indication of where the 90 and 100 cm mark is because it is where the line meets the x-axis.

Evaluation of Evidence

The technique of counting bubbles is a crude and a very inefficient way of measuring photosynthesis. This is because there is a large ma rgin for human error. We can try and count the bubbles but inevitably we will miss some and count some of the bubbles twice. Also oxygen and carbon dioxide can dissolve in water, rather than form bubbles.

The results collected fitted the pattern of resul ts that I expected. I have followed all of the procedures set out in my planning so all of my results are fair and the test as a whole was fair. Between experiments the pondweed may not have had time to recover so if I did this experiment again I would take an hour between experiments to allow the pondweed to recover. To support my conclusion I would investigate the results of other experiments performed by other people such as members of my class or people who have published their findings online. This exp eriment is very 'hit and miss' I had to perform the experiment several times before I found a piece of pondweed that produced any bubbles at all, as is the way with most living things.

If I were to do the experiment again there would be several things tha t I would change:

- I would spend more time on improving the accuracy of the experiment rather than writing it up.
- I would find a more efficient way of finding out how much gas is produced by the plant possibly by using a capillary tube and a ruler.
- I would make sure that the laboratory was in complete darkness with the exception of the test light source before commencing the experiment.