How Light Intensity Affects the Rate of Photosynthesis

Aim:
'To determine whether or not different light intensities affect the rate of photosynthesis in Canadian Pondweed'

Equation:

Carbon Dioxide + Water —(Sunlight, Chlorophyll)→ Oxygen + Glucose

$6CO_2$ $6H_2O$ $6O_2$ $C_6H_{12}O_6$

Prediction:
Seeing as the more light a plant got, within reason, the faster a plant would photosynthesise. Thus, I expect that the higher the light intensity, the higher the rate of photosynthesis. I also predict that as light intensity increases, the rate of photosynthesis will increase at a relative rate until the maximum level of light, at which point the level of increase in photosynthesis will decrease and eventually even out, as a limiting factor, probable temperature, will limit it at this point .

Preliminary Experiment:
In order to attain an accurate experiment, I did a preliminary experiment to determine an appropriate range of distances as to how far my lamp would be placed from the plant. The further away the lamp, the less the light intensity. The results are:-

Distance in cms	No. of Bubbles
40	13
35	13
30	16
25	17
20	20
15	20
10	22
5	23

Although this is not a very accurate way of measuring the rate of photosynthesis as all I am doing is physically counting the bubbles coming off the pondweed and relying on them all being the same size, it was the best method I could manage with the equipment I had. This preliminary experiment will allow me to compare my 2 main experiments and give me a point of origin to compare and check no unknown variables have happened in the next experiments. The preliminary also told me that the outer ranges, 40 and 5, tell me little so although they are justified, it would be better to take readings towards the middle of the range. So I will take readings 5, 10, 20, 25, 30, 35.

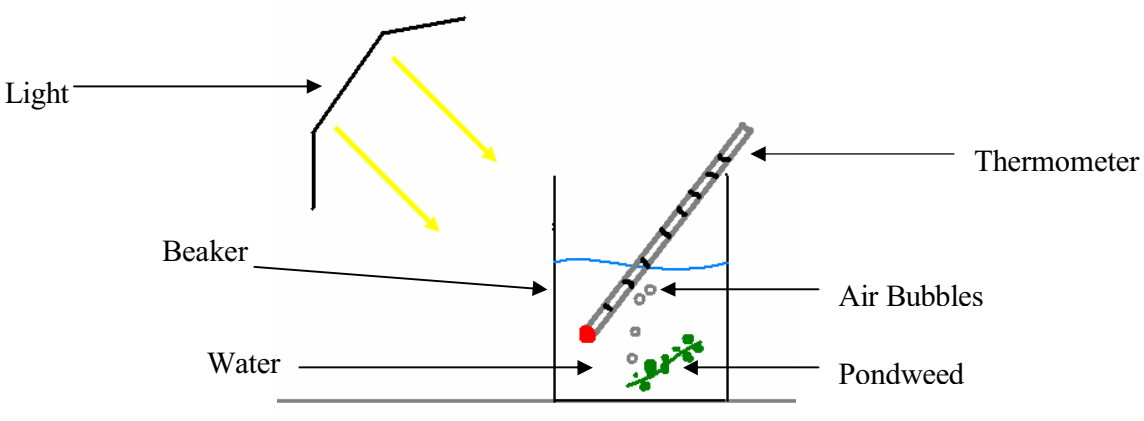
Method:
Apparatus: Pond Weed, Beaker, Thermometer, Water, Stopwatch, Sodium Bicarbonate, Scissors, Lamp, Paper Clips.

After collecting some pondweed of about 5cm in length, I filled a beaker of water and placed the pondweed in it along with some Sodium Bicarbonate to help keep the Carbon Dioxide levels in the water constant. Using the thermometer, I record the temperature of the water at the start and end of the experiment so that the results are all fair. Next, I set up the lamp at the first distance and make sure it is at the correct distance from the pondweed and not from the edge of the beaker. Wait a few minutes to get the pondweed to start photosynthesising and record how many bubbles of air are given off in 2 minutes and record the results. I then repeat this at all the different distances I have decided.

Input variables: Light intensity can be varied by placing the lamp at different distances from the pondweed.

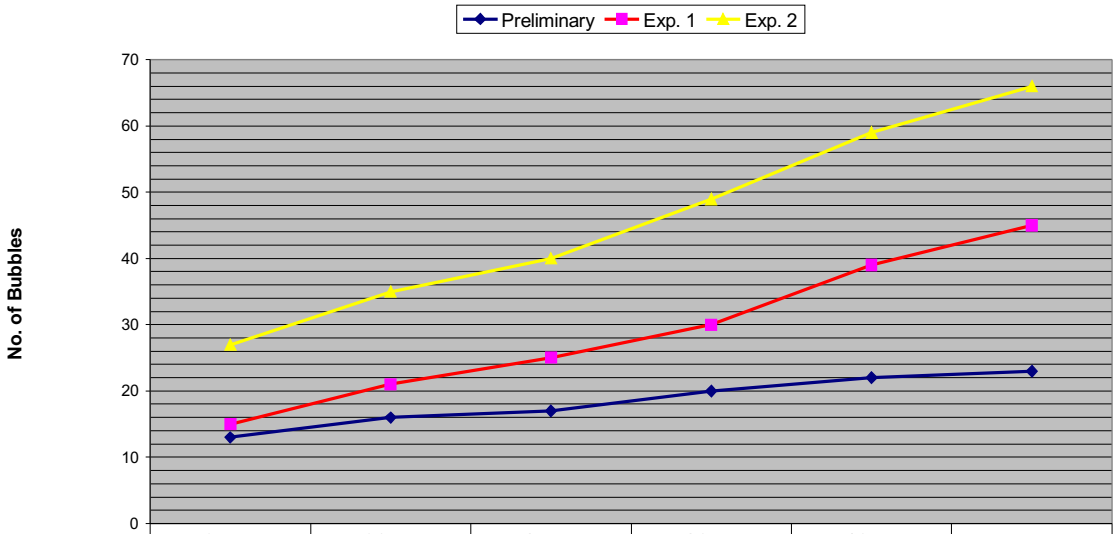
Output variables: Amount of oxygen given off in air bubbles (rate of photosynthesis) measured in how many oxygen bubbles are given off in 2 minutes.

Control variables: -Carbon dioxide concentration – If there is too little CO_2 in the water the pondweed will not photosynthesise well so I need to keep the level of Carbon Dioxide in the water using Sodium Bicarbonate, however if this were an experiment over 24 hours I would need a better way of controlling the levels in the water.
-Temperature – In a plant, enzymes are used to control photosynthesis reactions in a plant. Therefore if the temperature of the water increases, the rate of photosynthesis will increase until the pondweed becomes denatured. I am maintaining a rough constant temperature for all the tests as each time the water is coming from the taps at around room temperature. I will need to check the temperature remains constant as heat from the lamp could raise it.



Obtaining Evidence

Results:

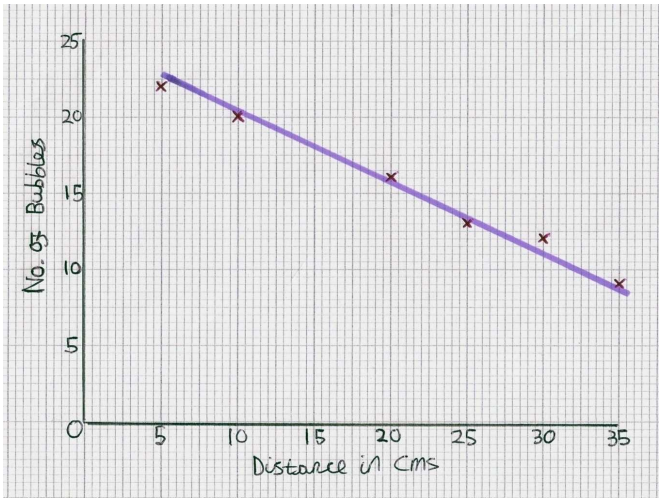


	35cm	30cm	25cm	20cm	10cm	5cm
Exp. 2	12	14	15	19	20	21
Exp. 1	2	5	8	10	17	22
Preliminary	13	16	17	20	22	23

Distance

Average Number of Bubbles per 2 Minutes:

Distance	Average No. of Bubbles
35cm	9
30cm	12
25cm	13
20cm	16
10cm	20
5cm	22



Analysing and Considering Evidence

The hand drawn graph I did had a best fit curve instead of a line of best fit to indicate the pattern the results had taken. As the lamp got closer to the pondweed, and therefore the light intensity increased, the rate of photosynthesis in the pondweed increased in coherence with the closer the lamp got. This was because photosynthesis needs light energy to produce glucose, the closer the light got to the plant, the faster the plant photosynthesised and therefore as a by-product the more oxygen it produced which were given off as air bubbles. My results showed that the difference between light intensity and the rate of photosynthesis in pondweed are non-linear as they are not stable and in coherence with each other (being that if the light got closer the rate of photosynthesis would increase) but it is erratic so although they do both increase with each other and are not synchronised and so the best we can manage is a line of best fit. However for Experiment 1 you could almost say that as the light intensity increased, so did the Rate of Respiration in proportion.

Sodium Bicarbonate played a large part in my results. I used Sodium Bicarbonate in an effort to both make sure there were sufficient Carbon Dioxide levels in the water and to try and keep constant the levels so that each reading would have more or less the same Carbon Dioxide amount to photosynthesise with and only the light intensity changes. This helps me maintain the control variables in order to get a fair and unbiased experiment. Towards the start of all 3 experiments, all though the number of bubbles is less than when the lamp was much closer, the rate that the bubbles were being produced was greater than towards the end of the experiment. This is because although it is not getting a great deal of light, it has the highest amounts of CO_2 to photosynthesis with.

In the Preliminary Experiment I performed, I got the highest Number of Bubbles of all 3 experiments. At 35cm, the pondweed produced 13 oxygen bubbles through photosynthesis where as Experiment 1 only produced 2 and Experiment 3 produced 12. I believe Experiment 1 went awry as I did not add Sodium Bicarbonate to the water as I wanted to see how much effect it would have on the Rate of Photosynthesis. When the lamp was 35cm away from the plant it was only producing 2 bubbles and again at 30cm it only made 5 air bubbles, far lower than the other two experiments. However when the pondweed was only 10cm away from the lamp, the Sodium Bicarbonate appeared to make little difference as the pondweed was producing 17 bubbles, which although was still behind Experiment 2 which made 20 bubbles, it was not low enough to present the theory that Sodium Bicarbonate was essential for the experiment.

Due to the fact that I was in a school laboratory, I did not have all th e equipment I would have liked. Because of this my results are not very accurate as a number of variables could have influenced the experiment: -

- Light – The lamp was not the only light source as it was done in a lit room so the pondweed was already photosynthesising. Although this probably did not influence it much, it will have thrown off my results a bit. There was also the chance of light pollution from other people's experiments. To solve this I would have to performed the experiment alone, in a completely dark room where the lamp was the only light source
- Temperature – As said earlier, the higher the temperature of the water, the faster the rate of photosynthesis until it gets so hot that the plant gets denatured. The lamp produced a lot of heat which then coul d have raised the temperature of the water, influencing the results. By keeping an eye on the thermometer, I made sure this did not happen, and as this was not a long experiment, it was not a factor of great importance. One way of solving this if it had been an issue was place a sheet of glass between the beaker and the lamp, allowing the light to pass through but at the same time absorbing most of the heat.
- Carbon Dioxide Levels – By using Sodium Bicarbonate I eliminated this variable but had it been a lon ger experiment and I not used this, the Carbon Dioxide in the water may have got depleted so may become a problem.
- Inaccuracy in the Collection of Data – To measure the rate of photosynthesis in the pondweed, I was physically counting the Oxygen bubbles gi ven off as by-product of photosynthesis. This meant that I was relying on them all being the same size so that the results would be equal, which of course was not the outcome. One way I could have more accurately measured the oxygen given off was with a gas syringe. By placing the gas syringe over the beaker, it would have collected all the Oxygen from the plant, which I could then have measured completely accurately.
- Different Pondweed Specimens – In each experiment I used a different pondweed specimen for the test. This meant that they were all different sizes. They could also not photosynthesise as fast as each other. One piece could produce many more air bubbles than another one. The way to solve this would have been simply to use the same piece of pondw eed each time, and make sure it does not become denatured between experiments.

Despite all of these variables making it a very inaccurate experiment, I thought there was enough evidence to support my original hypothesis. I could possibly have made it more accurate towards the start by taking many more readings using the same piece of pondweed each time and then calculating an average, however due to time restrictions and the equipment at my disposal, this was the best experiment I could manage.