Plan

In my experiment I plan to find out how the surrounding environment affects the rate of photosynthesis in Elodea (pond weed). To do this firstly I will consider the factors that have a key role in the rate of photosynthesis. There are four main factors I could investigate:

Factor 1. The intensity of light
Factor 2. The temperature
Factor 3. The concentration on CO_2 (Carbon Dioxide)
Factor 4. The concentration of water

Photosynthesis is carried out by many different organisms, ranging from plants to bacteria. The best-known form of photosynthesis is the one carried out by higher plants and algae, as well as by cyan bacteria and their relatives, which are responsible for a major part of photosynthesis in oceans.

The concentration of $CO_{2\ (factor\ 3)}$ is important because all the organisms specified above convert CO_2 to organic material by reducing this gas to carbohydrates in a rather complex set of reactions. Reducing the amount of CO_2 will reduce the amount of carbohydrates produced leading to a drop in the rate of photosynthesis.

Electrons for this reduction reaction ultimately come from water (factor 4), which is then converted to oxygen and protons. If there is not enough water then carbon dioxide, the plant wouldn't be able to produce any carbohydrates.

Energy for this process is provided by light (factor 1), which is absorbed by pigments (primarily chlorophylls and carotenoids). If there were not any light then the whole process could not take place.

Temperature increase (factor 2) affects the other key factors. As the temperature increases it increases the temperature of the water. As water temperature increases the:

- Rate of photosynthesis increases until plant suffers from heat stress
- Rate of plant growth increases
- Amount of dissolved oxygen decreases
- Metabolic rate of organisms increases thereby increasing the oxygen demand
- Vulnerability to toxic wastes can increase due to decrease in dissolved oxygen and stress of higher temperatures.

Therefore if the temperature increases the demand of oxygen increases.

I have chosen to investigate the light intensity further because light determines the whole process of photosynthesis and is the easiest to control in experimental conditions.

I am going to investigate how fast the rate of photosynthesis is by counting the bubbles of oxygen given off by the plant. My method for the experiment is as follows: I will shine a lamp on a test tube of water with a sample of Elodea in it, the lamp will act as the sun and will provide energy for the plant. I will test the elodea at different stages of light intensity by moving the distance from which the light shines. This should affect the rate of photosynthesis. When the light shines on the plant it acts with the chlorophyll in the plant and the carbon dioxide from water (taken up by the roots) and from the air to make glucose and oxygen.

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

Carbon Dioxide + Water $\xrightarrow[\text{Chlorophyll}]{\text{Light}}$ **Glucose + Oxygen**

The glucose is then stored in the plant for energy and the oxygen is given off in bubbles.

To find out what range of results I should take I'm going to conduct a preliminary experiment. The method will be the same as above and I will start off by using the lamp very close and working my way back to a distance where the bubbles will be slower.

The results were:

Distance (Centre metres)	Amount of bubbles per minute
2cm	154
20cm	120
40cm	90
60cm	70

We counted at 2cm but because the rate of bubbles given off were more than 2 per second we decided it would inaccurate to have the lamp so close because the readings would be wrong. This forced to decide to start our readings at 10cm. We stopped at 60cm because the rate of photosynthesis had halved its pace. We decided this would be a good area to study. We finally decided that it would be best going up in tens from ten to seventy.

To make sure are results are as accurate as possible we have decided to take three lots of readings and take an average. This would improve the accuracy in case we had accidentally counted wrong and had an anomaly.

I predict that the further away the lamp is, the slower the rate of photosynthesis will be because when the light is further away the light intensity is less and this would cause the rate of photosynthesis to slow because there will be less energy given by the light and taken in by the chlorophyll.

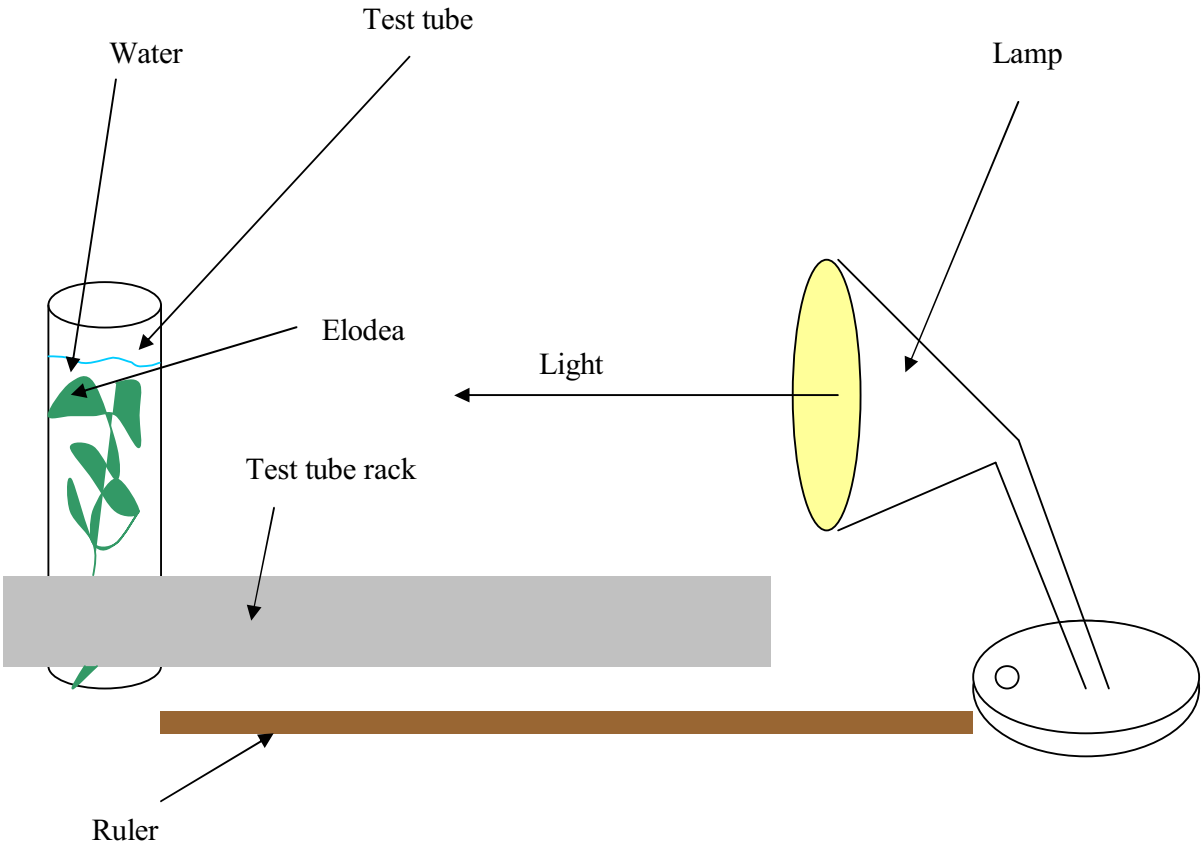
I plan to make my test as fair as possible by:

- Using the same lamp – this will make sure the same voltage of light is being used for each reading.
- Using the same sample of Elodea on the same day - This makes sure the Elodea is the same age for the experiment, if we left it too long it will become older and will grow bigger. Therefore making the rate of photosynthesis differ.
- Taking all the readings in the same lesson – This will make sure the CO2, temperature of water and the quantity of water remain the same, they will remain the same because there isn't enough time for them to differ.
- Measuring correctly to the nearest millimetre - Otherwise the readings will be incorrect because the light intensity can be different if the lamp isn't the correct distance away.
- Having the classroom lights turned off so the lights don't affect the experiment – the rate of photosynthesis will be wrong if other lights interfere.
- Doing all the experiment in one room so the temperature is the same - keeping the temperature constant will make sure its only the change in light I am testing.

Equipment

Test tube, WaterElodea, Test Tube rack, Ruler, Lamp, Tweezers, Bucket and a Desk

Diagram



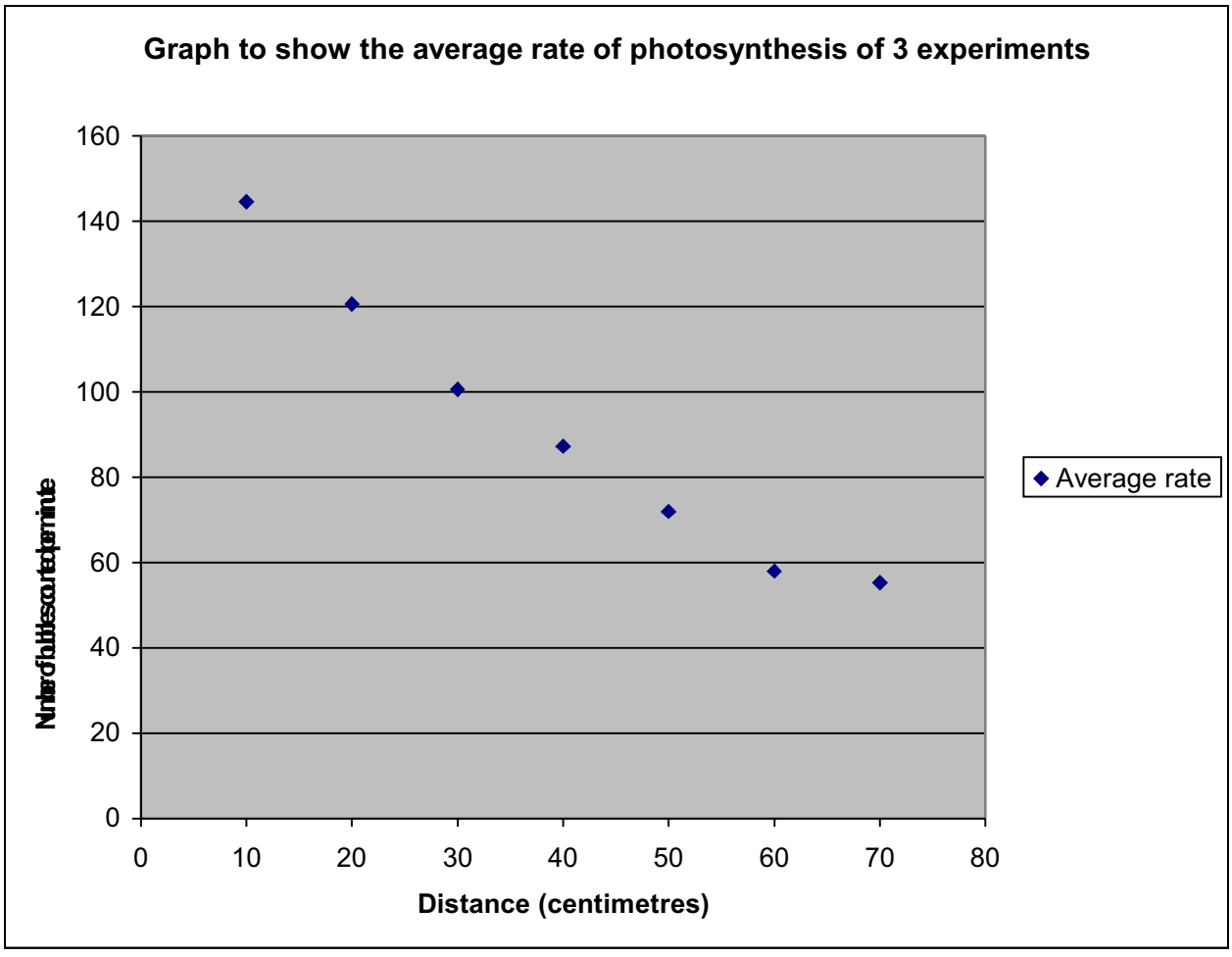
Analysing and considering evidence

My graph shows that the rate of photosynthesis is definitely in one way dependant on the intensity of light. I know this because as shown on the graph, the further away we move the lamp the less bubbles are produced. The graph has a steady curve showing a definite decrease in the amount of bubbles produced.

I predicted that:
the further away the lamp is, the slower the rate of photosynthesis will be because when the light is further away the light intensity is less and this would cause the rate of photosynthesis to slow because there will be less energy given by the light and taken in by the chlorophyll.

My graph and results prove my prediction because every time the light intensity is decreased so is the rate of photosynthesis. My graph shows that each time we decreased the light intensity the photosynthesis didn't decrease by the exact same amount each time. This is probably due to error in the counting of the bubbles or could be due to th e lack of the other factors.

Theoretically the rate of photosynthesis should decrease linearly with light intensity. The results do not show this. The curve shown is probably due to light intensity not being linearly dependent on distance. This maybe due to the shape of the light source or background light.



Evaluating

My results given by my method are quite reliable but could have been of a greater reliability if we had done the experiments more times because the average of them all will be a good indicator for the perfect rate per minute.

The data does not appear to have any anomalies as the trend of decreasing photsynthesis with light intensity is as expected. Errors in the taking and recording of the results are therefore unlikely.

I believe I have enough results to draw to the conclusion that all 4 of the key factors I picked at the start if changed have an impact on the amount of oxygen and glucose produced. I think mainly that it's the intensity of light, and therefore when gardeners are trying to use greenhouses or just boost the rate of photosynthesis of certain plants then they can use the findings I have found out and vary the different factors, or try and magnify the sun to create a higher light intensity.

To support my conclusion I would have to have gained several more lots of evidence with different plants and varying different factors. This would show which factor is the most important in keeping photosynthesis going. I could investigate that if other factors are increased how much affect they would actually have. For example if I increased the amount of Carbon Dioxide would it have any way near the amount of affect as increasing the light would. I could find this out for all the factors then decide on what I can just leave alone and what I can increase to create the maximum rate of photosynthesis all the time.

To improve the method used I would:

- Measure the variation of light intensity with distance using a photoelectric cell. This would allow a graph of light intensity with distance to be used to correct the data of the experiment.

Further work I could do to provide additional relevant evidence is as follows:

- Temperature – Repeat the experiment using water controlled at different temperatures. This will show that an increase in temperature will increase the rate of photosynthesis.
- Water – Repeat the experiment using different quantities of water in the test tube. The experiment will show whether the quantity of water is an important factor in the rate of photosynthesis given that the water must cover the Elodea.