Photosynthesis
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Introduction

Photosynthesis occurs only in the presence of light, and takes place in the chloroplasts of green plant cells. Photosynthesis can be defined as the production of simple sugars (glucose) from carbon dioxide and water, which then release sugar and oxygen. Belo is the chemical equation for photosynthesis:

$$6CO_2 + 6H_2O \xrightarrow{\text{light}} C_6H_{12}O_6 + 6O_2$$

Photosynthesis will only take place in the presence of chlorophyll.
All plants need light in order to photosynthesise (this is proven in many times in experiments) and so without light the plant would die.

The light intensity affects the rate of photosynthesis is because as light, falls on the chloroplasts in each leaf and is trapped by the chlorophyll. This makes the energy available for chemical reactions in the plant.
Which means as the amount of (sun)light (Light from the bulb) falls on the plant, more energy is absorbed, so more energy is available for the chemical reactions and so the quicker the rate of photosynthesis can occur. I have discovered that there are four ways in which the rate of Photosynthesis can change:

1. Light Intensity
2. Carbon Dioxide availability
3. Water availability
4. Temperature

In our experiment we will use the amount of Oxygen produced because we can measure this easily and that it is a by-product of photosynthesis.

Aim

The aim is to find out how changing the light intensity affects the rate of Photosynthesis

Prediction

I predict that as the light intensity increases so will the rate of photosynthesis. The rate of photosynthesis will not continue beyond a certain point for once it reaches a certain level the rate will level off due to limiting factors.

Preliminary Results

I firstly changed the temperature for it is one of the factors that affect photosynthesis. I made a suitable range of temperatures at which to record my results and from them I would decide what values to use for the SC1. Below are my temperatures and results from carrying out the experiment.

Temperature (^oC)	Light Intensity (lux)	Distance (cm)	Concentration of $NaHCO_3$ (%)	Oxygen made in 10 secs (mm^3)
0	50	30	2.5	0
5	50	30	2.5	1
10	50	30	2.5	5
15	50	30	2.5	25
20	50	30	2.5	42
25	50	30	2.5	25
30	50	30	2.5	5
35	50	30	2.5	1
40	50	30	2.5	0

From these results I have decided on using 20^oC as my temperature because it is the value where most oxygen is produced.

I then changed the amount of $NaHCO_3$ for it contains CO_2, which is one of the factors that affect photosynthesis. I made a suitable range of concentrations of the $NaHCO_3$ at which to record my results and from them I would decide what values to use for the SC1. Below are my concentrations of the $NaHCO_3$ and results from carrying out the experiment.

Temperature (^oC)	Light Intensity (lux)	Distance (cm)	Concentration of $NaHCO_3$ (%)	Oxygen made in 10 secs (mm^3)
20	50	30	**0**	0
20	50	30	**0.5**	9
20	50	30	**1.0**	26
20	50	30	**1.5**	38
20	50	30	**2.0**	41
20	50	30	**3.0**	41
20	50	30	**3.5**	41
20	50	30	**4.0**	41
20	50	30	**4.5**	41
20	50	30	**5.0**	41

From these results I have decided on using 2% concentrations of $NaHCO_3$ because using a higher concentration than this does not increase the volume of oxygen produced.

Apparatus

Photometer
Syringe
2 X ruler
Test tube
Pondweed
Thermometer
Capillary tube
Lamp
$NaHCO_3$
Water
Stopwatch

Diagram

Method

1. We got out the apparatus and set it up as shown above.
2. We then set the lamp (the variable) into our pre chosen position.
3. We switched the light on and started the stopwatch.
4. We then waited 10 seconds and switched the light off.
5. We pulled back the syringe and recorded the amount of oxygen in mm^3 that was produced.
6. We then empted the capillary tube and repeated the experiment.
7. We did this three times and calculated the average.
8. We then moved the lamp into another position and did the experiment three times from another distance.

9. We continued this until we had sufficient results.

Safety

The lamp was plugged into the mains and we had to be careful water did not get into it or we would get an electric shock. We also used Sodium Hydrogen Carbonate, which is an irritant, and we should wear safety glasses.

Fair Test

To keep the test fair we had to keep the volume of the Sodium Hydrogen Carbonate and water the same. Also to keep the test fair we had to keep the time in front of the lamp at 10 seconds. We had to also keep the temperature the same as it affects the rate of photosynthesis and so the volume of oxygen produced. Finally to keep the test fair we had to keep the light colour the same because the chlorophyll absorbs different colours of light at different distances.

Limitations

We kept the tin of ten seconds because it would get us a sufficient volume of oxygen that could be measured accurately.

Results

Below are the distances that I had chosen to do and how much oxygen was produced in ten seconds. From these results I put my results into a graph Oxygen produced Against Distance

Temperature (^oC)	Light Intensity (lux)	Distance (cm)	Concentration of $NaHCO_3$ (%)	Oxygen made in 10 secs (mm^3)			
				1	2	3	Adv
20	100	10	2	82	82	82	82
20	70	20	2	58	58	58	58
20	50	30	2	41	41	41	41
20	34	40	2	28	28	28	28
20	23	50	2	20	20	20	20
20	17	60	2	14	14	14	14
20	11	70	2	10	10	10	10

Analysis and Conclusion

My graph shows that an increase in light intensity increases the rate of photosynthesis. The gradual decrease in the rate of photosynthesis (the shallowing of the curve and reduction of the gradient) can be attributed to the other factors limiting the rate of photosynthesis

The relationship between the light intensity and the rate of photosynthesis was that for the very first part of the graph, proportional to the increase in light intensity but it starts to level off due to limiting factors.

My line of best-fit is a negative curve. I drew it as a curve rather than a straight line because it shows a clear pattern of the points. This meant that the rate of photosynthesis increased as the light intensity increased. This was because photosynthesis is a reaction, which needs energy from light to work. As the amount of energy available from light increased with the rise in light intensityand closer the lamp was to the pondweed, so did the amount of oxygen produced as a product of photosynthesis.

As light intensity increases, the rate of photosynthesis is being limited by certain factors, such as carbon dioxide and temperature. These factors do not immediately affect the rate but gradually. As light intensity increases further, so the rate of photosynthesis is decreasing more and more, until the rate of photosynthesis is constant, and is fully limited by another factor.

My graphs and my results support my predictions that as the light intensity increases so will the rate of photosynthesis and the rate of photosynthesis will not continue beyond a certain point for once it reaches a certain level the rate will level off due to limiting factors.

Evaluation

I have proved both of my predictions. I have proved that as the light intensity increases so will the rate of photosynthesis and The rate of photosynthesis will not continue beyond a certain point for once it reaches a certain level the rate will level off due to limiting factors.

My results were good ones but I have proved my predictions to an extent for there were limitations that could affect my results:

- Measuring the volume of oxygen given off was not measured accurately for we used a ruler. When reading the syringe there could have been an error. The lower the reading the more chance of there being a mistake. To combat

this I could of done the readings over a longer period of time, therefore increasing the volumes, and in turn reducing the percentage errors.

- Background light in the vicinity could of increased the light intensity slightly and so making errors in my results. To combat this we could have done the experiment in a dark room and away from the other students' experiments.

- The distance between the lamp and the Pondweed were not measured accurately for we used a ruler, especially when you note the fact that the distance should have been measured exactly from the light bulb to the centre of the plant. The further away from the plant though it would not have mattered as much.

- There could have been a slight difference from when the lamp was switched off and when the stopwatch reached ten seconds because our reaction times are not that quick and in the time that it took for the light to turn off a bubble could have been produced.

- Heat generated by the lamp, which could change the temperature, which is one of the properties of photosynthesis. To combat this I could wait for the temperature after each experiment to cool back down to 20^{o}C before I restarted.

When there was 100% light intensity, the lamp was 10cm away the pondweed we found the quickest rate of photosynthesis because there was more light energy to use to do the reaction.
When there was When there was 11% light intensity, the lamp was 70cm away the pondweed we found the slowest rate of photosynthesis because there was less light energy to use to do the reaction.

There were no anomalies.

I could have also done other experiments with the other properties that are known to affect the rate of photosynthesis such as carbon dioxide availability, water availability and Temperature. We could have also changed the light colour and the light bulb such as Florissant tubing.