Factors Affecting the Rate of Photosynthesis

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Introduction:

All living green plants photosynthesise. In photosynthesis, carbon dioxide, water and light are absorbed and used to form glucose for the plant and oxygen as a by-product. As with all reactions, the rate can be changed by altering a number of factors. In photosynthesis, the most substantial variables which affect the rate are temperature, carbon dioxide concentration and light intensity.

This is the premise of this experiment – investigating the limiting factors in photosynthesis. Due to restrictions in the environment, it would not be viable to alter the carbon dioxide concentration in the air in the classroom and it would be near impossible to achieve a suitable degree of accuracy if temperature was the independent variable. Therefore, light intensity had to be chosen as the factor to be investigated. The plant on which the theory and prediction will be tested will be Canadian pondweed.

Aim:

The aim of this experiment is to investigate how light intensity affects the rate of photosynthesis in Canadian pondweed.

Variables:

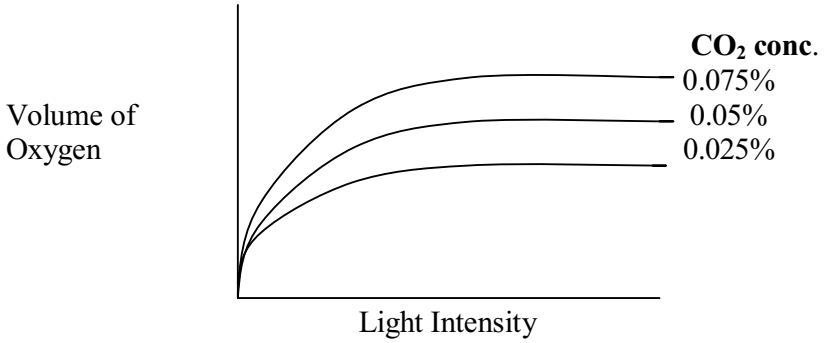
VARIABLE	TYPE OF VARIABLE	HOW MONITORED
Light intensity	Independent	The distance between the plant and the light source will be carefully measured with a ruler
Concentration of carbon dioxide	Control	The water will be saturated with sodium hydrocarbonate to ensure no change
Temperature	Control	The room temperature will be constantly monitored using a thermometer
Moisture	Control	The humidity of the classroom will be kept constant throughout
Section of plant	Control	The same section of plant will be used for each observation
Time	Control	A stopwatch will be used to ensure that each observation is only one minute
No. of bubbles	Dependent	The number of bubbles produced in a minute will be observed and noted straight after

Apparatus:

- Photoelectric cell
- Tap water
- Beaker
- Stopwatch
- Lamp
- Piece of Elodea (Canadian pondweed)
- Metre rule
- Paper clip

Preliminary Work:

Using a computer program called 'PSYNTH', I investigated the effect light intensity and the other limiting factors have on the rate of photosynthesis in varying conditions. The most relevant graph of those observed is as follows:



Temp: 25°c

Where the curve levels out, another limiting factor is preventing the increase in rate. Using this graph I can make a prediction of what I expect the results to be.

Prediction:

The process of photosynthesis is as follows: light energy is used to split water molecules into hydrogen and oxygen. The oxygen, the product which we shall be using as an indicator for the rate, is then expelled through the leaf. Therefore, if light intensity is increased, light energy is increased and the product, oxygen, is also increased. Therefore, my first prediction is that as light intensity increases, the no. of bubbles of oxygen produced per minute will also increase.

If the light intensity is doubled, this will mean that there will be twice as much light energy absorbed. This will, in turn, mean that twice as much energy will be available to split the water molecules, so twice as many molecules will be split, producing twice as much oxygen. Therefore, my second prediction is that as light intensity is doubled, no. of oxygen bubbles

produced per minute will double also. As this will produce a graph which shows astraight line through the origin, I can conclude that the two variables will be proportional.

As can be seen from the preliminary work, this pattern would increase until a limiting factor came into effect. However, due to the use of sodium hydrocarbonate, the limitation will not come into effect with carbon dioxide or any of the variables listed in the variables table. Therefore I propose that the graph will not level off as would be expected.

Method:

To begin, the lights were turned off so that there was no light coming into the classroom Then a beaker was taken and filled with 200cm^3 water. The light source was taken and placed 10cm away from the beaker. The reading in volts was observed and recorded. The Canadian pondweed was then placed in the water, as shown in the diagram, and the stopwatch was started. The number of bubbles produced in one minute was observed and recorded. This process was then repeated with the lamp at distances of 20, 30, 40, 50 and 60cm from the beaker. Then the whole process was repeated in order to obtain an average result.

Diagram:

Results:

Volume of water (cm^3)	Distance from lamp (cm)	Light Intensity (mV)	No. bubbles produced per minute			Average
			1	2	3	
400	10.0	322	161	160	164	162
400	13.0	313	133	131	137	134
400	20.0	255	99	93	84	92
400	30.0	192	68	60	60	63
400	40.0	143	45	42	39	42
400	50.0	107	33	35	34	34
400	60.0	83	30	26	25	27
400	70.0	68	22	23	21	22
400	80.0	55	19	18	19	19
400	90.0	46	16	17	16	16

max L.I. = 500 mV
room L.I. = 7 mV
temp = 22^{o}c