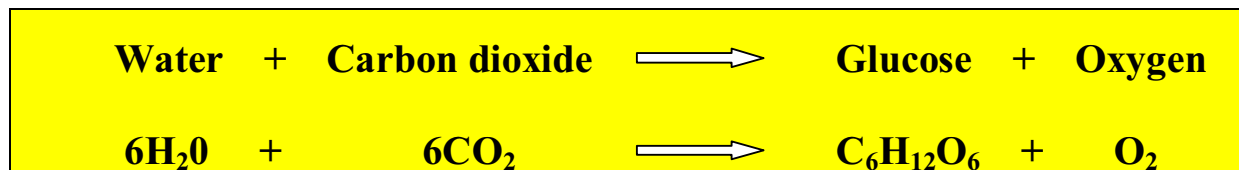


Biology Coursework

Aim

I am going to investigate the effect of light intensity from a lamp projecting its rays onto some Elodea pondweed, - to test the rate of photosynthesis. The rate of photosynthesis is expressed in the equation:



Apparatus

This experiment requires the following equipment:

- Elodea pondweed
- Sodium Hydrogen Carbonate NaHCO₃
- Capillary tube attached to a syringe
- A stopwatch
- A clamp stand

Method

- First cut a piece of elodea pondweed about an inch long and put into a syringe
- Then with a finger over the end of the syringe, pour the NaHCO_3 solution into it, until the syringe is $\frac{3}{4}$ full.
- Then with finger still over the end, insert the plunger and press hard to release bubbles.
- Attach syringe via tubing to the capillary tube.
- Then after tapping the bubbles away, push solution down to the foot of the capillary tube by pushing down the plunger.
- Next pull the plunger gently upward and watch the oxygen bubble rise. Pull until a relevant measuring point is found.
- Attach plunger to a clamp stand and elevate in the air.
- Then shine a light at a measured distance away from the syringe, at 5cm for example.
- Next, start the stopwatch when the bubble in the capillary tube starts to descend in the capillary tube.
- Then stop the watch after 3 minutes and read off the tube how far (in cm) the bubble has moved, e.g. 1cm.
- Repeating the experiment from same distance twice more in the same process as before and record results. The table will have distance lamp was away, distance travelled.
- Then continue experimenting, using different varieties of measurements away. E.g. 10 and 15 cm.

Fair test

To make the experiment fair we have used the same bulb wattage (60 watts) each time. This is to enable the same light intensity on the syringe. Different bulbs would either speed up or down the process depending on the wattage, this would give unreliable results.

Also using the same solution (NaHCO_3) in the syringe is vital. Because it is carbon dioxide based, this enables photosynthesis to be speeded up. This is because the pondweed is feeding Carbon dioxide (which is within the solution) to the pondweed and therefore photosynthesising. If the solution changed during the experiments then results would be fiction.

Control

This is needed to check that if the plant was eliminated from the tray and the solution remained, that oxygen would still be produced. If the pondweed was removed and then had a light shined upon it, would it still produce oxygen in the capillary tube? This makes the control experiment.

Range

In the result collation, I will be ranging the distance the lamp is away from the syringe. The distances I am using are 10, 15, 20, 25 and 30 cm away. These distances will be measured for three minutes each and taken three times each.

Timing

The time is the same in each test and will have three minutes duration. The rate of photosynthesis is calculated by:

$$\frac{\text{Distance (oxygen moved in capillary tube)}}{\text{Time (3 minutes)}} = \text{Speed}$$

This will measure the rate of photosynthesis to plot onto a graph.

In addition, another formula that I will be using is that of light intensity. It is:

Background knowledge

Plants can only photosynthesise in daytime hours, but do respire like humans all day long. I have tried to simulate this light dependant reaction, by a lamp (in place of the sun) shining on the syringe. From the formula of photosynthesis, water and carbon dioxide are needed as inputs to the process. In our experiment, the gasses both come from the sodium hydrogen carbonate (NaHCO_3) solution, encapsulated in the syringe. The lamp then is shone onto the pondweed (light being a throughput to the formula) acting as sunlight. The carbon dioxide from the solution enters the cells of the pondweed and it is exchanged in the chlorophyll and released into the syringe, to

then travel to the capillary tube. This after time forces the level of oxygen in the capillary tube down. This is what gives us the results.

Prediction

I think that the further the lamp is placed from the syringe. The slower the rate of photosynthesis will be. This is because the further away the lamp is, the less concentrated energy is available on the rays hitting the syringe. I will test results from 10, 15, 20, 25 and 30cm away from the syringe. This should establish a trend in the results. The results will be lower as the distance increases because the light has to travel further through the air to reach the lamp, so the light intensity would be higher for the lamp at 10 cm than at 30cm.

Preliminary testing

We used preliminary testing to establish the distances and timings for our results. We decided to set the experiment up and set the lamp away at 5cm. Then wait for the bubble in the capillary tube to move and then start watch. We timed for 8 minutes and took results after every minute.

Total distance moved in tube (cm)	Distance moved in tube each minute (cm)
5	5
6	1
8	2
9	1
10.5	1.5
11.5	1
13	1.5
14	1

Here it shows steady results over the period. After this, I decide to change the first distance to 10cm and only have three minutes on each experiment. In total, we hope to complete 20 experiments. Testing each of the five lengths four times.

Obtaining results

Here are my results that I have collated. The results for the distance away and distance oxygen moved were calculated myself, but the rest were calculated by the computer on excel. I checked over them by hand and achieved the same. I thought that putting it onto a computer would and did save time.

Lamp Distance (cm)	Moved in capillary tube (cm)	Speed Dis/time (cm/min)	Light intensity	light intensity x 1000
10	0.9	0.30	0.01000	10.000
10	1.6	0.53	0.01000	10.000
10	1.3	0.43	0.01000	10.000
10	1	0.33	0.01000	10.000
15	0.6	0.20	0.00444	4.444
15	0.7	0.23	0.00444	4.444
15	0.5	0.17	0.00444	4.444
15	0.5	0.17	0.00444	4.444
20	0.6	0.20	0.00250	2.500
20	0.2	0.07	0.00250	2.500
20	0.1	0.03	0.00250	2.500
20	0.2	0.07	0.00250	2.500
25	0	0.00	0.00160	1.600
25	0	0.00	0.00160	1.600
25	0.1	0.03	0.00160	1.600
25	0.1	0.03	0.00160	1.600
30	0	0.00	0.00111	1.111
30	0	0.00	0.00111	1.111
30	0	0.00	0.00111	1.111
30	0	0.00	0.00111	1.111

Analysis

From the results, I have been able to plot two graphs. One of speed and distance, and the other of speed and light intensity. Speed has been calculated by the distance moved inside the capillary tube divided by time. This was the time in minutes used for all experiments. It shows a negative correlation because the speed decreases as the lamp moved further away from the syringe. The best fit line is a downward curve to the right; this shows the deterioration of speed. This is because the further away the lamp is the more air the light has to pass through. Therefore, at 5cm, maybe the speed was quicker but this is only theoretical.

I have two columns for light intensity in my results table. This is to show the real value, which is small, and the light intensity multiplied by 1000. This is to make it easier to plot results onto a graph.

The second graph shows the relationship between speed and light intensity multiplied by 1000. This graph shows the speed decreasing as the light intensity decreases. The best-fit line shows this. It curves upward and to the right. From the graph the assumption maybe that the higher the light intensity the faster the speed is.

I believe my results answers my prediction, because on both graphs as the control moves (the x-axis, because I control what distance or the distance determines the light intensity) the speed decreases. So therefore, the smaller the amount of light that is shined onto the pondweed the slower the rate of photosynthesis and speed is.

In addition, I have found the light intensity is greater at 10cm than at 30cm by using the formula.

Evaluation

My results were accurate to a certain point. They're maybe some human error because we may have started the stopwatch too early or too late after the oxygen bubble had moved. In addition, the results called out may have been rounded up and so results may be changed slightly. Overall, I thought I had good results and they gave me good opportunity to make a good graph.

I had only one anomalous result, which was at 10cm away. It was that it had moved 1.6 cm, whereas the other results at that distance were 0.9, 1.0, and 1.3cm. You will see it on the graph.

The results may have been biased because December is not really the time for growing elodea pondweed. In addition, the pondweed we used each time may have been of a different length or maybe a old piece from a previous experiment. This may of sudee my results.

I could have improved my results by using a dark box placed over the experiment to keep the light in. Also, by using the same length piece of pondweed and a different piece every time. Also maybe trying different distances away from the syringe like 5cm or 7.5cm and so on.

I think that my results resembled my prediction and my preliminary testing. It showed that the further away the lamp is the slower the rate of photosynthesis will be.