SCIENCE COURSEWORK
PHOTOSYNTHESIS

Aim:

The aim of my experiment is to find out how light intensity affects the rate of photosynthesis in elodea (pondweed). To do this I will place the light intensity to various distances and observe the amount of oxygen bubble given off from the reaction

Prediction:

I predict that as the light intensity changes the rate of photosynthesis will increases of decreases dependent on the amount of light intensity. This will be observed by counting the amount of oxygen bubble given off from the reaction. The oxygen bubbles are given off as a waste product of the plant.

Hypothesis:

I hypothesised that if the light intensity increases, the rate of photosynthesis will also increase until a certain level is reached. After, the rate of reaction will than fall down, ultimately increase in light intensity will no longer affect the rate of reaction. This is because other factors effecting rate of reaction will be limited for example: carbon dioxide and temperature.

Preliminary work

To check if the range that I chose for my experiment were correct I carried out a preliminary investigation in which I counted the amount of oxygen bubble given off from the reaction at several distances in a given time. To adjust different light intensity I used a lamp at various distances from the reaction of the pondweed. I used the meter ruler to measure the various distances from the plant.

Table of result (preliminary work)

amount of sodium carbonate (g)	Amount of water(HCl) (ml)	Amount of pondweed (g)	Time (min)	Distance of length from the lamp (cm)	Number of oxygen bubble given off			
					1st reading	2nd reading	3rd reading	Average
3	1350	1.1	2	10	121	121	125	122
3	1350	1.1	2	20	67	52	61	60
3	1350	1.1	2	30	19	18	23	20
3	1350	1.1	2	40	15	18	21	18
3	1350	1.1	2	50	6	5	6	5

From my opinion I think this experiment was accurate enough to be the foundation for my main experiment because it gave me a good set of results which were reliable since it met my prediction and hypothesis which was, as the light intensity increases the rate of reaction also increases so the closer the lamp to the reaction the more oxygen bubble were given off. The preliminary experiment also helped me to check if the range of 10, 20,30,40,50 were good enough to give me a good set result which I can draw a graph too. The graph for this result was accurate because it gave me a good best fit curve I think it was simple and efficient way of obtaining an idea of the trends for the graph

Variables

Independent variable	Dependent variable	Control variable
• The distance from the through - this is to make sure that the light intensity varies, so that we obtain an adequate range of result. To make it reliable I used measurement meter ruler to measure the distance	• Number of oxygen bubble given off – this is a result of the reaction pondweed takes in carbon dioxide (from the sodium hydrogen chloride) and Water to produce oxygen, this is noticed by the volume of oxygen produced in a minute, and there for finding the rate of photosynthesis	• <u>The amount of pondweed</u> - is kept the same because the increase in pondweed the higher the rate of photosynthesis, so keep it constant I used the same pondweed through out the experiment. • <u>Water</u> - this is also required in the reaction of photosynthesis and it is important that it is kept constant thought out the experiment because water can also effect the rate of photosynthesis, how ever in a water plant like a pondweed, as long as the plant is fully submerged in water all the time there is no a problem of keeping the water constant. • <u>Sodium hydrogen carbonate</u> - kept constant to keep the carbon dioxide even as it varies in photosynthesis, so I would make sure that fixed amount of sodium hydrogen carbonate is in the water and also that it is sufficient for the whole experiment to take place so it doesn't become a limiting factor during the experiment. • <u>Temperature</u> – temperature also effects the rate of photosynthesis temperature will increase the rate of photosynthesis, until a point at which the enzymes denature, so it is important to keep the temperature constant so I have chosen to keep the temperature at the room temperature, to make it stays steady I am going to put the thermometer in to the water and check it frequently to make sure it stays to room temperature, some time the light given off from the lamp also increases the temperature so I am going to use a screen in front of the lamp to prevent the heat from the light so it is fair.

		• Light wavelength – this can simply be controlled by keeping the same lamp to the same amount of light given of through the whole experiment.

Apparatus used:

- Pond weed – of the experiment
- Lamp – for the light
- Thermometer – check the temperature
- Water -
- Funnel – to keep the pondweed in the same place
- Screen – to allow light and prevent heat
- Trough -
- Boiling tube
- Spatula
- Stop watch
- Mass balance
- Sodium hydrogen carbonate
- Meter ruler

Drawing of how the apparatus was assembled:

Method:

1. I Collected all the equipment that were needed
2. Then filled the sink with water.
3. Later on, I then filled the trough with water.
4. I than set the pondweed in the funnel
5. And covered the top of the funnel with boiling tube so the oxygen in the air would not affect my experiment.
6. I added a small amount of Sodium Hydrogen Carbonate (3g) to the water, which was under the funnel using a spatula.
7. I than placed the lamp at the first distance (10cm); lamp was switched off.
8. I placed a thermometer in the water.
9. Then I set/reset the stopwatch.
10. I then switched on the lamp and started the stop watch at the sight of the fist bubble.
11. I used the stopwatch to time for 2 minutes in order for me to calculate how many bubbles were being produced.
12. I then switched off the lamp and took the reading down.
13. And used the same method to get the reading for other distances.

Fair test:

- to make the experiment fair I maintain the control variable which were:
  - The amount of pondweed was kept the same through out the experiment.
  - Water kept constant thought out the experiment.
  - Keep the temperature constant at the room temperature.
  - Use the same lamp through out the experiment
- The experiment was done 3 times.
- Stop watch was used to time the reaction
- Same people counted the bubbles through out.
- Have 2 people counting the bubbles to make it more fair.

Safety:

- Wear goggles through out the experiment.
- Do not touch the lamp as it might be hot.
- Do not touch electrical equipment with wet hands.
- Do not look into the lamp while on as it might effect the eye.

Range:

- 10cm
- 20cm
- 30cm
- 40cm
- 50cm

How the collected data was made reliable:

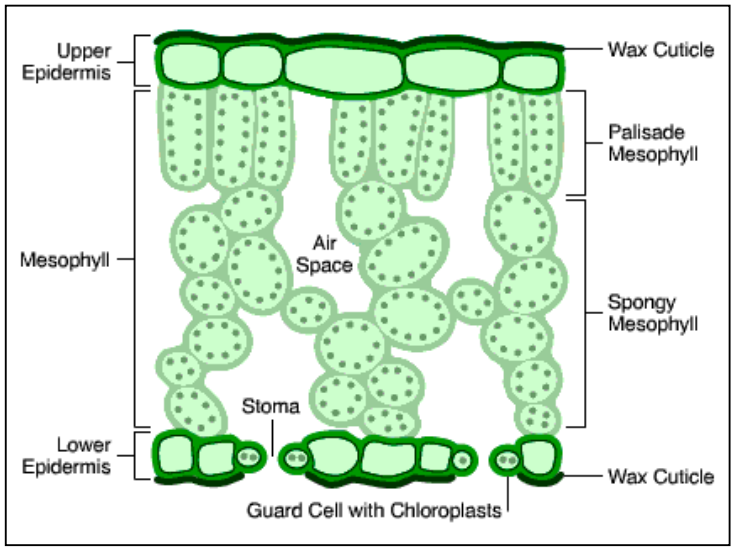
- I used a wide range of distances – 5
- Done the experiment 3 times so its reliable
- Averaged out the 3 readings

PHOTOSYNTHESIS

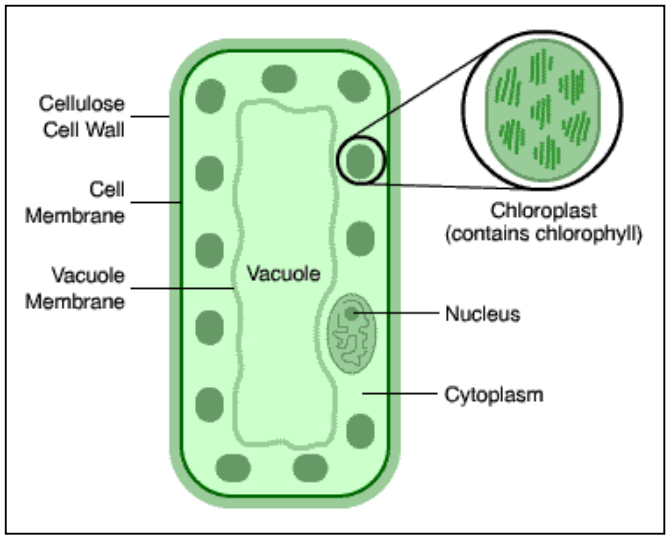
THE PROCESS OF PHOTOSYNTHESIS:

Photosynthesis is the chemical process change which happens in the leaves of green plants. It is the first step towards making food not just for plants, but ultimately for every animal on the planet as well. During this reaction, **carbon dioxide** and water are converted into glucose and **oxygen**. The reaction requires energy in the form of sunlight, and **chlorophyll** must also be present.

The glucose produced in the photosynthesis reaction can be converted to sucrose and carried to other parts of the plant in **phloem vessels**. Glucose can also be converted into **starch** and stored (the starch can later be turned back into glucose and used in respiration). Oxygen is a 'waste' product of photosynthesis.



Photosynthesis takes place primarily in plant leaves, and little to none occurs in stems, etc. The parts of a typical leaf include the **upper and lower epidermis**, the **Mesophyll**, the **vascular bundle(s)** (veins), and the **stomata's**. The upper and lower epidermal cells do not have chloroplasts, thus photosynthesis does not occur there. They serve primarily as protection for the rest of the leaf. The stomata's are holes which occur primarily in the lower epidermis and are for air exchange: they let CO_2 in and O_2 out. The vascular bundles or veins in a leaf are part of the plant's transportation system, moving water and nutrients around the plant as needed. The **Mesophyll** cells have chloroplasts and this is where photosynthesis occurs.



There are two kinds of Mesophyll cells - **palisade Mesophyll** and **spongy Mesophyll**. The Mesophyll cells contain tiny bodies called **chloroplasts** which contain green chemical called **chlorophyll**. Chlorophyll enables the light energy from sunlight to be converted into chemical energy for the photosynthesis reaction.

Conditions needed for photosynthesis

Photosynthesis needs:

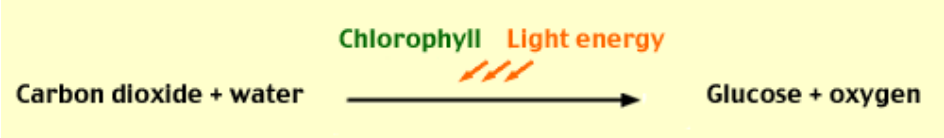
- chlorophyll
- carbon dioxide (from the air)
- water (from the soil)
- sunlight energy (any light will do except green light)

Photosynthesis produces:

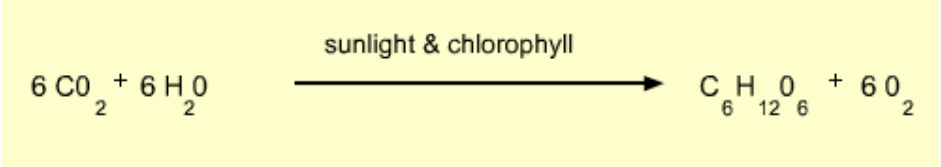
- glucose
- oxygen (a waste product)

Chlorophyll and **light energy** both need to be present for **photosynthesis** to take place, but they are not actually part of the reaction - they are not used up.

Word equation for photosynthesis:



Symbol equation for photosynthesis:

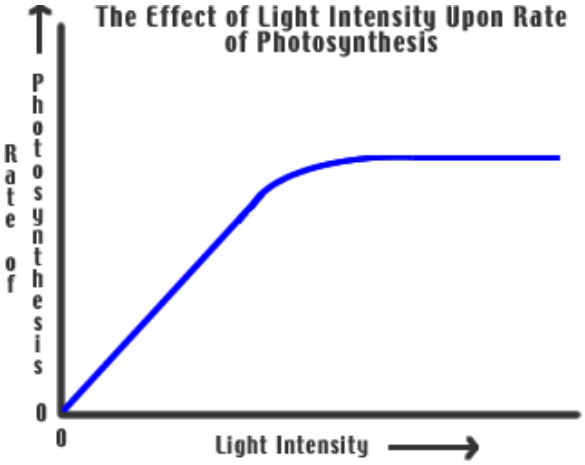


FACTORS AFFECTING PHOTOSYNTHESIS:

Factors which affect the rate of photosynthesis include, light intensity, temperature and carbon dioxide concentration. Each factor affects a different ratelimiting step.

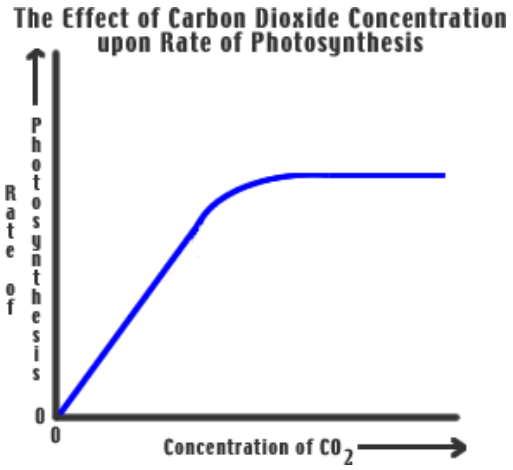
How Light Intensity affects photosynthesis:

As light intensity increases, the photosynthetic rate increases until a point is reached where the rate begins to level off. At low light intensity, photosynthesis occurs slowly because only a small quantity of ATP and NADPH is created by the light dependent reactions. As light intensity increases, more ATP and NADPH are created, thus increasing the photosynthetic rate. At high light intensity, photosynthetic rate levels out, not due to light intensity but due to other limiting factors, including competition between oxygen and carbon dioxide for the active site.



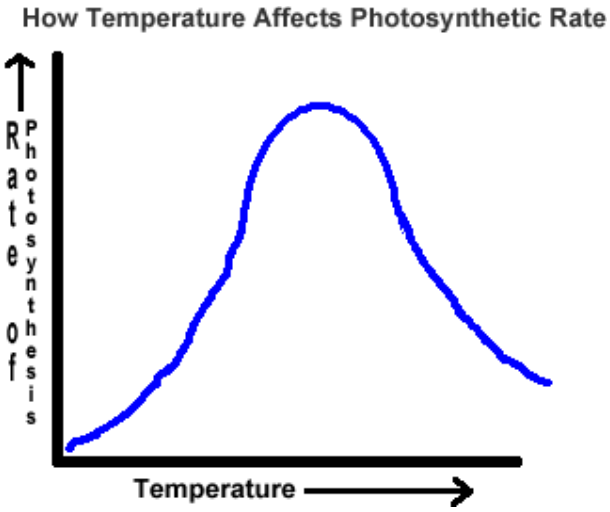
How Carbon dioxide affects photosynthesis:

As carbon dioxide concentration increases, the rate of photosynthesis increases. At high concentrations, the rate of photosynthesis begins to level out due to factors not related to carbon dioxide concentration. One reason might be that some of the enzymes of photosynthesis are working at their maximum rate. In general, carbon dioxide is found in low concentration in the atmosphere, and so atmospheric carbon dioxide levels may be a major limiting factor on photosynthesis when at low levels.

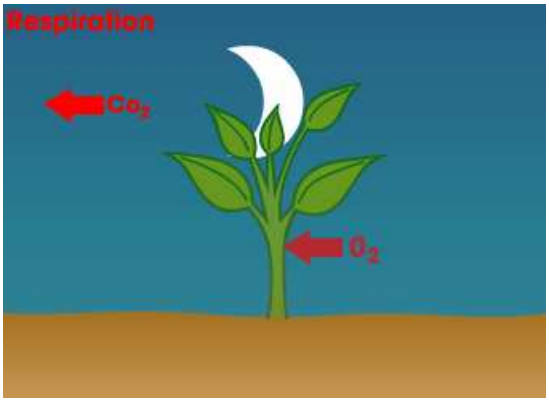


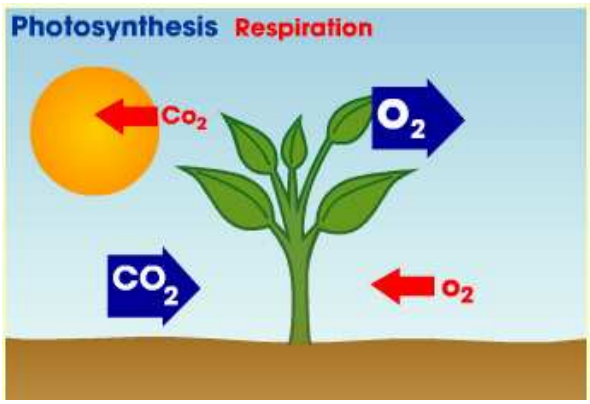
How Temperature Affects Photosynthetic Rate:

As temperature increases above freezing, the rate of photosynthesis increases. This occurs because molecules are moving more quickly and there is a greater chance of a collision resulting in a chemical reaction. At some point, a temperature is reached that is an optimum temperature. The photosynthetic reaction rate is at its quickest rate at this point. Above that temperature, the enzymes begin to denature, slowing the rate of photosynthesis until a temperature is reached where photosynthesis does not occur at all.



Photosynthesis and respiration





To unlock the energy in the carbohydrate produced in photosynthesis, green plants need to respire, just as animals do. Respiration takes place in the plant's cells, using oxygen to produce energy and giving off carbon dioxide as a waste product. So in terms of the gas taken in and the gas given out, respiration is the opposite of photosynthesis.

The result is that during the day when the plant is both respiring and photosynthesising there is a two-way traffic of oxygen and carbon dioxide both into and out of the plant.

During the night when the plant is respiring but not photosynthesising, oxygen is being taken in but not given out - and carbon dioxide is being given out but not taken in.

Plants use up more carbon dioxide in photosynthesis than they produce in respiration, and produce more oxygen while photosynthesising than they use up while respiring.

Table of result (final)

amount of sodium hydrogen carbonate (g)	Amount of water (ml)	Amount of pondweed (g)	Time (min)	Distance from the lamp (cm)	Number of oxygen bubble given off			
					1st reading	2nd reading	3rd reading	Average
3	1350	1.1	2	10	119	121	128	122
3	1350	1.1	2	20	62	54	63	60
3	1350	1.1	2	30	17	18	21	19
3	1350	1.1	2	40	14	16	17	15
3	1350	1.1	2	50	5	4	6	5

Analysis

From my graph I found out that the rate of photosynthesis decreased as the light intensity decreased. This is because photosynthesis is a reaction, which needs light energy to work, so as the amount of energy from the light intensity decreased so did the amount of photosynthesis thus less oxygen bubbles were given off.

In addition, I saw that there is a pattern on my graph which was, as the distance of lamp is decreased the number of bubbles increases. As I expected in my hypothesis; that if the light intensity increases, the rate of photosynthesis will also increase so if the lamp is moved near the trough there will be more oxygen bubbles given off since the light intensity is increased.

From these results I am able to conclude that as the light intensity increases more water molecules are split by photolysis which means more oxygen bubbles would be produced this shows that the rate of photosynthesis has also increased.
However my result doesn't show a definite conclusion because there are were other factors that were affecting the rate of photosynthesis such as carbon dioxideand the temperature which as a result produced an anomalous point on the graph.

Overall, my graphs and results support my prediction fully. My idea that the rate of photosynthesis would increase with light intensity was comprehensively backed up by my results.

Evaluation

In my opinion I think that this experiment was quite successful overall, since I followed the way I did my preliminary experiment as it was accurate enough to be the base of my final experiment. The method that I used was accurate enough to give me a reliable data however there were some error which affected my results such as the heat generated by the lamp. As I have earlier described, temperature has a very noticeable effect on the rate of photosynthesis, to stop this I used the screen in front of the lamp so the heat does affect the process of photosynthesis yet because the screen was quite small the heat escaped and affected the reaction. Another error was counting the bubbles; because I counted the bubbles visually I think it made the experiment unreliable therefore to make my experiment reliable and fair next time I would use a gas syringe to measure the volume of oxygen given out from the process of photosynthesis.

I think that the result that I found was reliable overall because on my graph there was only one anomalous point which didn't fit the curve of best-fit this might have been because of one of the reasons from the errors which I mentioned earlier in the evaluation might have affected the result at that point

Overall, I felt that due to the small volumes of oxygen involved, my experiment was not as accurate as it could have been, however I believe the result that I got from this experiment was accurate enough to support and justify my hypothesesand prediction.