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Investigating how the amount of oxygen given off by Pond weed, when the environment is changed.

Aim: My aim is to do a well planned safe experiment. It should show clearly how the amount of oxygen given off by pond weed can be changed by changing the environment.

Photosynthesis Equation:

$6CO_2 + 6H_2O$ light energy & chlorophyll $C_6H_{12}O_6 + 6O_2$

Carbon dioxide + water carbon hydroxide + oxygen

List of Equipment:
When choosing the equipment for my investigation I have to take into account which will be the most appropriate for the task.

* beaker 200ml
* Thermometer
* Stop watch
* Funnel
* 5cm piece of pond weed (Elodea)
* water
* lamp
* 25w, 40w, 60w, 75w, 100w bulbs
* test tube

Variable:

These are some possible variables I could use:

* I could change the intensity of the light shone on the pond weed. I would do this by testing the amount of oxygen given off after a period of time, using different wattage bulbs.

* I could change the colour of the light shone on the pond weed. I could easily do this by covering the head of the lamp with coloured translucent material.

For the variable in my experiment I will be changing the Intensity of the Light shone apon the pond weed. The different wattage which I will use are 100w, 80w, 60w, 40w, 20w. Once I have allowed for the light to start effecting the weed I will be able to see how much oxygen is produced in a set time.

Fixed Variables:

These are the fixed variables which I am going to have in my investigation:

* Light wavelength - The colour of the light should remain the same all thought my experiment, this will be done by using the same lamp throughout. I could Change this easily by coating the beaker in coloured transparent material.

* The plant - should say as elodea, Which is the species of pond weed I will be using throughout my experiment, changing this would result in un-fair results. As some plants may photosynthesise more than others.

* Carbon dioxide - The concentration of CO2 in the water should remain constant as this can affect the amount of oxygen produced. The concentration of CO2 in the water can be controlled by adding sodium hydrogen carbonate.

* Temperature - the temperature should remain constant throughout the experiment as temperature can increase enzyme reaction. This can be controlled by applying heat from a water bath or Bunsen burner, the temperature could be decreased by applying ice in the correct amount.

Temperature affecting molecules

Safe Test:

I will make this a safe test by doing the following:

* I will roll up the sleeves to my shirt to make sure that they don't get in the way of the experiment or knock any objects over causing hazard.
* I will make sure that I tuck my tie into my shirt to avoid it catching of objects and causing hazard.
* I will make sure that when I am dealing with hot objects in the experiment I am careful not to burn myself or others.

Fair test:

To make it a fair test I will:

* I will do each of the wattage three times to allow for any outlying results
* I will be careful to use the same amount of pond weed in each batch, this should be roughly 5cm. This should prevent pieces of pond weed having a advantage over the other, because of the larger surface area.

* I will also make sure that I change the piece of pond weed that I am using each time, so as not to bias the order in which I record my results.
* I will also make sure that the water temperature is constant throughout all the batches, this should be between 29 and 30?C at all times.

Diagram:

Method:

1. First set up the equipment as is shown in my diagram above, leaving out the pond weed, funnel, test tube and water.
2. Then fill the beaker with 400ml of water.
3. Take one of the pieces of pond weed and place inside the beaker, with the funnel over the top upside down.
4. Then place a filled test tube full of water over the top of the funnel as shown in my diagram.
5. Set up the first lamp with the 20w bulb, Allow the plant to adjust to the light intensity (equilibrate) for 2-3 min.
6. Start the stop watch and count the number of bubbles produced by the pond weed for a period of 60 seconds, recording these.
7. repeat this three times, to allow for outlying results, also so a average is obtainable.
8. repeat step 5, 6 and 7 with a 40w, 60w, 80w and 100w bulbs.

Prediction:

I predict that as I increase the light intensity I will notice a clear increase in the amount of oxygen produced, due to how the rate of photosynthesis is affected by the intensity of the light. The increase in Oxygen produced should be roughly proportional to the increase in light intensity. The increase in oxygen produced should continue to rise, as the wattage is increased until a optimum point is reached . This is where the light intensity is no longer the limiting factor. The graph of my results will probably look something like this as seen in graph 2.
Graph 2

Scientific knowledge:
Plants use green pigments called chlorophylls to trap light energy. The chlorophylls give a plant its green colour. The Chlorophyll is one of the several pigments present in leaves, the main ones being Chlorophyll, Xanthophyll and Carotene. These all help to capture light energy, of which chlorophyll is still the main. Once the light energy is captured by the Chlorophyll it is transformed into chemical energy in sugar molecules. Chlorophyll absorbs Blue and Red light wavelengths. As I will be using only white light which contains all the colours of the spectrum I should not have any problems. Inside the cells that have

Chloroplasts, the light energy is used to make a simple sugar called glucose. The process by which plants use light energy to make glucose is called photosynthesis. during this process of sugar production, carbon dioxide combines with water to form glucose and oxygen is released. Oxygen that is produced in photosynthesis is given off as a gas. If a lot of oxygen is being given off, photosynthesis is occurring rapidly. If little oxygen is being given off, photosynthesis is occurring slowly. The amount of trapped light energy and the amount of carbon dioxide available affects the rate of photosynthesis. Photosynthesis is a two stage process. The first process is the Light Dependent Process (Light Reactions), requires the direct energy of light to make energy carrier molecules that are used in the second process. The Light Independent Process (or Dark Reactions) occurs when the products of the Light Reaction are used to form C-C covalent bonds of carbohydrates. The Dark Reactions can usually occur in the dark, if the energy carriers from the light process are present. The Light Reactions occur in the Grana and the Dark Reactions take place in the Stroma of the chloroplasts.

As in my experiment I am going to be changing the wattage of the bulbs, I should easily be able to predict that the amount of oxygen produce will increase. As a watt is a unit of power, or work done per unit time, equal to 1 joule per second. It is used as a measure of electrical and mechanical power. One watt is the amount of power that is delivered to a component of an electric circuit when a current of 1 ampere flows through the component and a voltage of 1 volt exists across it. So basically the greater the wattage the more power that is applied to the device. So as I increase the wattage of the bulbs there is more power being used, and as more power is used more power is transferred to photosynthesis in the plant. So the rate of photosynthesis will increase as the watts do. This will only continue until the rate is stopped by other limiting factors, such as when all the carbon dioxide in the water is used up the reaction will stop. This can be clearly shown using graph 2 above as an example.

Results:

Bulb wattage (W)	1st try bubbles per min	2nd try bubbles per min	3rd try bubbles per min	average bubbles per min	temperature (°C)
25w	3.0	3.0	4.0	3.3	29.0
40w	4.0	6.0	6.0	5.3	29.0
60w	10.0	8.0	9.0	9.0	29.5
75w	17.0	19.0	17.0	17.7	29.5
100w	26.0	30.0	32.0	29.3	30.0

Conclusion:

From the results I have gathered I can clearly say that the light intensity does increase the rate of photosynthesis in the plant. This will have happened due to when I increased the intensity of the light the result would be more energy being caught in the chlorophyll. Allowing more of the simple sugar called glucose to be created, as a product of the reaction. The more glucose being created the greater the rate of photosynthesis. I noticed the increase in energy by observing the number of oxygen bubbles being produced by the chemical reaction. These bubbles were oxygen which is the waste product of the photosynthesis reaction. Photosynthesis is the process by which all plants must complete to survive, where by Carbon dioxide and water are taken by the plant cells from the surrounding environment. These are used for the photosynthesis reaction, resulting in the final product of oxygen and glucose. The oxygen is released as a waste product and is what I was seeing when observing. So more Oxygen is produced when the reaction is greater and I will of seen far more bubbles. The glucose is distributed and used as food allowing the plant to grow and survive. So the number of bubbles being produced increasing is a very good indicator of the rate of photosynthesis also increasing, proving my prediction. In my prediction I thought that the increase in reactivity would be roughly proportional to the increase in wattage This is only very roughly shown, as the graph shows my results to rise at a roughly proportional rate until the limiting factors enter. This is good thought, as I also predicted that this would happen. From graph 1 you can clearly see that although the rate of photosynthesis is increasing as the wattage does the rate at which it is increasing is accelerating. This is shown where graph 1 starts to have larger gaps in the number of bubbles per minute. I also gave an example of this in graph 2 in my prediction. From my results and the graph you can also see that where the wattage of the bulb is decreasing the rate of photosynthesis is also, but this action is decelerating and flattening out. Proof that the wattage is proportional to the amount of bubbles given off would be that when 0w is used and there is no light energy photosynthesis is impossible. When this is plot on a graph the line of best fit would be shown to go through the origin, thus there is some proportionality between the two. In my results I went up to using a 100w bulb, at this point the rate of

photosynthesis was still accelerating, this I do believe would have started to plane off when the rate of reaction is stopped by other factors affecting the reaction, this would have been carbon dioxide or temperature, limiting the rate of reaction.

Evaluation:

I overall think that my experiment has been fairly successful, since my predictions where proved by my results. This is a good reflection of my success in my prediction was good and logical. Also I accomplished all that I set out to prove. This investigation was probably not carried out as accurately as it could have been. This is due to some conditions which where uncontrollable. While performing the experiment, the piece of pond weed did not photosynthesise at a balanced rate, even when the wattage of the bulb is unchanged. An example of this is the fact that my first result for 100w was quite far away from others. This was still not enough thought to be called an anomalous result. In the whole experiment I only encountered one anomalous result at 60w, this I decided was too far away from previous pilot attempts so I recorded a new result instead. Overall I found there to be far less anomalous results than I was expecting, and most of my results seemed more of less to correlate with the others. A large factor in accuracy for my experiment is the issue of human error, as at some points in my experiment, especially when using the higher wattage, I found that I was finding it quite hard to count the number of bubbles being produced, accurately. I would estimate that the margin for error present due to the speed of the bubbles being produced would not exceed 4 bubbles. To possibly make this more reliable I could have continued with more repetitions to give a more accurate result.

There are many factors which could have affected the results of my experiment, some of these I explained earlier and could not be controlled under the circumstances, others where also variables considered but not initially controlled. The Oxygen which was produced from the elodea could have gone to many places, some may have dissolved into the water or been used but algae or other micro organisms in the water or pond weed. Although the amount used my them is probably irrelevant to my results since the degree of

accuracy I used was too low. In my experiment I was measuring the number of bubbles to come off the pond weed, not the volume of them. Its is likely that when using the lower wattage bulbs the size of the bubbles produced by the pond weed will of decreased in size. This was also one of my observations in the experiment as I noticed the bubbles where getting bigger as the wattage increased. This would probably make my results less accurate as the number of bubbles for the higher wattage would have been far more if all bubbles seen produced in the experiment where of the same volume. This change in bubble size was not accounted for in my analysis. For more correct accurate results I could have used a gas syringe to collect the exact amount of oxygen produced. Other factors where present when I was measuring the lower light intensities as there is some light energy present from background lighting. This was stopped as far as possible by shutting the blinds and turning off all the lights. But even then other peoples lamps where providing some light, but probably of an insignificant amount. The temperature was also another factor which could affect the rate of photosynthesis. This was a problem as most of the energy from a lamp is heat energy, so this could increase reaction speed. To make sure this was not happening we measured the temperature, which stayed between 29.0°C and 30?C. The method for my experiment could also be improved to generally increase the quality of my results. As I said before a gas syringe could be used to collect all the gas for greater accuracy. I also said that I was finding counting the number of bubbles a problem, this could be solved by only testing the rate of photosynthesis over a shorter period, such as 10seconds. Measuring over a shorter period of time will reduce the chance of human error as there are fewer bubbles to count and they are over a shorter period of time. Because of the way my experiment is set up it is easy for me to adapt to measure another variable of photosynthesis. As it is possible to control the amount of carbon dioxide in the water by using sodium hydrogen carbonate ($NaHCO_3$). This could be easily done by using different volumes of $NaHCO_3$. All other variables will be kept at constants. Another possible adaptation would be to alter the wavelength of the light used for photosynthesis. This would be done my using translucent colour filters in front of the lamps. The only problem is that there is no way to define or

measure the wavelength of light. It is because of this point that we only have a basic way to
class colours, that the coloured light experiment would not be as affective or interesting as
light intensity or CO2 concentration.

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