Investigating the factors that will affect the rate of photosynthesis

Aim: I will be investigating how light intensity affects the rate of photosynthesis, whether it decreases or increases the rate of photosynthesis.

Background Knowledge: Photosynthesis is the process by which plants make their own food. For photosynthesis to occur, plants need:

- Light energy from the sun
- Chlorophyll to absorb light energy
- Carbon dioxide from the atmosphere and from respiration in plant cells
- Water which is absorbed by the roots and transported to the leaves by the xylem tubes.

Photosynthesis can be summarised by the equation:

$$6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$$

The reactants are Carbon dioxide and Water; the products are Glucose and Oxygen.

The factors that affect the rate of photosynthesis are:

- Light intensity- if the light is brighter, then the rate of photosynthesis increases and visa versa.
- Water supply- if a plant cannot absorb enough water, then the rate of photosynthesis decreases.
- Carbon dioxide concentration- if the percentage of carbon dioxide in the atmosphere increases, so does the rate of photosynthesis.
- Temperature- if the temperature increases, then the rate of photosynthesis also increases, (however, temperatures above $40^{O}C$ can damage a plant and photosynthesis stops because the chlorophyll gets too hot).

The factor I will be investigating is light intensity; how it affects the rate of photosynthesis.

The factors I will be keeping constant are:

- Water supply- by using same millimetre of water each time.
- Temperature- by using a thermometer to make sure the water is at the temperature each time.
- Carbon dioxide- by not adding any thing in the water which increase the carbon dioxide level, such as Hydrogen carbonate.

By keeping these factors constant I will only be investigating how light intensity affects the rate of photosynthesis and the other factors will not affect my results.

Prediction: I predict that the closer the lamp is to the plant the more oxygen bubbles will be produced, hence the higher the rate of photosynthesis, for example when the lamp is 10cm away from the Elodea plant, the number of oxygen bubbles produced will be the greatest, and the further away the plant is to the lamp, the lower the number of oxygen bubbles are produced, for example when the lamp is 60cm away from the Elodea plant the least number of oxygen bubbles will be produced. This is my prediction because my background knowledge tells me that the higher the light intensity, the higher the rate of photosynthesis (for this investigation more oxygen bubbles are produced) and the lower the light intensity, the lower the rate of photosynthesis (for this investigation less oxygen bubbles are produced), and also because of the fact that light energy is one of the reactants of photosynthesis therefore the more light, the more products are produced (the higher the rate of photosynthesis).

Apparatus:

1. Lamp- This will act as the sun, providing the light energy needed for photosynthesis. I will move the lamp away from the lamp step by step beginning at 10cm, finishing at 60cm.

2. Elodea- I will use this plant to investigate how light intensity affects the rate of photosynthesis, by counting the number of oxygen bubbles the Elodea gives out.
3. Thermometer- I will use the thermometer to observe the temperature of the water in the beaker so my test will be a fair test.
4. Stopwatch- I will use this to know when 1 minute is up, for 6 minutes so my test will be a fair test.
5. Metre ruler- I will this to measure the distance between the lamp and the Elodea.
6. Measuring cylinder- I will us this to measure the amount of water I supply the Elodea so that my test will be fair.
7. Clamp and stand- I will use this to hold up the boiling tube which Elodea will be in and photosynthesis will take place in.
8. Boiling tube- This is where I will put the Elodea plant along with some water, so photosynthesis will take place.
9. I will use this because it is one of the reactants of photosynthesis.

The measurements I will be taking are:

- The amount of water in the boiling tube, in millimetres.
- The distance between the Elodea and the lamp, in centimetres (10cm-60cm).
- The number of oxygen bubbles produced.
- The minutes of each interval for every minute, to about 5-8 minutes.

Safety:

1. Do not touch the light bulb as it will be very hot.
2. Keep the lamp and boiling tube away from the edge of the table so it does not fall as smash.
3. Tie back long hair and secure loose jewellery and items of clothing.
4. Do not touch the power supply with wet hands and make sure water is not poured near the power supply.
5. When pouring water, pour it in the sink.
6. Keep eyes on experiment at all times.

Method:

1. Set up apparatus as shown below.

2. Measure 10cm between the boiling tube containing the Elodea plant and the lamp.
3. Switch on the lamp and start the stop watch.
4. Count the number of oxygen bubbles produced in 5 minutes.
5. Record the result in my results table.
6. Repeat the experiment from steps 3-5 foe when the Elodea and lamp are at the following distances apart: 20cm, 30cm, 40cm, 50cm and 60cm.

Result Table:

Distance between the Elodea and the lamp (cm)	Number of oxygen bubbles produced in 5 minutes		
	1st experiment	2nd experiment	Average
10	14	16	15
20	6	6	6
30	4	5	4.5
40	2	2	2
50	1	2	1.5
60	0	1	0.5

The result table shows the number of oxygen bubbles the Elodea plant produces in 5 minutes, during photosynthesis, at each of the distances between the lamp and Elodea, for the first and second experiment and also and average of the number of oxygen bubbles produced for both experiments.

Analysing my evidence:
From my investigation I found out photosynthesis is limited immensely by light intensity: the greater the light intensity, the higher the rate of photosynthesis or the lower the light intensity, the lower the rate of photosynthesis (for this investigation, the more or less number of oxygen bubbles is produced).

The trend and pattern was that the closer the lamp was to the Elodea plant, the more oxygen bubbles are produced and when the further away the lamp was to the Elodea plant the less oxygen bubbles are produced, e.g. when the lamp was 20cm away from the Elodea, an average 6 oxygen, whereas when the lamp was 40cm away from the Elodea plant, an average 2 oxygen bubbles are produced.

My prediction that the closer the lamp is to the plant, the more oxygen bubbles would be produced and that the further away the lamp is to the plant the less oxygen bubbles would be produced was correct because when the lamp and Elodea were 10cm apart, an average 15 oxygen bubbles are produced, and when the Elodea and lamp were 40cm apart, an average 2 oxygen bubbles are produced.

From this I can conclude, as my result table confirms, that as light intensity decreases or increases, the rate of photosynthesis also decreases or increases. This is my conclusion because light intensity is one of the limiting factors of photosynthesis and also one of the reactants of photosynthesis therefore it will directly affect the rate of photosynthesis when increased or decreased (more evidently in this investigation as the other two limiting factors of photosynthesis, carbon dioxide concentration and temperature are keep constant).

My conclusion fully supports my prediction because my prediction stated that the rate of photosynthesis would decrease or increase when light intensity decreased or increased and this is also the final conclusion I have made therefore my prediction supports my conclusion substantially.

Evaluation:

My method worked very well; there were no results which contradict my background knowledge or prediction. My step-by-step guide was very helpful and my evidence obtaining procedure work well.

The quality of my result was quite high because I only had 2 anomalous results which's percentage of errors were not too great but 1 was over 10% and may be considered invalid but apart fro this most of my results are valid.

My procedure was very suitable because it did not cause any mistakes which could have caused shock and unexpected

results, so it is very suitable. To improve my work I could have repeated the experiment another 4 or 5 times to solidly confirm my conclusion and I could have do my experiments in a close area, where the temperature and carbon dioxide were 100% constant and therefore would not affect my results the slightest bit.

Percentage of error= error/what it should be *100
= 0.3/4.2 * 100
= 7.1%
This error is not over 10% and is insignificant, my result is therefore still valid.

Percentage of error=error/what it should be *100
=0.25/1.25 *100
=20%
This percentage is over 10% and can be considered invalid and is probably due to human error such as miscounting of the number of oxygen bubbles.