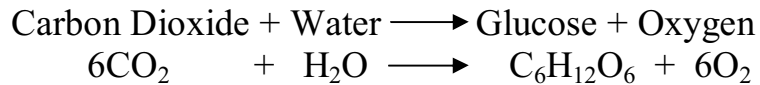


## Plan

### Introduction

All living organisms need food. Animals take in 'ready-made' food which they digest. They use the digested products for energy and to build new cells and tissues. Plants also require raw materials for building tissues and a source of energy. They manufacture everything they need out of simple ions and compounds available in the environment. The building up of complex molecules from simpler substances requires energy and enzymes. The enzymes are in the plants cells and the energy comes from sunlight. The process is called photosynthesis. Plants are able to absorb and use light energy because they have a green pigment, chlorophyll, contained in chloroplasts in some of their cells. Chlorophyll allows the energy in sunlight to drive chemical reactions. Chloroplasts act as energy transducers, converting light energy into chemical energy.

**Photosynthesis is the process in which light energy, trapped by chlorophyll, is used to convert carbon dioxide and water into glucose and oxygen.**



There are four main things which affect the rate of photosynthesis:

- Light intensity
- Carbon dioxide
- Water
- Temperature for enzyme activity

These are called limiting factors. Whichever one of these is furthest away from its optimum level most affects the rate of the overall process. For example, if a plant is in direct sunlight, the rate of photosynthesis will be high, as this is when the chlorophyll can absorb the most sunlight. In this investigation, we are controlling the rate of photosynthesis by altering the light intensity.

### Method

1. Set up equipment (as below)
2. Put 1 heaped spatula of sodium bicarbonate in water
3. Place light 25cm from the boiling tube
4. Switch light on
5. Count No. Of bubbles released for 1 min
6. Record in results table
7. Repeat 2-6 twice
8. Repeat 2-7 but decrease distance between boiling tube and pond weed to 20cm, 15cm, 10cm, 5cm and finally 0cm

### Equipment

- Pond weed (plant)
- Light Bulb
- Measuring Cylinder
- Boiling Tube
- Clamp stand/clamp
- Sodium Bicarbonate (releases CO<sub>2</sub> - used in photosynthesis)
- Stop watch
- Thermometer
- Spatula
- Metre rule

### Diagram

Fair test

To make this a fair test, there are a number of things which have to be controlled. The amount of sodium bicarbonate needs to remain constant to give a specific volume of carbon dioxide. I will use a heaped spatula. The temperature of the water and volume of water will have to be constant. The temperature will remain at room temperature, around 23 degrees C, and the volume of water at 40cm<sup>3</sup>. The amount light shining on to the experiment needs to be controlled, so the blinds were put down and the lights were turned off, and the lamps will be the only source of light.

Variation

The only variable in this investigation is light intensity. Altering the distance between the light bulb and the pondweed in the boiling tube will do this.

Measurements

Measurements	Unit	Equipment
Volume of water	cm <sup>3</sup>	Measuring cylinder
Temp. of water	°C	Thermometer
Distance between light bulb and pond weed	cm	Metre rule
Time	Minutes	Stop watch
No. Of bubbles produced (Will be counted by eye)	-	-

Prediction

I predict that as light intensity increases, so will the rate of photosynthesis. Therefore the closer the light bulb is to the pondweed; the more bubbles should be produced from the stem. I think this because as the light bulb moves towards the pondweed, the light intensity increases, and therefore so should the rate of photosynthesis. This is why plants photosynthesize during the day and not during the night.

Before planning this investigation, we completed a trial experiment. The purpose of this was to give us an idea of the experiment we were going to do. This meant that we could avoid making mistakes mid-investigation, and also finding results which do not accurately represent what should occur.

### Obtaining Evidence

To make the experiment as accurate possible I made sure all measurements were the same and made sure that the constants did not vary. If for any reason something didn't go to plan, that particular experiment was repeated and not recorded.

No sunlight came in, and the only light that was in the room was that of the lamps. After each experiment the boiling tube was emptied of water and sodium bicarbonate and refilled, making sure that every time the boiling tube contained the same quantities. I also left the fresh water a couple of minutes before adding the sodium bicarbonate, so the pondweed could get used to the water around it. The measuring cylinder was emptied completely of water making sure there was exactly 40cm<sup>3</sup>. The metre rule was taped to the table so that the distance between the lamp and the weed was accurately controlled.

### Analysing

I have found that as the distance between the light source and the weed is decreased, the more bubbles are produced. This therefore shows that as light intensity increases, so does the rate of photosynthesis.

### Results

Distance from pondweed (cm)	No of bubbles produced		Average
	Exp. 1	Exp. 2	
0	97	100	98.5
5	76	68	72
10	55	49	52
15	24	21	22.5
20	21	17	19
25	9	13	11

My graph shows negative correlation between the distance between the light bulb and the weed and the rate of photosynthesis. This however does mean

that there is positive correlation between light intensity and the rate of photosynthesis. My results show a definite trend.

The best fit line on the graph gets gradually steeper, which perhaps suggests that the light intensity and the rate of photosynthesis might not be directly proportional, and perhaps there are other factors to consider, e.g. the carbon dioxide being released.

My results do support my prediction. "I predict that as light intensity increases, so will the rate of photosynthesis". Therefore my results should show me that the closer the light bulb is to the pond weed, the more bubbles are produced from its stem".

### Evaluation

I think my results are quite good, but I could have made them more accurate. However, they do show that light intensity does have an effect on the rate of photosynthesis, which was our original aim.

My method was good and I did not have to make any alterations. However, I did encounter a few problems. When the light source was 0cm away from the light source, it was very difficult to count the bubbles being released because of the harsh light on my eyes. This may have meant that the number of bubbles I counted was inaccurate.

The only anomalous results we received were at the very beginning of the investigation. At first no bubbles were produced, so we changed for a different piece of pondweed. Fortunately the 2<sup>nd</sup> piece of pondweed worked well. The anomalous results were not included in the results table.

If I did the experiment again to get better results, I would find a wider range of results and repeat each experiment three times. I would also move the pondweed by 2.5cm rather than 5cm. I couldn't do this originally because there wasn't enough time.

My results allow me to reach a conclusion. If I were asked to make a prediction of how many bubbles would be released with a distance between the light source and weed of 12.5cm I could use my trend line and make an accurate prediction.

To get more evidence to support my theory I would change the variable. I would perhaps alter the amount of sodium bicarbonate, but keep the light intensity constant. This would give me a broader idea on what factors affect the rate of photosynthesis.

If I did extend the enquiry I think I would find that the rate of photosynthesis could be changed by a number of factors, each partly in control of the overall process.

