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a) (i) The half life of an isotope is the time it takes for the substance to decay to half of its initial weight.

(ii) Radioisotopes such as ^{14}C and ^{18}O can be used to trace biochemical pathways to determine the fate of some reactants in the pathway.

(iii) Hill and Scarisbruck isolated chloroplasts and exposed them to light without CO_2. They found that as they added an oxidising agent, oxygen was produced and the oxidising agent was reduced. This experiment showed that this oxidising agent was the source of O_2 produced in photosynthesis. Ruben used ^{18}O and single celled plants in solution to determine the source of O_2.

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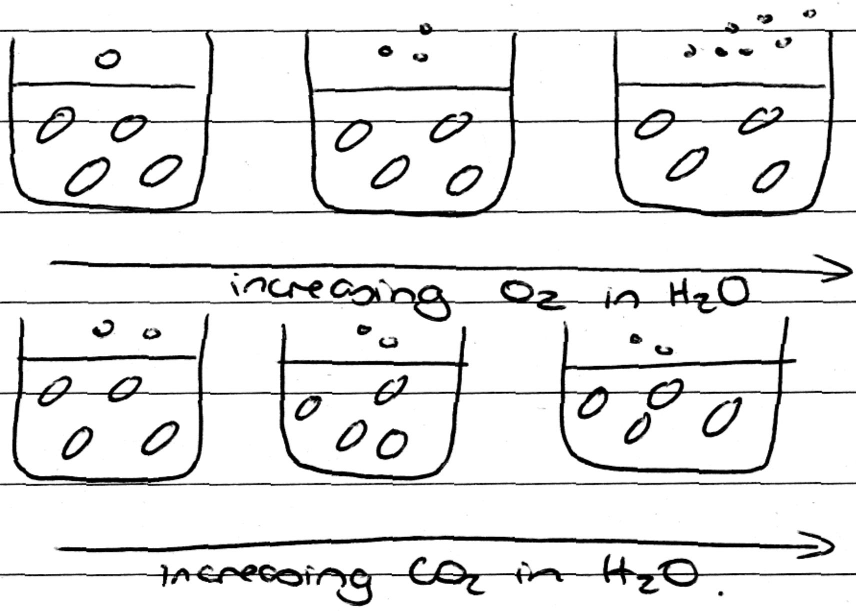

Ruben used ^{18}O in water. As the concentration of ^{18}O in the water increased, the amount of O_2 given off also increased. If he added more CO_2 containing ^{18}O in the form of a bicarbonate, he found that the amount of ^{18}O given off did not increase. ~~[illegible] [illegible] and [illegible]~~, This experiment proved that the source of O_2 given off in photo-synthesis was water.

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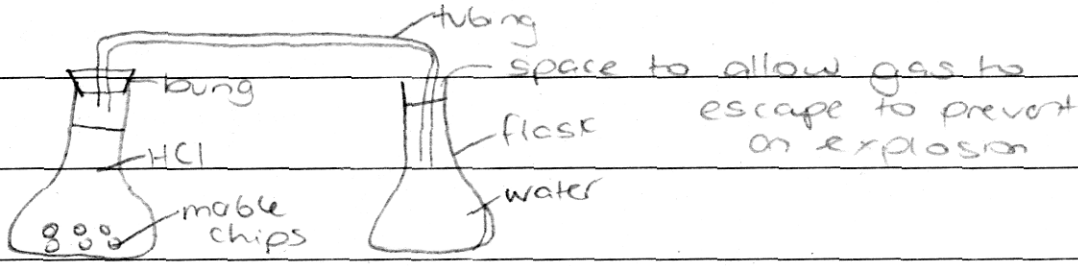
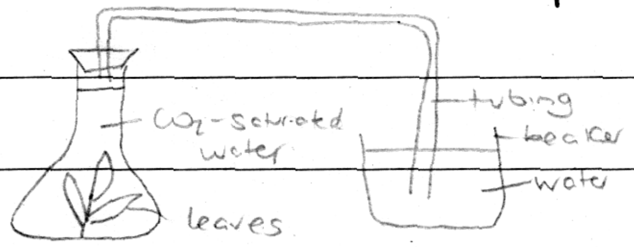
b) (i) Testing Senebiers experiment

Method:

① Place marble chips and Hydrochloric acid in a conical flask, and fill another flask with water, and set up as below to saturate the water with CO_2.



② Add leaves to the flask with water and set up as below



③ Set up this apparatus again, but without saturating the water with CO_2

④ Observe the equipment and watch for O_2 to be produced ~~~~ ~~~~ and ~~~~ ~~~~ bubbled through the beaker of water

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* Note: when this experiment was performed in class, no noticeable bubbles were produced in either beaker. Perhaps the experiment was too small scaled, or maybe an oxygen probe was needed.

If Senebie's observation was correct, bubbles of O_2 would be produced in the flask of CO_2-saturated water and not in the other flask, proving that plants need CO_2 to photosynthesise.

(ii) Variables to control

- amount of water
- amount + type of leaves used
- Size of conical flask and equipment.
- Keeping the tubing above the water level in the flasks, but below the water level in the beakers.
- Ensuring both flasks are sealed.

- temperature for each experiment
- amount of light for each..

c) (i) See graph

(ii) At 575 nm, the rate of photosynthesis would be about 54% of maximum

(iii) The action spectrum of chlorophyll is similar to that of photo synthesis, but not exactly the same. This means that there are other pigments present, which allow the ~~other~~ plant to absorb light over a greater wavelength.

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d) Photosynthesis research has a very important role in confirming the ~~xxx~~ relationship between ATP production and photosyntheis research.

~~xxxxx~~ Blackman and Mathgel studied rates of photosynthesis against light intensity, ad found that after a certain light intensity, the rate of photosynthesis plateaud. They hypothesised that photosynthesis was a two step process.

~~A~~ Emerson and Arnold later on conducted similar experiments to determine the amount of chlorophyll needed to form 1 molecule of O_2. They found that 2400 chlorophyll molecules were needed, and suggested that because so many were needed, that they were not all

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of the same importance. He went on to say that ~~some~~ most were responsible for trapping light, and others were important for converting the light energy into chemical energy (in the form of NADPH and ATP as we now know). Gaffron and Wohl then provided the correct and complete interpretation that light was trapped and processed in a photosynthetic unit and then transferred to a photoenzyme for chemical processing. More research by Emerson showed that when light of a wavelength of 680 nm and 700nm was provided, the rate of photosynthesis increased, whereas if only one of these conditions was provided, the rate of Photosynthesis did not increase. He suggested that ~~two~~ two photochemical units

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occurred in plants, and both were needed for efficient photosynthesis ~~[illegible] [illegible] to the mid nineteenth cent~~ More recently, ATP and NADPH were discovered, and the role of each became obvious. The two photochemical units, (photosystems 1&2) were important for photosynthesis. ~~The light~~ . ~~Both absorbed light~~ ~~2~~ Photosystem 1 absorbs light of 700 nm and Photosystem 2 absorbs light of 680 nm. Photosystem 2 feeds electrons to photosystem ~~[illegible]~~ 1, and photosystem 1 ~~[illegible]~~ then transfers an electron to form NADPH or ATP. It is left oxidised, and can't produce any ~~[illegible]~~ more of either molecule until Photosystem 2 traps more light and passes another electron down the chain.

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The ATP and NADPH then provide the energy to drive the Calvin cycle (or light independent reaction). This uses CO_2 to produce glucose. The more ATP and NADPH produced by the light dependent reactions, the more glucose that can be produced, and the more growth and reproduction the plant can undertake. The relationship between ATP production and photosynthesis is that the more light available, the more ATP production and therefore the more photosynthesis. This knowledge has come about by research from a number of scientists including Emerson, Arnold, Gaffron, Wahl, Blackman and Mathgel.

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this research has played an important role in confirming the relationship between ATP production and photosynthesis.

2002 HIGHER SCHOOL CERTIFICATE EXAMINATION

Biology

This page is to be detached, completed and attached to the inside front cover of your writing booklet for the option question you have attempted.

The rate of Photosynthesis compared to light intensity