# 13.2 Investigation of Limiting Factors

## Question Paper

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| Course | CIE A Level Biology |
| Section | 13. Photosynthesis |
| Topic | 13.2 Investigation of Limiting Factors |
| Difficulty | Hard |

**Time allowed:** 30

**Score:** /21

**Percentage:** /100

## Question 1a

A group of students wanted to investigate the effect of light intensity on photosynthesis. They followed the procedure below:

1. Prepare a chloroplast suspension using an isolation medium.
2. Set up a series of test tubes in a water bath at 20 °C.
3. Set up the following tubes for the purposes of control or reference:
    - Tube **X** = 5 $cm^3$ DCPIP + 0.5 $cm^3$ water + 0.5 $cm^3$ liquid isolation medium
    - Tube **Y** = 5 $cm^3$ DCPIP + 0.5 $cm^3$ water + 0.5 $cm^3$ chloroplast suspension, wrapped in aluminium foil
    - Tube **Z** = 5.5 $cm^3$ water + 0.5 $cm^3$ chloroplast suspension
4. Set up another series of tubes containing 5 $cm^3$ DCPIP + 0.5 $cm^3$ water.
5. Take one of the second series of tubes and place it 5 cm away from a lamp. Add 0.5 $cm^3$ chloroplast suspension and start a timer.
6. Time how long it takes for the DCPIP to become colourless.
7. Repeat steps 6–7 at different distances from the lamp, e.g. 10 cm, 15 cm, 20 cm, 25 cm, 30 cm

It is important that the isolation medium used in step 1 is at the same solute concentration as the spinach cells.

Explain why this is the case.

**[2 marks]**

## Question 1b

From the investigation described in part a), explain the purpose of the following:

(i)
Tube **X**.

[1]

(ii)
Tube **Y**.

[1]

(iii)
Tube **Z**.

[1]

**[3 marks]**

## Question 1c

The results of the investigation described in part a) are shown in Fig. 1.

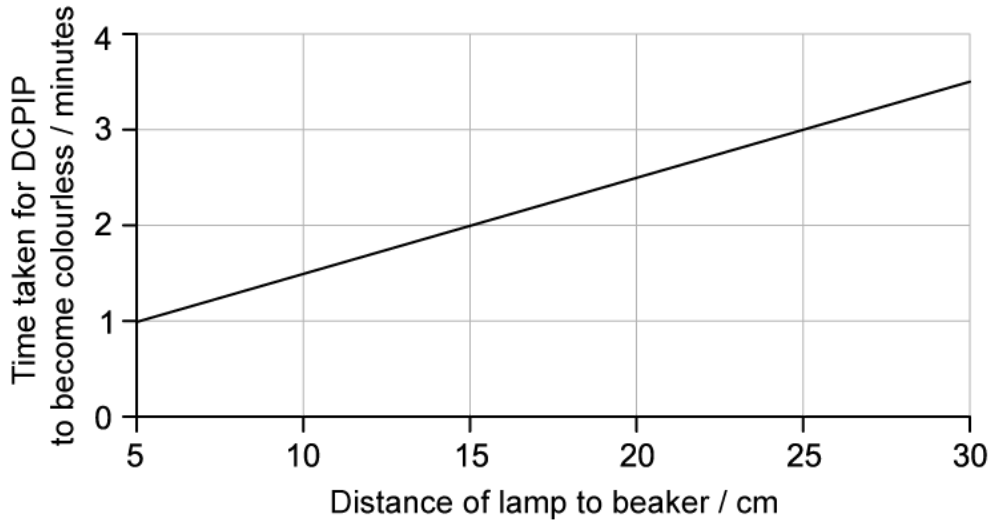


**Fig. 1**

Explain the results shown in Fig. 1

**[3 marks]**

## Question 1d

Some weedkillers contain ammonium hydroxide, a chemical that acts in a similar way to DCPIP during photosynthesis. A farmer wanted to use ammonium hydroxide weedkiller on their crop fields, but a scientist recommended that they choose a different type of weedkiller.

Suggest why the farmer was advised not to use ammonium hydroxide weedkiller on their crop fields.

**[2 marks]**

## Question 2a

A group of scientists used radioactive carbon to investigate the Calvin Cycle in both light and dark conditions. Multiple leaves of a plant were enclosed within a sealed bag containing radioactive carbon dioxide for different lengths of time. The leaves were then removed and analysed for radioactive compounds. Their results are shown in Fig. 1.

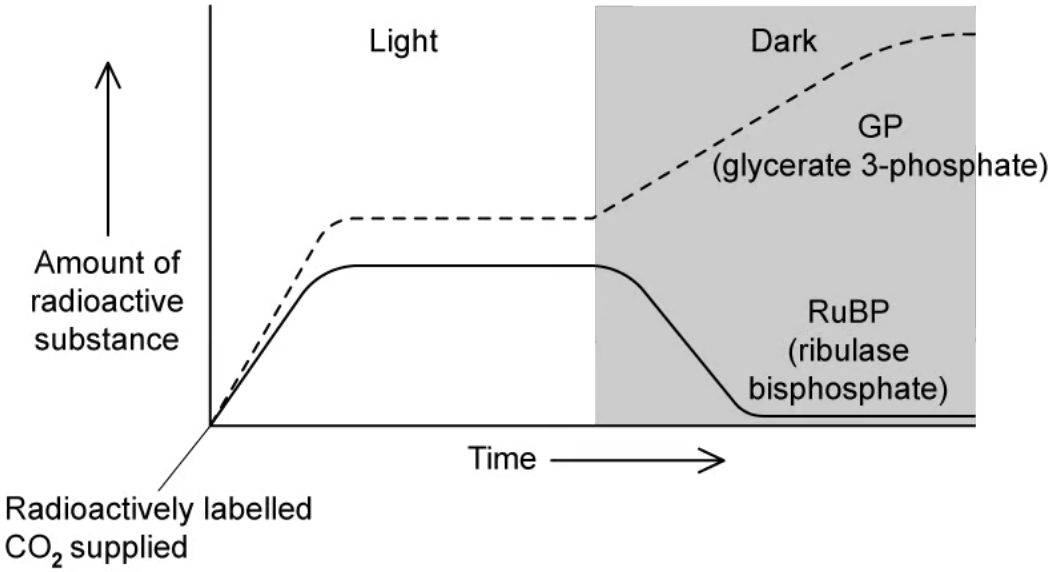


**Fig. 1**

Describe how radioactively labelled carbon dioxide is fixed inside the leaves of the plant while it is exposed to light in Fig..1.

**[3 marks]**

## Question 2b

Explain the results shown in Fig. 1 when the plant is moved into the dark.

**[4 marks]**

## Question 2c

At high temperatures, the enzyme that is involved with fixing carbon for the plant increasingly combines with oxygen instead of carbon dioxide in a reaction known as photorespiration. A simplified version of the photorespiration reactions can be seen in Fig. 2.

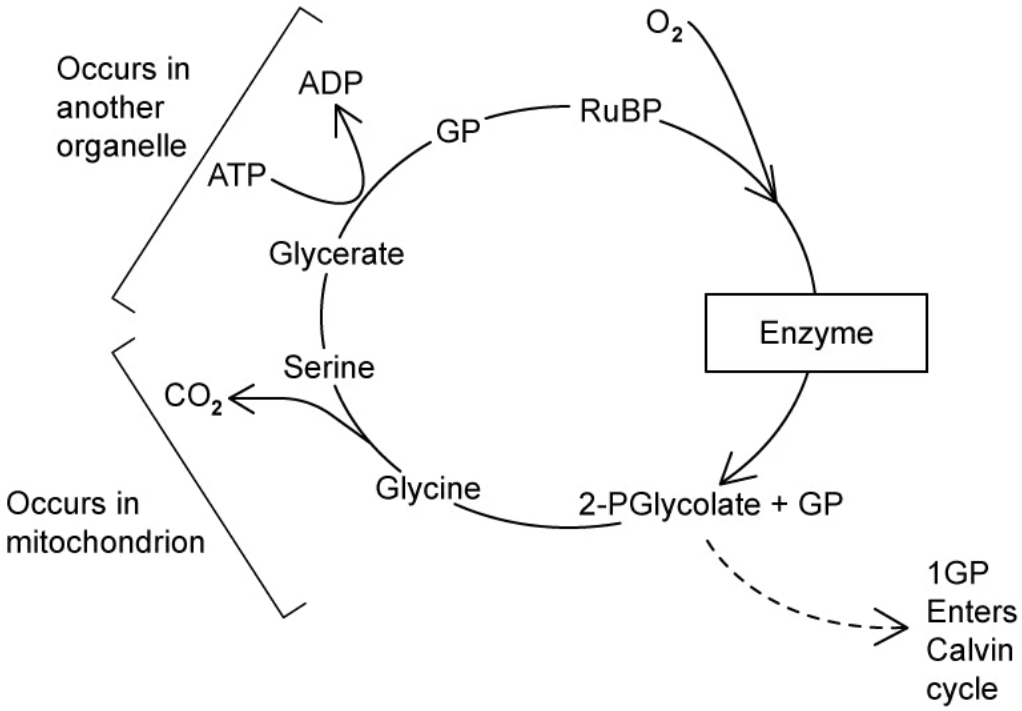


**Fig. 2**

Photorespiration reduces the efficiency of photosynthesis.

Use Fig. 2 to suggest why this is the case.

**[2 marks]**

## Question 2d

Many scientists are interested in finding ways of improving the action of the enzyme that fixes carbon to reduce the rate at which it carries out photorespiration.

Suggest how the action of this enzyme could be improved.

**[2 marks]**