Model Answers: Easy

1a

(a) Carbon dioxide concentration is a limiting factor in photosynthesis because…

Any **two** of the following:

- It is needed in the Calvin cycle/light independent reactions **OR** the higher the carbon dioxide concentration the faster the Calvin cycle/light independent reactions can occur; [1 mark]
- It combines with RuBP to form GP / an intermediate compound; [1 mark]
- It provides carbon for fixing / converting to other organic molecules (such as sugars, amino acids, glycerol); [1 mark]

[Total: 2 marks]

1b

(b) The relationship between carbon dioxide concentration and rate of photosynthesis shown in Fig. 1 can be described as follows…

- As carbon dioxide concentration increases the rate of photosynthesis also increases (up to a point); [1 mark]
- (After a certain concentration is reached) the rate of photosynthesis levels off/plateaus; [1 mark]

[Total: 2 marks]

When you are describing a graph, be sure to include every part of the relationship shown; here we can see a linear relationship to begin with, before the rate of reaction then levels off. Sometimes, the graph contains a numbered scale, in which case it is a good idea to include numbers in your description.

1c

(c) A possible limiting factor at the point labelled X in Fig. 1 could be…

Any **one** of the following:

- Temperature; [1 mark]
- Light intensity; [1 mark]

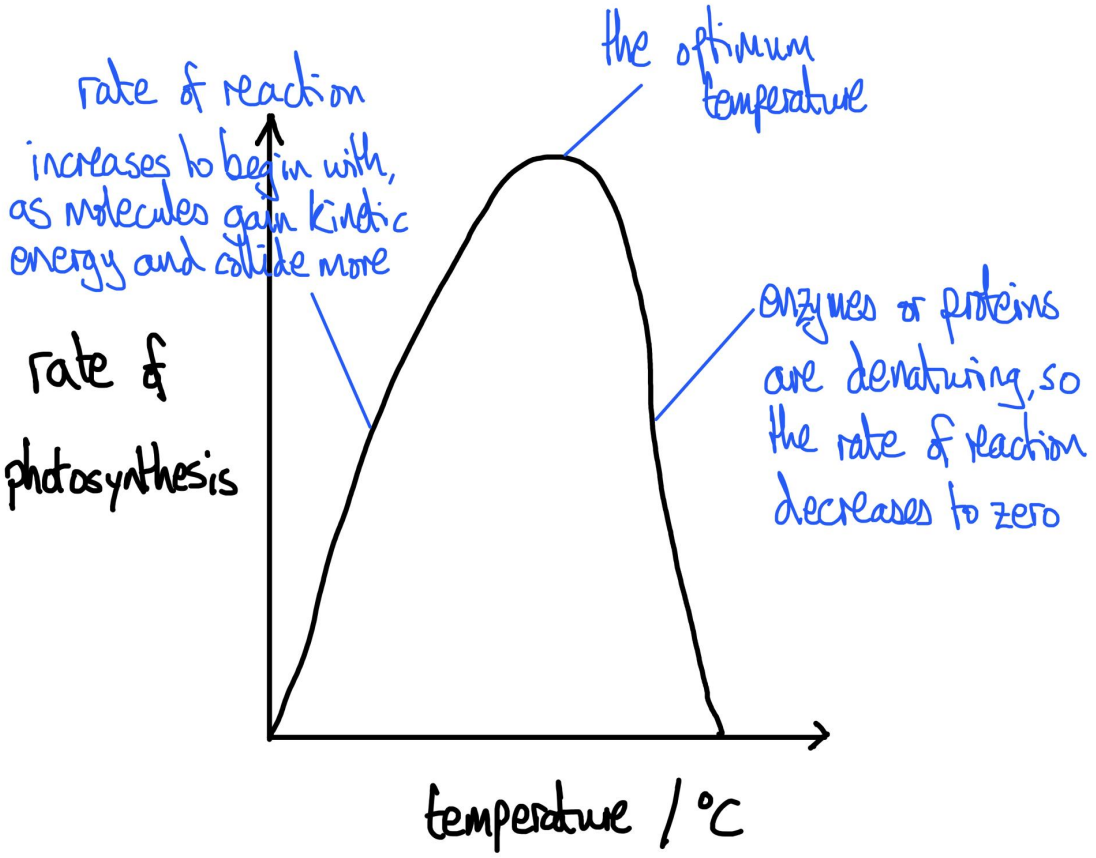
[Total: 1 mark]

Although water is needed for photosynthesis, its effects on a plant can be varied and complex, so it is not an acceptable answer here. It is also important to mention the word 'intensity', rather than just 'light'. If you just write, 'light' then you could be referring to other aspects of light such as its direction, wavelength etc, so you have to be specific with your language.

1d

(d) A sketched graph of the rate of photosynthesis against temperature should looks as follows…

- Line on graph initially shows an increase in reaction rate as temperature increases **AND** then drops back down to zero; [1 mark]



(d) (ii) The shape of the graph can be explained as follows...

- As temperature increases molecules have more kinetic energy / there are more collisions between enzymes and substrate (and so reaction rate increases); [1 mark]
- Above a certain temperature enzymes/proteins / a named enzyme/protein, e.g. rubisco / the proteins of the electron transport chain denature (causing reactions to slow down and stop); [1 mark]

[Total: 3 marks]

2a

(a) The variable measured here to give the rate of photosynthesis is the...

- Volume of (oxygen) gas produced/collected (by the pondweed); [1 mark]

[Total: 1 mark]

You wouldn't get the mark here for saying 'amount' of oxygen produced. Get into the habit of being as specific as possible; here it is 'volume' because oxygen is a gas and is being measured in cm^3.

2b

(b) Two variables that need to be controlled in the investigation shown in Fig. 1 include...

Any **two** of the following:

- The temperature of the water bath; [1 mark]
- The wavelength of the light / colour of the bulb; [1 mark]
- The species of pond weed used; [1 mark]
- The length/mass of the piece of pond weed used; [1 mark]
- Concentration of dissolved $NaHCO_3$/sodium hydrogen carbonate; [1 mark]
- Light coming from other sources / carrying out investigation in a darkened room; [1

mark]

- Length of time gas is collected for; [1 mark]
- Pondweed given same amount of time to adjust to new light level each time intensity changes; [1 mark]

[Total: 2 marks]

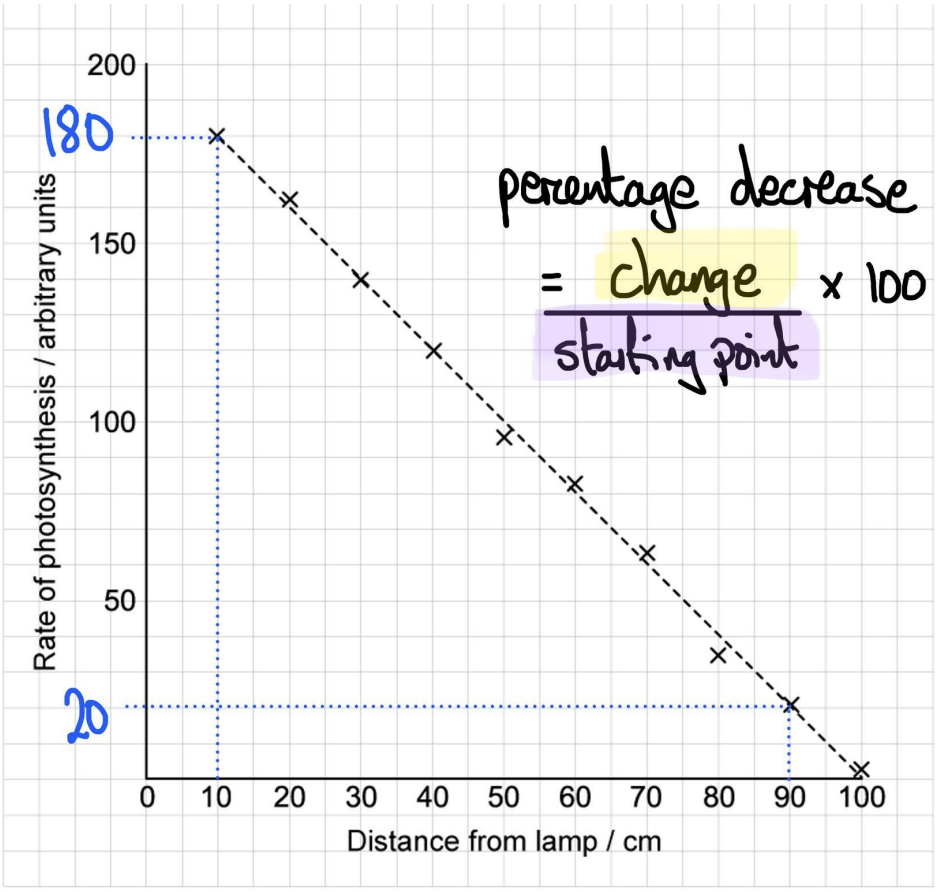
2c

(c) The percentage decrease in the rate of photosynthesis is...

- 160 ÷ 180; [1 mark]
- 89 / 88.9 / 88.89 (%); [1 mark]

Full marks can be awarded for the correct answer in the absence of other calculations.

[Total: 2 marks]



Calculate the change in the rate of reaction:

At 10cm = 180 a.u. At 90cm = 20 a.u.

180 - 20 = 160

Substitute into equation:

$\frac{160}{180} \times 100 =$ 89 / 88.9 / 88.89 %

[Total: 2 marks]

2d

(d) The rate of photosynthesis decreases when light intensity is reduced because...

Any **two** of the following:

- Light energy is needed for photoactivation / to excite electrons / to raise electrons to

a higher energy level / electrons to enter the electron transport chain; [1 mark]

- Light energy is needed for photolysis / to split water into hydrogen ions, electrons and oxygen; [1 mark]
- If the light dependent reactions cannot take place then no ATP / NADPH/reduced NADP can be passed to the Calvin cycle/light independent reactions OR there will be no ATP / NADPH/reduced NADP to convert GP into TP; [1 mark]

[Total: 2 marks]

Light energy is required for the light dependent reactions of photosynthesis to take place; both to excite electrons and pass them down the electron transport chain, and to supply hydrogen ions and electrons from photolysis. If these reactions cannot take place then the products of ATP and NADPH will not be produced and cannot pass into the Calvin cycle, meaning that GP cannot be converted into TP and the useful products of photosynthesis cannot be produced.

3a

(a) (i) A redox indicator that can be used to measure the rate of photosynthesis is…

- DCPIP / methylene blue; [1 mark]

(a) (ii) The colour change that is observed when the indicator goes from an oxidised to a reduced state is…

- Blue (oxidised) to colourless (reduced); [1 mark]

[Total: 2 marks]

3b

(b) The exact colour change from part (a) (ii) may not be observed because…

- The chloroplasts contain green pigment / chlorophyll is green / the final colour may be green (rather than colourless); [1 mark]

[Total: 1 mark]

3c

(c) Another light-related variable that must be controlled / kept constant in this experiment is…

- Light wavelength / the range/combination of wavelengths available; [1 mark]

[Total: 1 mark]

You have to state an aspect of light here, so a more typical experimental control variable, like temperature, will not be awarded a mark.

3d

(d) Three conditions of an isolation medium that are required when preparing a chloroplast suspension are…

- The same water potential / solute concentration (as leaf cells) / the medium must be isotonic; [1 mark]
- Ice-cold / held at around 0 °C; [1 mark]
- Buffered / held at a constant pH; [1 mark]

[Total: 3 marks]