

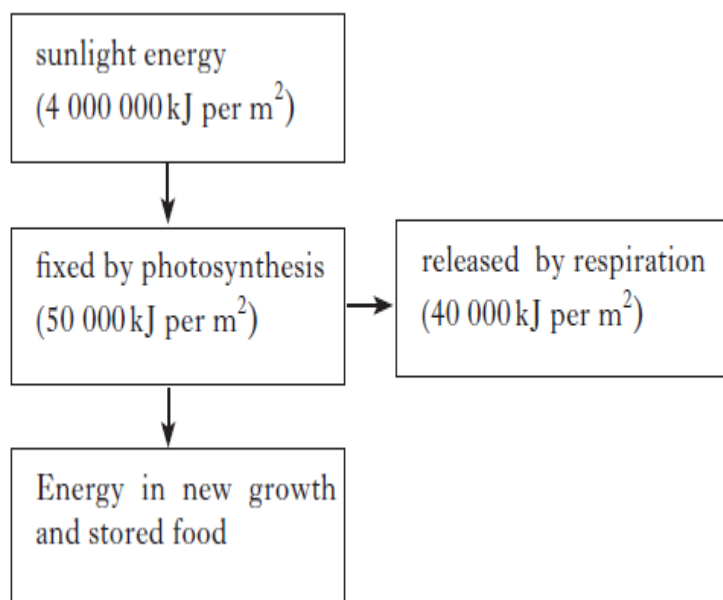
## Higher Unit 3 Sustainability and Interdependence

### Key Area 1 Plant Supply, Plant Growth & Productivity

1. The action spectrum of photosynthesis is a measure of the ability of plants to

- A absorb all wavelengths of light
- B absorb light of different intensities
- C use light to build up food
- D use light of different wavelengths for synthesis.

2. The flow chart below shows the energy flow in a field of potatoes during 1 year.



What percentage of the available sunlight energy would be present in new growth and stored food in the potato crop?

- A 2.25
- B 1.25
- C 0.25
- D 1.00

3. An investigation was carried out to compare the rate of photosynthesis of green algal cells immobilised into gel beads in different light intensities.

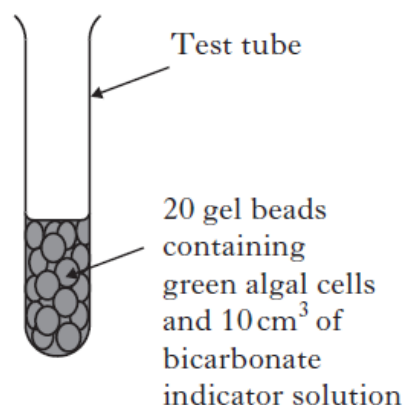
Twenty gel beads containing green algal cells were placed in each of seven test tubes containing  $10\text{ cm}^3$  of bicarbonate indicator solution as shown in the diagram.

These tubes were placed in beakers of water and each positioned at a different distance from a light source to alter the light intensity.

Photosynthesis causes the bicarbonate indicator solution to change colour.

After 60 minutes the bicarbonate indicator solution was transferred from each tube to a colorimeter. The higher the colorimeter reading, the higher the rate of photosynthesis which has occurred in the tube.

Results are shown in the table below.



<i>Tube</i>	<i>Distance of tube from light source (cm)</i>	<i>Colorimeter Reading (units)</i>
1	25	92
2	35	92
3	50	83
4	75	32
5	100	14
6	125	6
7	200	0

- (a) Identify **two** variables, not already mentioned, which should have been kept constant for each tube to ensure that the experimental procedure was valid.

1 \_\_\_\_\_

2 \_\_\_\_\_

2

- (b) (i) Give a reason why each tube was placed in a beaker of water.

\_\_\_\_\_

1

- (ii) Suggest an advantage of using algae immobilised into gel beads.

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1

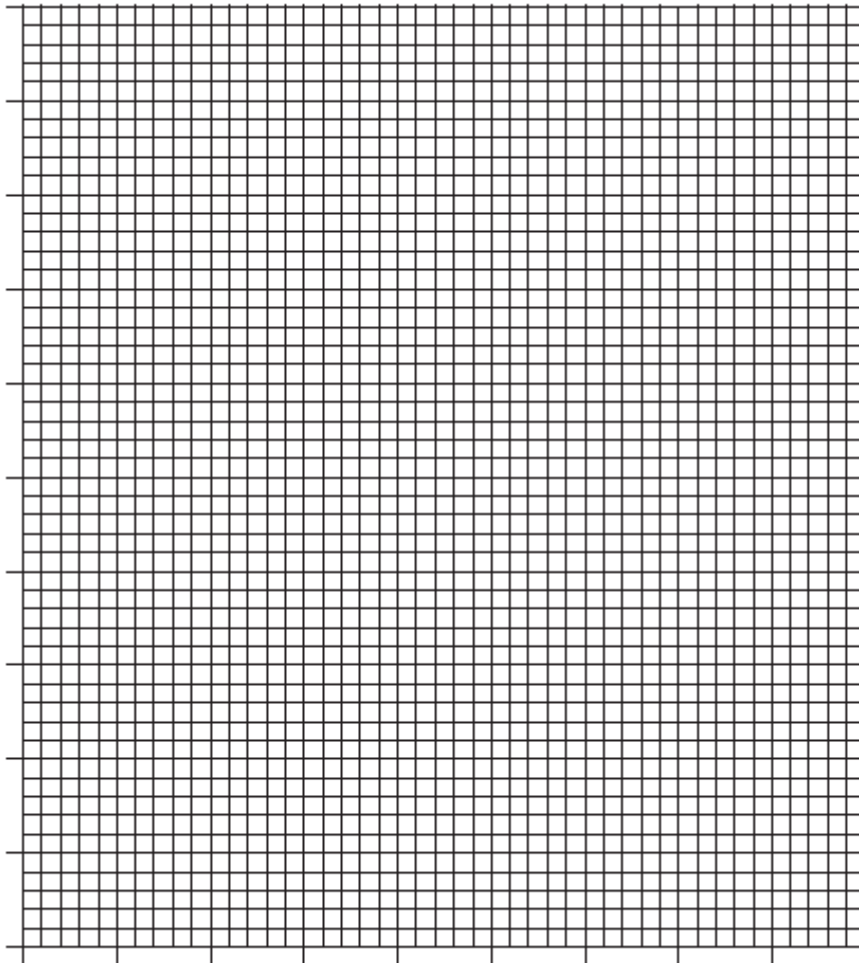
(c) Describe how the experimental procedure could be improved to increase the reliability of the results.

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(d) On the grid below, complete the line graph to show the colorimeter reading against distance of the tubes from the light source.



2

(e) Draw a conclusion about the effect of light intensity on the rate of photosynthesis.

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2

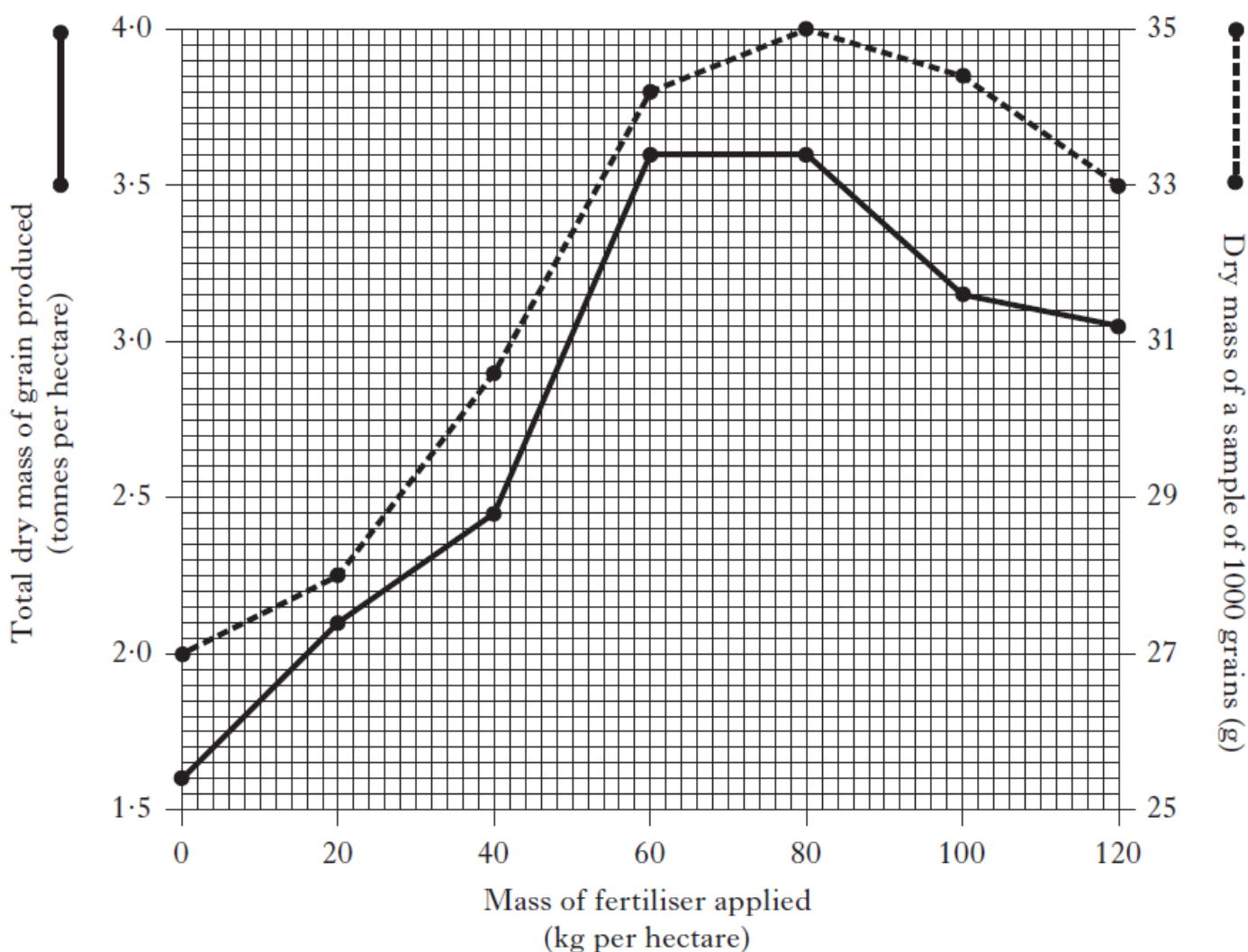
4. Human food production can be increased by the use of fertiliser which improves crop growth.

A field trial was carried out to show how the mass of fertiliser applied per hectare affected the growth of a wheat crop and to determine the level of fertiliser which should be recommended for use with this crop.

After the harvest of the wheat at each fertiliser level the following measurements of plant growth were made.

- Total dry mass of grain produced per hectare
- Dry mass of a sample of 1000 grains

The results are shown in the graph below.



- (a) (i) Use values from the graph to describe the changes in the total dry mass of grain produced as the fertiliser application increased from 40 kg to 120 kg per hectare.

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- (ii) Calculate the **average increase** in total dry mass of grain produced for every additional kg of fertiliser applied from 0 kg to 80 kg per hectare.

*Space for calculation*

\_\_\_\_\_ tonnes per hectare      **1**

- (b) (i) Calculate the simplest whole number ratio of the dry mass of 1000 grains produced at 0 kg fertiliser per hectare to that at 120 kg fertiliser per hectare.

*Space for calculation*

\_\_\_\_\_ : \_\_\_\_\_      **1**  
At 0 kg per                      At 120 kg per  
hectare                              hectare

- (ii) Calculate the **percentage increase** in the dry mass of 1000 grains when the fertiliser level was increased from 20 kg to 80 kg per hectare.

*Space for calculation*

\_\_\_\_\_ %      **1**

- (c) At which fertiliser level is the average dry mass of an individual wheat grain the greatest.

Tick (✓) the correct box.

60 kg per  
hectare

80 kg per  
hectare

100 kg per  
hectare

120 kg per  
hectare

**1**

5. The following statements refer to photosynthesis.
- 1 Carbon dioxide is fixed by RuBisCO.
  - 2 Sugar molecules are combined to form starch.
  - 3 G3P is used to regenerate RuBP.

Which of the statements correctly refer to the Calvin cycle?

- A 1 and 2 only
- B 1 and 3 only
- C 2 and 3 only
- D 1, 2 and 3

6. Plants can be grown for human food or used as food for livestock.

In terms of food security, explain **one** benefit of using plants rather than livestock for human food.

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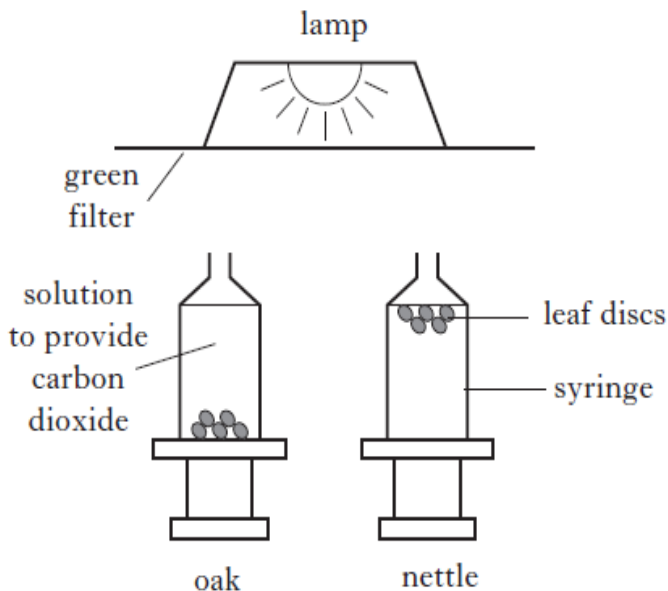


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1

7. An investigation was carried out to compare photosynthesis in green light by oak and nettle leaves. Five leaf discs were cut from each plant and placed in syringes containing a solution to provide carbon dioxide.

The diagram below shows the positions of the leaf discs after one hour.



How could the experiment be improved to allow valid conclusions to be drawn?

- A Carry out the experiment in a darkened room.
- B Use different species of plant.
- C Use more leaf discs.
- D Repeat the experiment.

8. Nettles are shade plants which often grow below trees.

Their leaves contain photosynthetic pigments X and Y. The table below shows the percentage of light of different wavelengths absorbed by these pigments.

<i>Wavelength of light (nm)</i>	<i>Colour of light</i>	<i>Light absorbed (%)</i>	
		<i>Pigment X</i>	<i>Pigment Y</i>
400	violet	40	20
440	blue	60	30
550	green	5	60
680	red	50	5

(a) Apart from being absorbed, state what else can happen to light striking the leaves of plants.

\_\_\_\_\_

1

(b) Identify which of the pigments, X or Y, in the table is chlorophyll. Justify your choice.

Pigment \_\_\_\_\_

Justification \_\_\_\_\_

\_\_\_\_\_

1

(c) (i) Describe the relationship between the wavelength of light and the percentage of light absorbed by pigment Y.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

2

(ii) Describe how the presence of pigment Y in their leaves would benefit nettle plants growing below trees.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

1

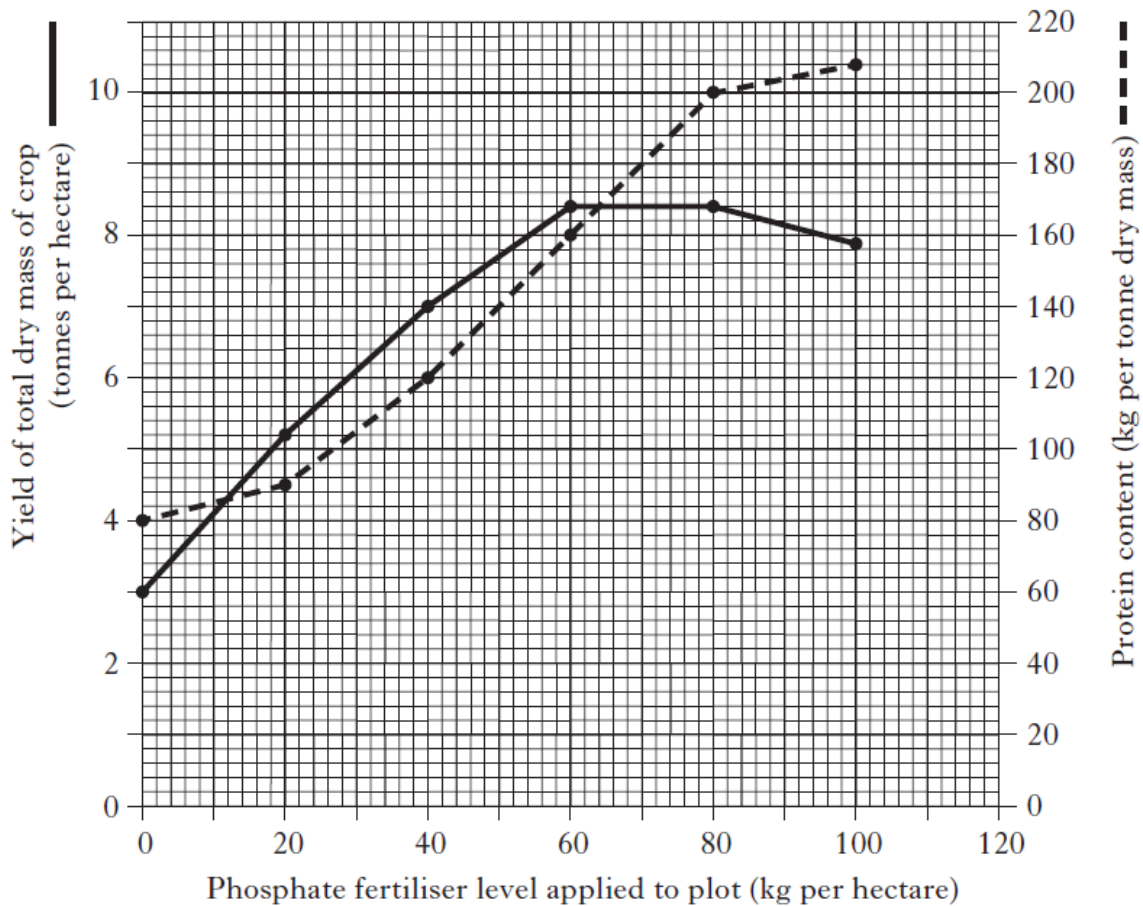
9. Which of the following occurs during the Calvin cycle?
- A ATP is produced
  - B Oxygen is released
  - C Water is split
  - D Carbon dioxide is fixed
10. Which of the following results in the transfer of electrons down the electron transport chains during the light dependent reactions of photosynthesis?
- A NADP is converted to NADPH
  - B Water is split by photolysis
  - C ATP is synthesised
  - D Pigment molecules absorb energy



11. Alfalfa is a crop plant often grown for cattle food.

In an investigation, alfalfa was grown in six plots each of which had been treated with a different level of phosphate fertiliser. The alfalfa was harvested after 24 weeks of growth and the total dry mass of the crop at each fertiliser level was calculated. The protein content of the alfalfa grown at each fertiliser level was also determined.

The results are shown in the graph below.



- (a) (i) Use values from the graph to describe the changes in the yield of total dry mass of the crop as the phosphate fertiliser level was increased from 0 to 100 kg per hectare.

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11 continued

- (ii) Predict the protein content of an alfalfa crop if 120 kg of phosphate fertiliser per hectare had been applied.

\_\_\_\_\_ kg per tonne dry mass      **1**

- (iii) Calculate the total mass of protein produced from one hectare when 40 kg of phosphate fertiliser per hectare was applied.

*Space for calculation*

\_\_\_\_\_ kg      **1**

- (b) In a feeding trial, three groups of 10 cattle were fed with alfalfa of different protein contents over a 25 day period. The cattle were weighed at the beginning and end of this period and the average increase in their body mass calculated.

The results are shown in the table below.

<i>Cattle group</i>	<i>Protein content of alfalfa fed to cattle (kg per tonne dry mass)</i>	<i>Average increase in body mass of cattle over a 25 day period (kg)</i>
1	80	12
2	90	15
3	120	17

- (i) State how the design of the feeding trial ensured the reliability of the results.

**1**

\_\_\_\_\_

- (ii) Using the information from the **table**, calculate the average increase in body mass per day of the cattle in Group 2.

*Space for calculation*

\_\_\_\_\_ kg per day      **1**

11 continued

(iii) Using information from the **graph and table**:

1 suggest the phosphate fertiliser level which was applied in the production of the alfalfa which the cattle from Group 2 were fed;

1

\_\_\_\_\_ kg per hectare

2 draw a conclusion about how phosphate fertiliser levels applied to the alfalfa affected the growth of cattle in the feeding trial.

1

\_\_\_\_\_

(c) In terms of food security, explain why using agricultural land to grow cereal for human consumption rather than to grow cattle food would produce more food for humans per unit area.

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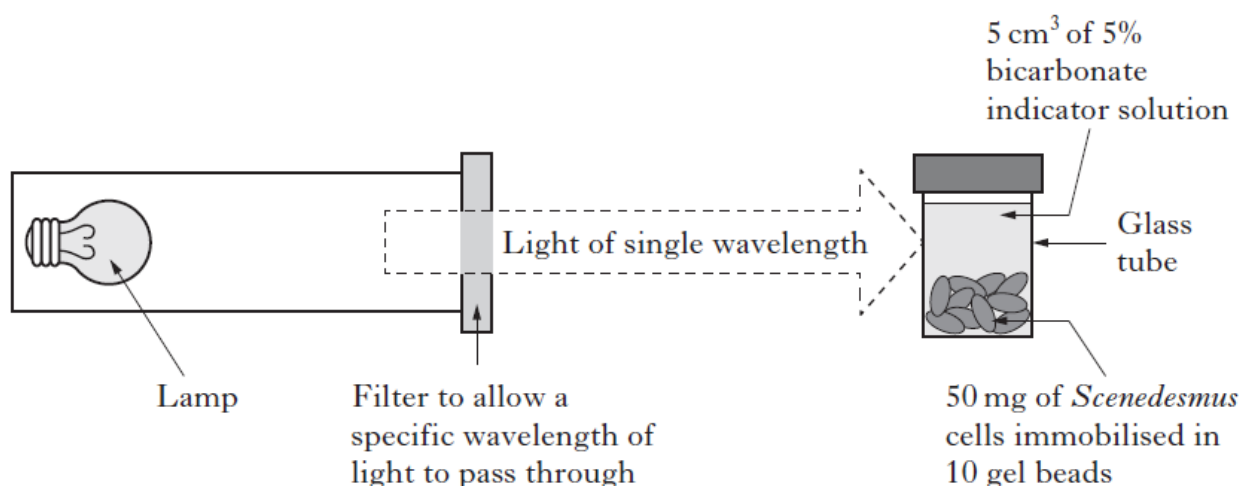
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12.

Photosynthesis in algal cells can be measured by immersing them in bicarbonate indicator solution. The indicator solution gradually changes colour as carbon dioxide is removed from it by photosynthesis. This colour change can be measured by placing the solution in a colorimeter. The higher the rate of photosynthesis, the higher the reading on the colorimeter.

The effect of different wavelengths of light on rate of photosynthesis in *Scenedesmus*, an algal species which grows near the surface layers of fresh water lochs, was measured. The apparatus shown below was set up in a darkened room.



After one hour, the bicarbonate indicator was removed from the tube, placed in a colorimeter and a reading taken.

The experiment was carried out seven times using different filters, each of which allowed a single wavelength of light to pass through.

The results are shown in the table below.

<i>Filter</i>	<i>Wavelength of light passing through (nanometres)</i>	<i>Colorimeter reading (units)</i>
1	400	0.48
2	450	0.74
3	500	0.36
4	550	0.32
5	600	0.24
6	650	0.96
7	700	0.26

12 continued

- (a) Identify **two** variables, not already mentioned, that would have to be controlled to ensure that the experimental procedure was valid.

1 \_\_\_\_\_

2 \_\_\_\_\_

2

- (b) A control tube would be required for each wavelength of light being investigated.

Describe the contents of a suitable control tube.

\_\_\_\_\_  
\_\_\_\_\_

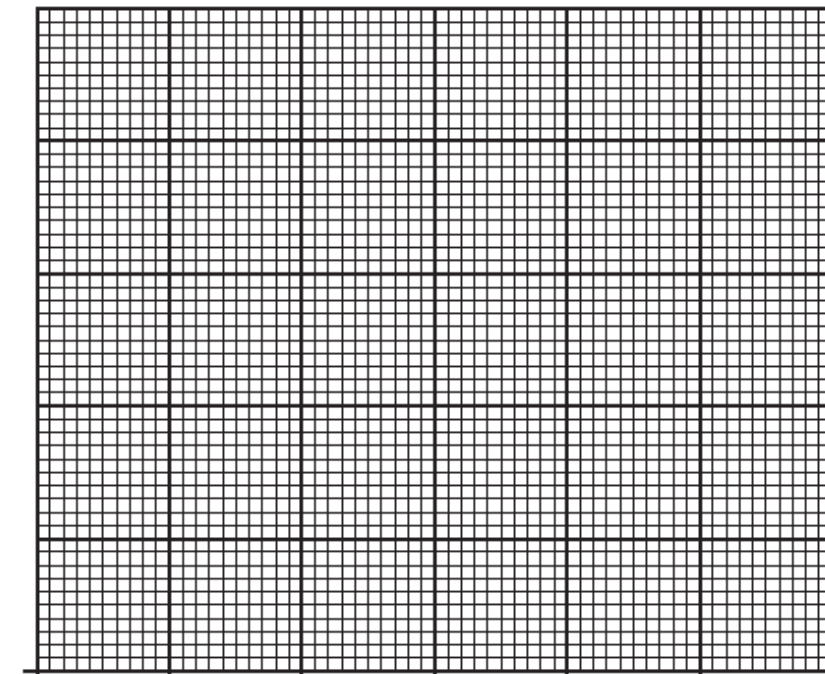
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- (c) State why the tubes were left for one hour before the colorimeter readings were taken.

\_\_\_\_\_

1

- (d) (i) On the grid provided, draw a line graph to show the colorimeter readings against wavelength of light.



400

Wavelength of light (nanometres)

2

- (ii) Give the reason why the graph of colorimeter reading against wavelength of light can be described as an action spectrum.

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- (e) The experiment was repeated with a second alga which lives in the water below *Scenedesmus*. This species has a higher proportion of carotenoid pigments in its cells than *Scenedesmus*.

Predict the colorimeter reading the indicator would give after exposure of the second alga to light of 500 nanometres and explain your answer.

Prediction \_\_\_\_\_ units

1

Explanation \_\_\_\_\_

1

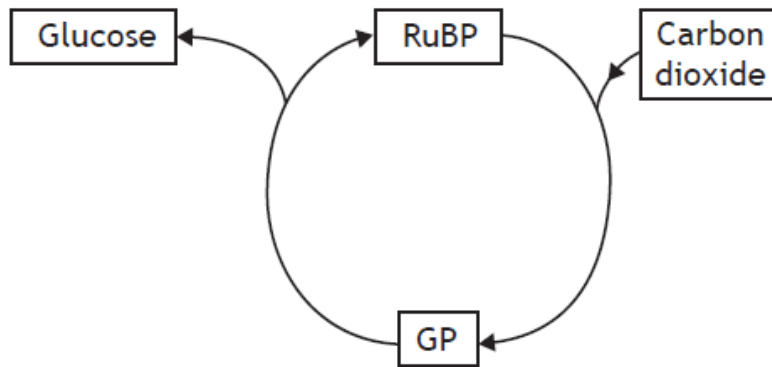
13.

The action spectrum of photosynthesis is a measure of the ability of plants to

- A absorb all wavelengths of light
- B absorb light of different intensities
- C use light to build up food
- D use light of different wavelengths for photosynthesis.

14.

The diagram below represents part of the Calvin cycle within a chloroplast.



Which line in the table below shows the effect of decreasing CO<sub>2</sub> availability on the concentrations of RuBP and GP in the cycle?

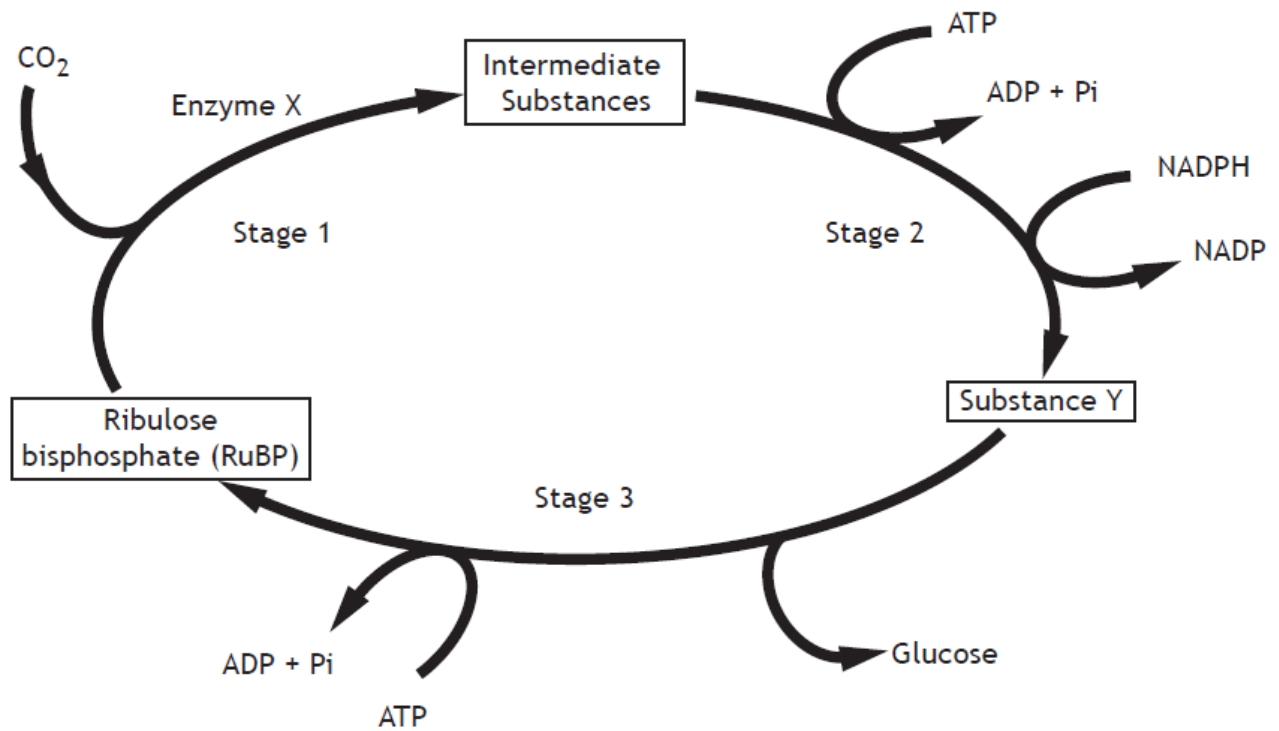
	<i>RuBP concentration</i>	<i>GP concentration</i>
A	decrease	decrease
B	increase	increase
C	decrease	increase
D	increase	decrease

15.

Which of the following results in a transfer of electrons down the electron transport chains during the light dependent reactions of photosynthesis?

- A NADP is converted to NADPH
- B Water is split by photolysis
- C ATP is synthesised
- D Pigment molecules absorb energy

16. The diagram below shows some stages in the Calvin cycle of photosynthesis.



- (a) (i) Name Enzyme X and Substance Y. 2

Enzyme X \_\_\_\_\_

Substance Y \_\_\_\_\_

- (ii) Explain the importance of producing glucose and RuBP in Stage 3. 2

Glucose \_\_\_\_\_

\_\_\_\_\_

RuBP \_\_\_\_\_



16 continued

(b) Research has been carried out which aims to increase photosynthesis in crop plants by inserting genes for the production of prokaryotic pigments into the cells. These pigments absorb wavelengths of light which are different to those absorbed by the pigments present in the crop plants.

(i) Predict what would happen to the concentrations of ATP and NADPH in the crop plant cells.

2

ATP \_\_\_\_\_

NADPH \_\_\_\_\_

17.

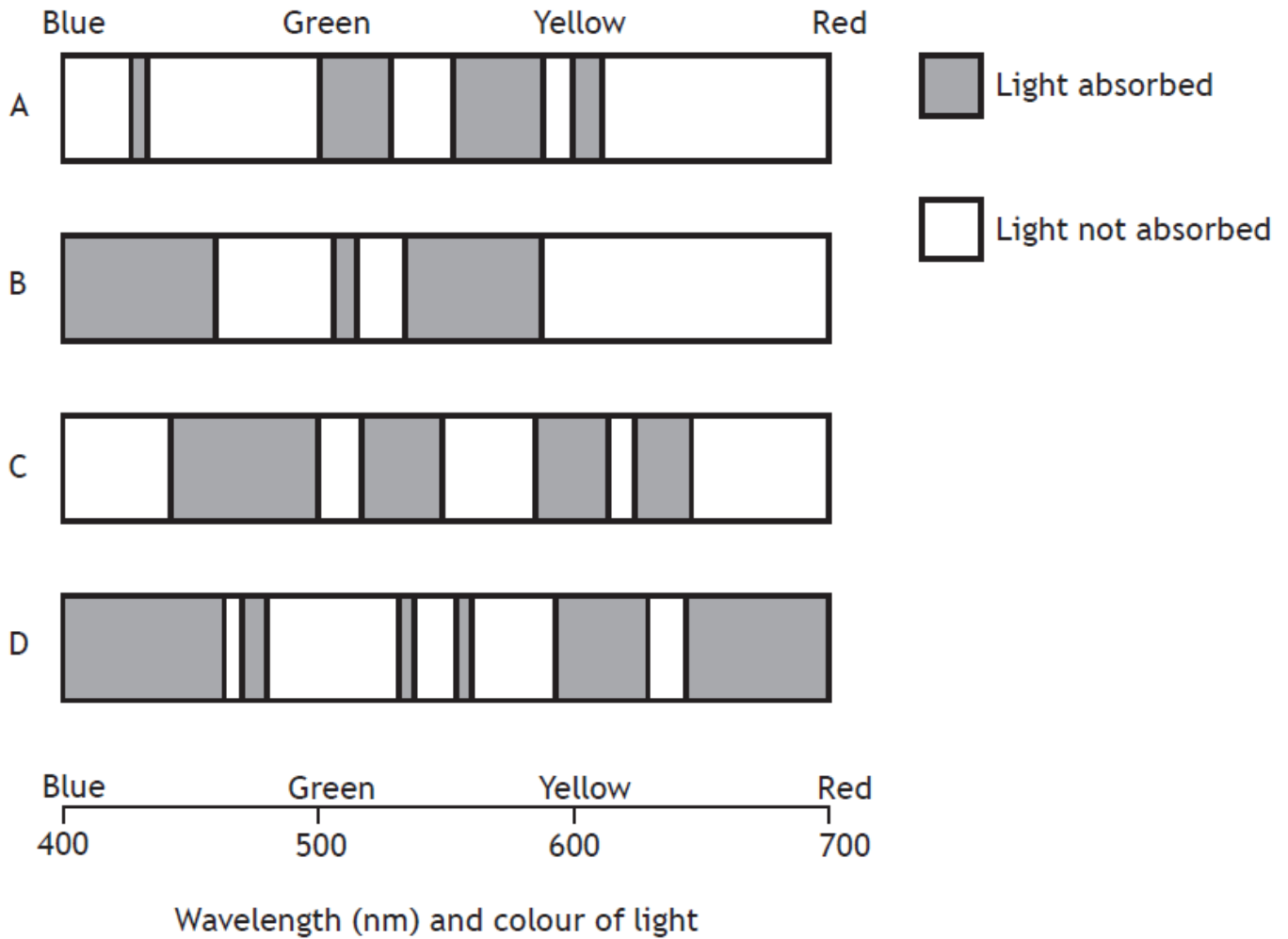
Which compound combines with hydrogen during carbon fixation (Calvin cycle)?

- A Ribulose biphosphate
- B NADP
- C Oxygen
- D 3-phosphoglycerate

18.

The following absorption spectra were obtained by testing four different plant extracts.

Which extract contains chlorophyll?



19.

During photosynthesis light energy is absorbed by photosynthetic pigments in the chloroplasts.

(a) (i) State one fate of the light which is not absorbed by the photosynthetic pigments. 1

\_\_\_\_\_

(ii) Describe the effect of absorbed light energy on the pigment molecules. 1

\_\_\_\_\_

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(iii) Plants contain several pigments including chlorophyll a, chlorophyll b and carotenoids. Explain the advantage to a plant of having more than one type of photosynthetic pigment. 1

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(b) Following photolysis, hydrogen is transferred to the coenzyme NADP. State the source of this hydrogen. 1

\_\_\_\_\_

(c) Describe the role of the NADPH in the Calvin cycle (carbon fixation). 1

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