WJEC EDUQAS A-LEVEL BIOLOGY · COMPONENT 1

BIOLOGY



EXAM QUESTION PACK

1.2 PHOTOSYNTHESIS

SCORE	PERCENTAGE
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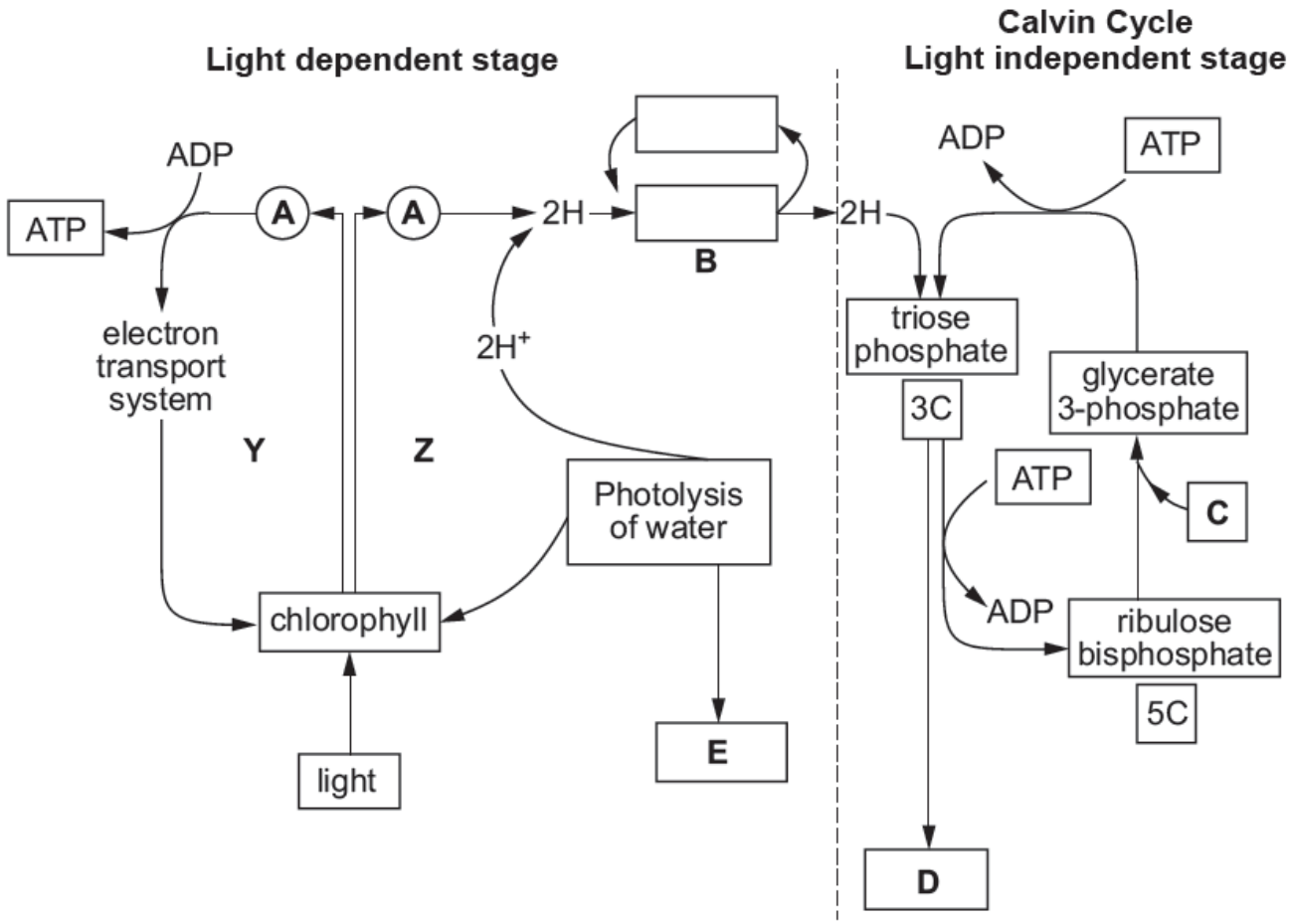
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1. The diagram below shows the events involved in photosynthesis.



(a) (i) Name stages **Y** and **Z** in the light dependent stage.

[1]

Y . . . . . .

. . . . . .

Z . . . . . .

. . . . . .

(ii) What is represented by circles **A**?

[1]

.....

(iii) Complete the boxes above to show the reactions occurring at point **B**.

[1]

(iv) What is being produced at **E**?

[1]

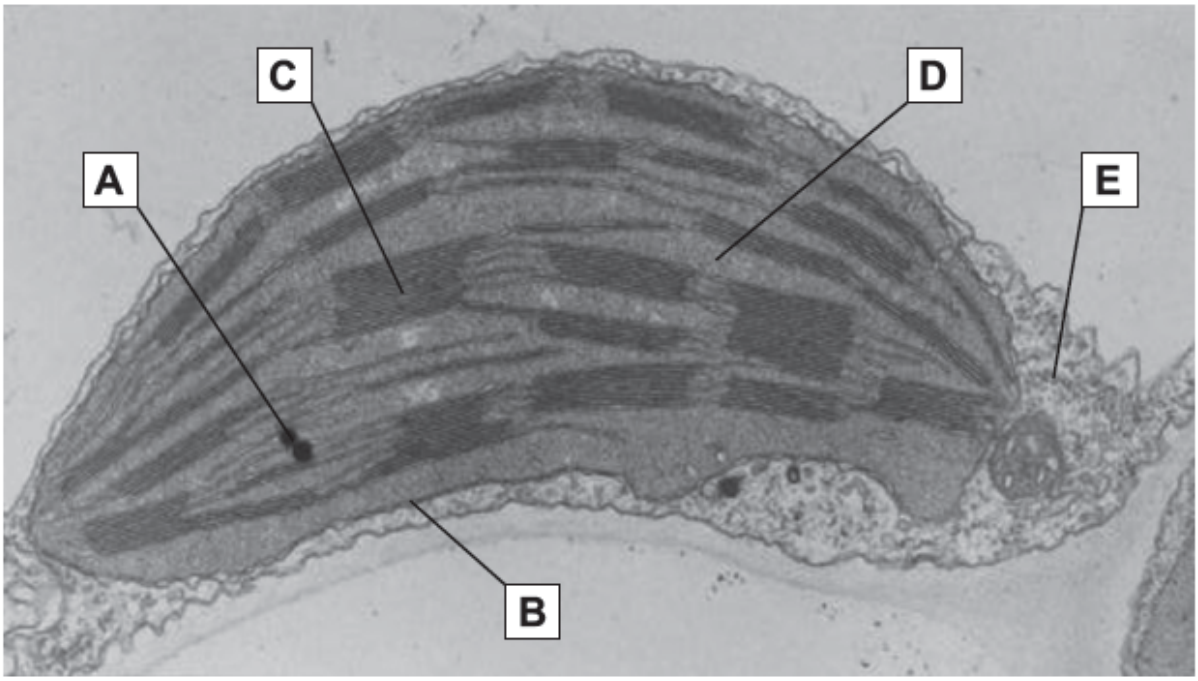
(v) Name the molecule entering at **C**.

[1]

(vi) What compound is produced at **D**?

[1]

(b) The photomicrograph below is of a chloroplast



Using the letters on the photomicrograph, complete the following table.

[4]

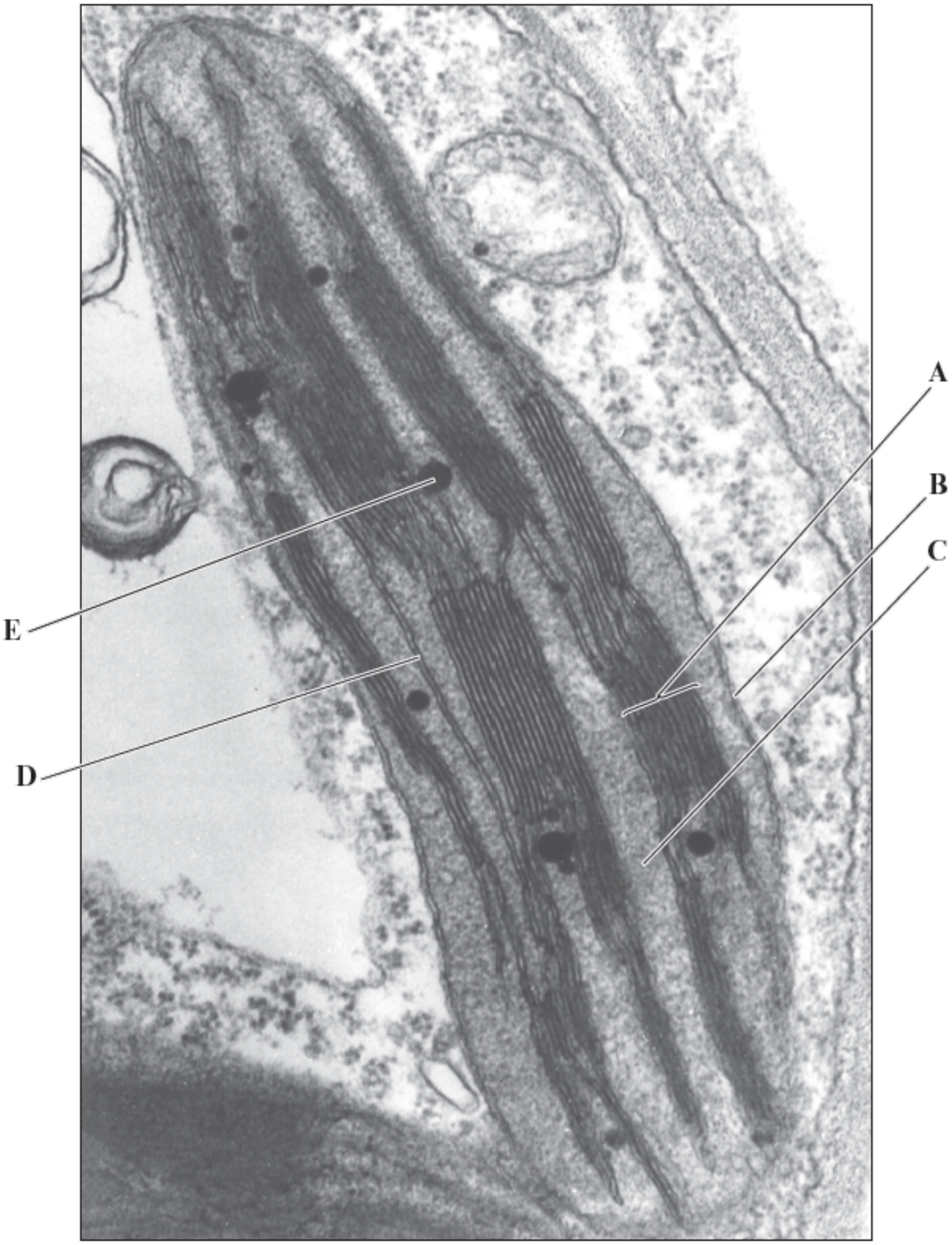
Area	Letter	Name of region
Where the light dependent stage occurs		
Where the light independent stage occurs		

(c) Plants take up minerals from the soil. These are combined with the products of the light independent stage to produce other molecules needed by the plant.

Give **three** examples of minerals taken up from the soil and state what molecules are produced when each example combines with the products of the light independent stage.

[3]

2. The electron micrograph below shows part of a palisade cell, including one chloroplast.



(a) Choose a letter or letters from the electron micrograph above that indicate. [3]

(i) one granum, ...

(ii) parts of the chloroplast where photosynthetic pigments are located, ...

(iii) where reactions of the Calvin cycle occur. .....

(b) The Calvin cycle involves the conversion of inorganic carbon dioxide into useful organic compounds.

(i) Explain how carbon dioxide is used in the production of glycerate-3-phosphate.

[2]

(ii) Describe how glycerate-3-phosphate is converted to triose phosphate.

[3]

(c) (i) State why only some of the triose phosphate produced by the Calvin cycle can be used to produce hexose phosphate.

[1]

(ii) Suggest how many times the Calvin cycle must occur to produce one molecule of glucose.

[1]

3. Diuron is a weed-killer which is a very specific and sensitive inhibitor of photosynthesis. It blocks the electron carrier binding site on photosystem II. This stops the electron flow from where it is generated, in photosystem II, to the electron carrier. This reduces the ability of the plant to convert light energy into chemical energy.

Diuron only blocks electron flow from photosystem II. It has no effect on photosystem I or other reactions in photosynthesis, such as light absorption or carbon fixation in the Calvin cycle.

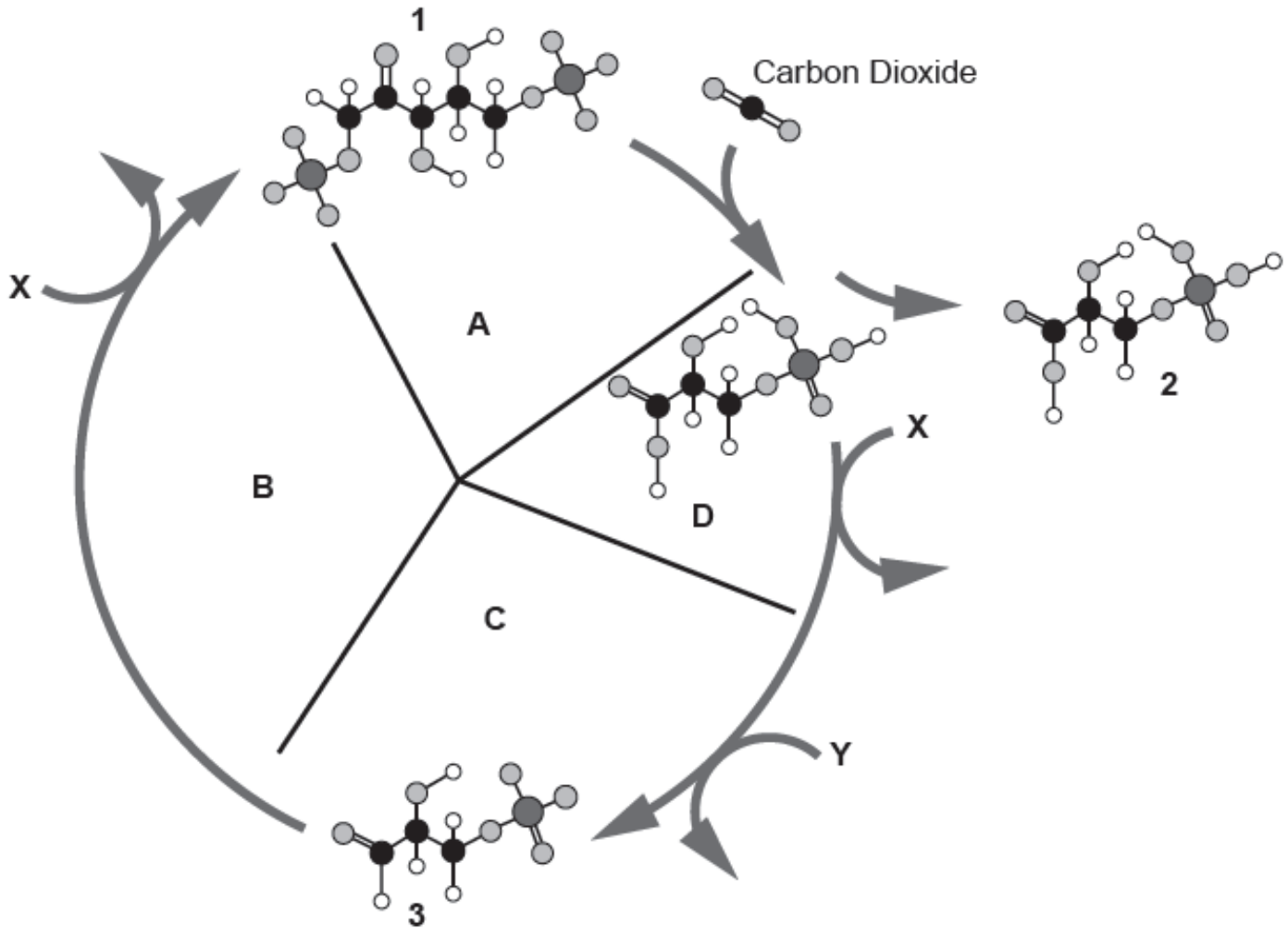
(a) Explain the effects of Diuron on non-cyclic photophosphorylation and why cyclic photophosphorylation is not affected.

[4]

(b) Suggest why a plant would die when the weedkiller Diuron is sprayed onto it.

[3]

(c) The Calvin cycle is shown below with some of the intermediate compounds drawn.



(i) Name compounds 1, 2 and 3 shown on the diagram above.

[3]

1 . . . . . .

. . . . . .

2 . . . . . .

. . . . . .

3 . . . . . .

. . . . . .

(ii) What is the role of ribulose bisphosphate carboxylase (RuBisCo) in the Calvin cycle?

[1]

(iii) Name molecules X and Y shown on the diagram above.

[2]

X . . . . . .

. . . . . .

Y . . . . . .

. . . . . .

(iv) Describe simply what is happening at each stage of the cycle indicated by **A**, **B** and **C** on the diagram above.

[3]

A . . . . . .

. . . . . .

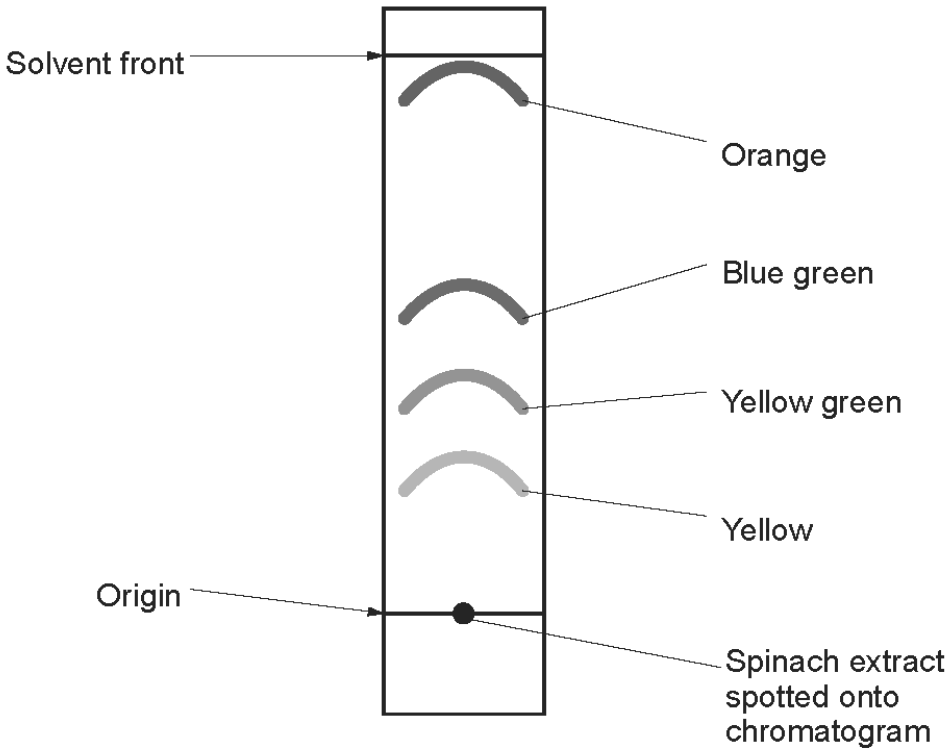
B . . . . . .

. . . . . .

C . . . . . .

. . . . . .

4. A student carried out a practical to separate the pigments in spinach leaves and the results are shown in the diagram below.



(a) The blue-green pigment is chlorophyll *a*.
State precisely where chlorophyll *a* is found in a photosynthetic cell. [2]

.....

(b) The Rf value of the pigments can be calculated using the following formula.

$$\text{Rf} = \frac{\text{distance moved by pigment from origin}}{\text{distance moved by solvent front from origin}}$$

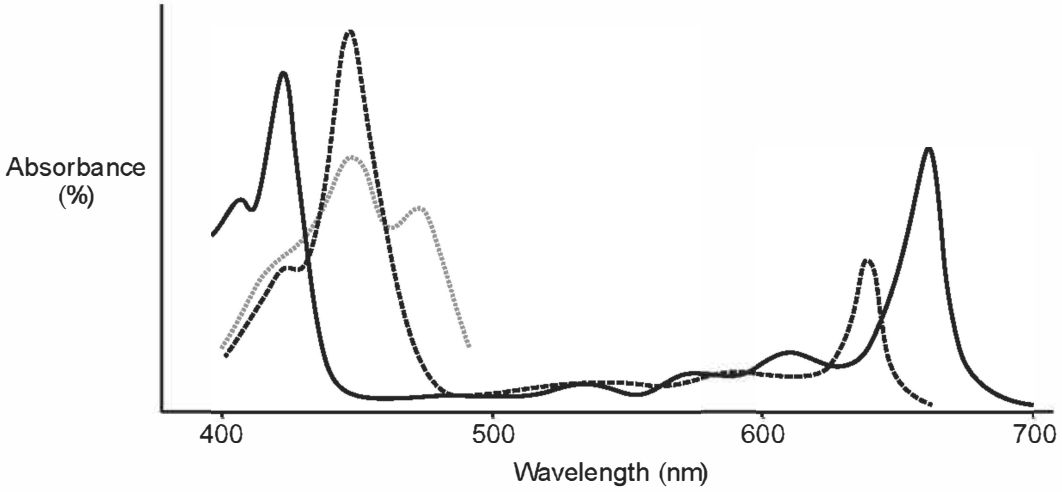
Calculate the Rf value of the yellow band and use the following table of Rf values to identify it. Show your working. [3]

Rf value = ...

Pigment	Rf value
xanthophyll	0.28
chlorophyll *b*	0.42
chlorophyll *a*	0.59
carotene	0.98

Identity of yellow band .....

(c) Some of the pigments were extracted from the chromatogram separately. The percentage of light absorbed at wavelengths from 400 to 700 nm by each of them was measured and a chart produced.



(i) Name this type of chart. [1]

.....

(ii) Explain the results in the 500 to 600 nm range. [1]

.....

.....

.....

(iii) Explain the advantage to plants of having more than one pigment in their leaves. [2]

.....

.....

.....

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(d) Use your knowledge of photosynthesis to explain the role of these pigments in the production of ATP. [3]

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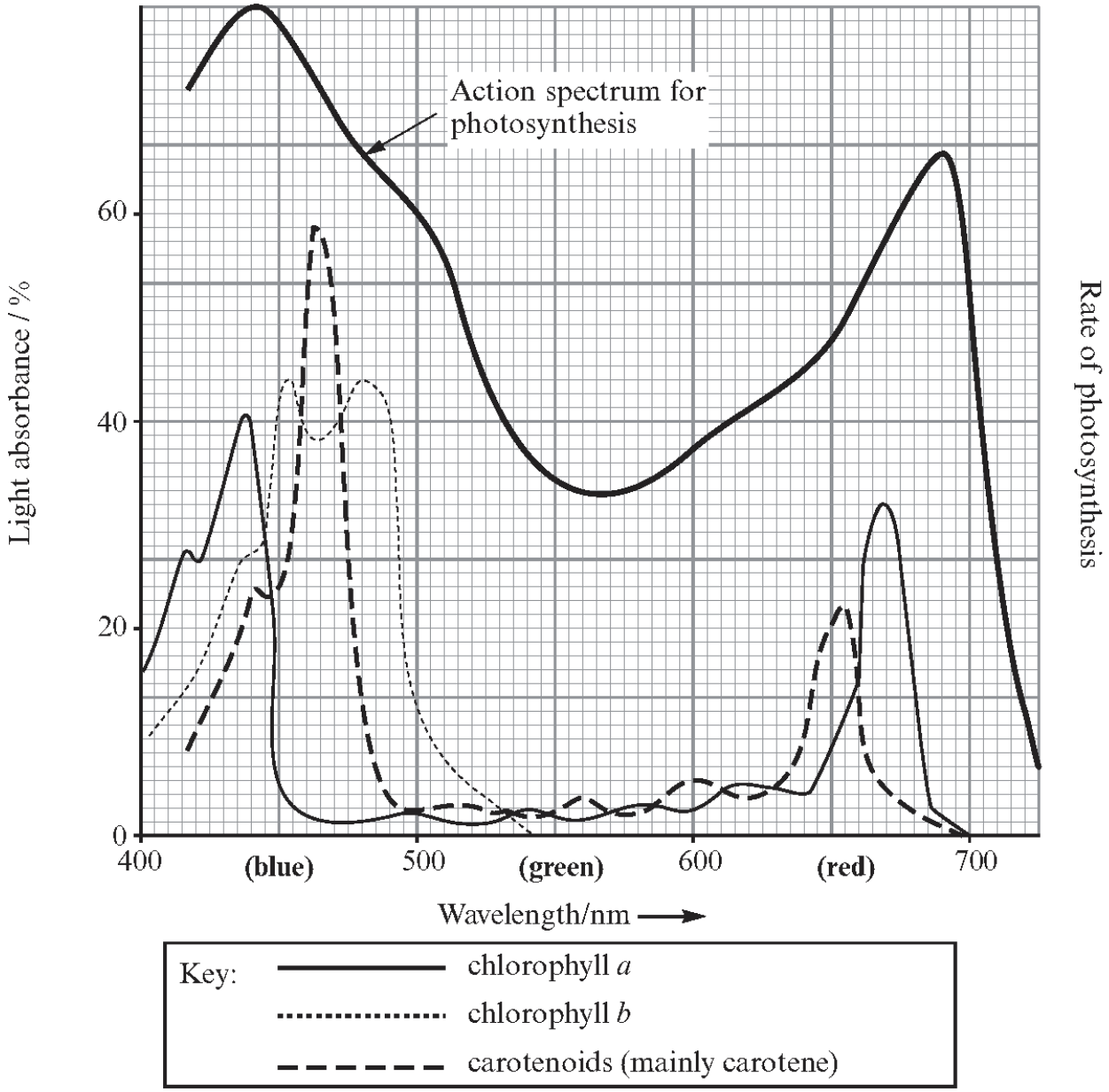
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12

5. The important pigments in most chloroplasts are chlorophyll *a*, chlorophyll *b*, and carotene. The graph below shows the absorbtion spectrum of these pigments along with the action spectrum for photosynthesis.



(a) Describe the function of chlorophyll *a*. [1]

.....

.....

(b) (i) State the wavelength which is most effectively absorbed by chlorophyll *a*. [1]

.....

(ii) Use the information in the graph to explain why it is an advantage for a leaf to contain more than one pigment. [2]

.....

.....

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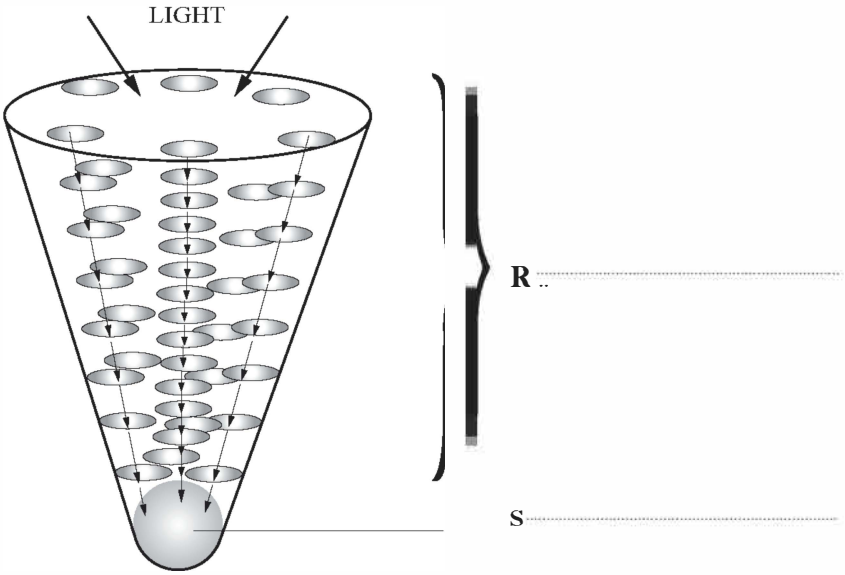
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(c) Why do most leaves characteristically have a green colour? [1]

(d) The graph also shows the *action spectrum* for photosynthesis.

Describe the relationship between the absorption spectrum and the action spectrum and explain what this relationship tells us about light absorption and photosynthesis. [2]

(e) The following diagram is of a photosystem.



[2]

(i) Identify regions **R** and **S** shown on the diagram.

(ii) Indicate, with a cross (×) on the diagram, where you would expect to find chlorophyll *a*. [1]

(iii) State exactly where in the chloroplast you would expect to find photosystems. [1]

(Total 11 marks)

6.

(a) It is important that humans try to maintain or reduce the carbon dioxide levels in the atmosphere.

(i) Name **two** processes which increase carbon dioxide levels. [1]

.....

.....

(ii) State which organelle in a plant cell is responsible for photosynthesis. [1]

.....

(iii) State precisely how the process of photosynthesis reduces the carbon dioxide levels. [2]

.....

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(b) Suggest why the following processes are required for cellular respiration to continue.

(i) Light independent stage of photosynthesis; [1]

.....

.....

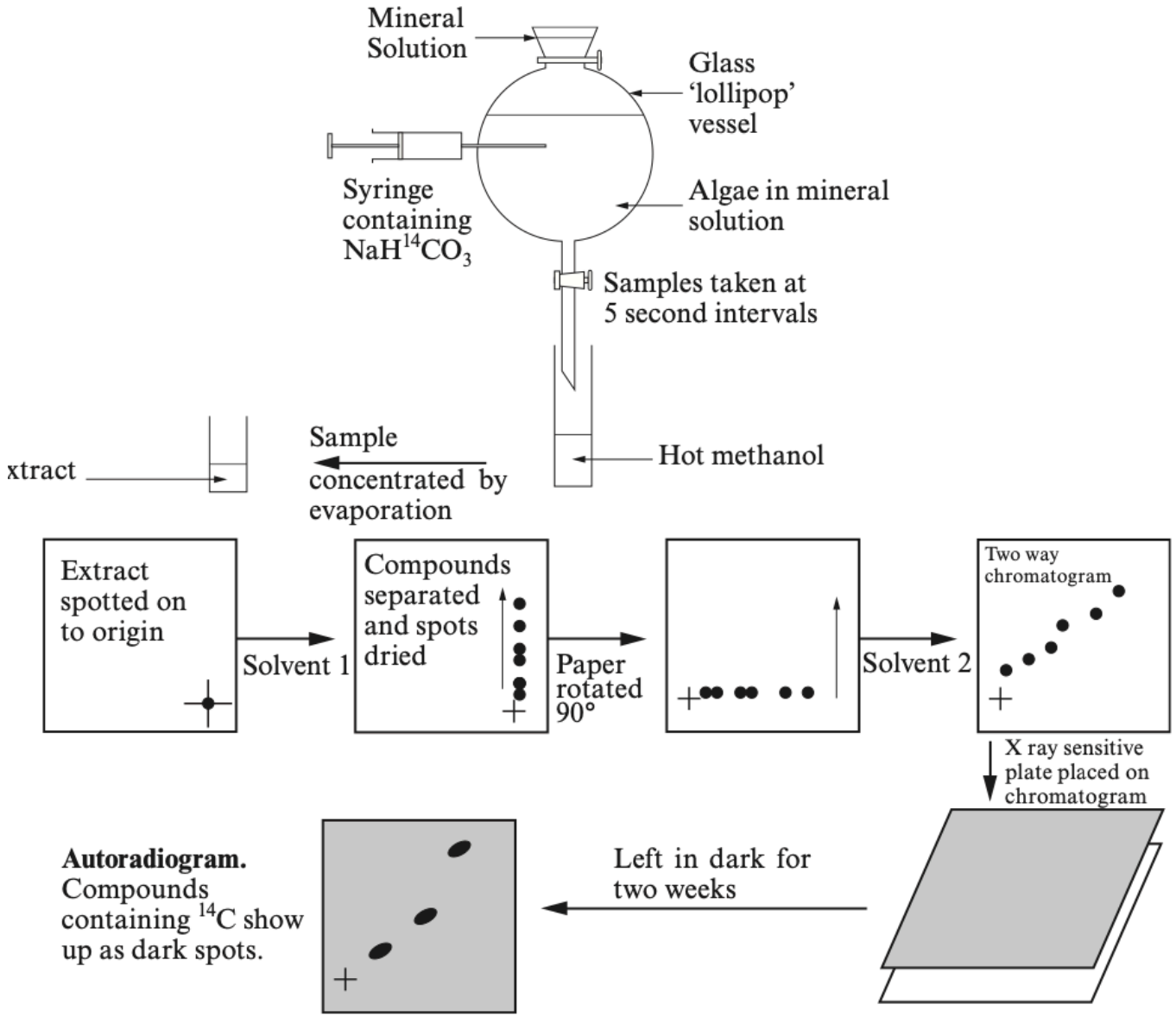
(ii) Light dependent stage of photosynthesis. [1]

.....

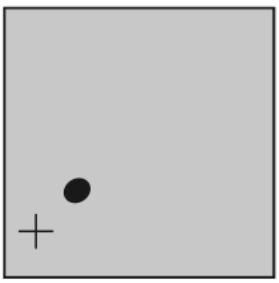
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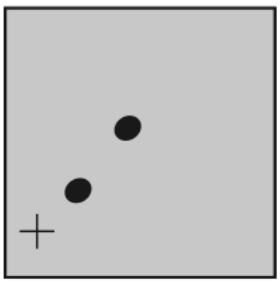
7. Calvin did experiments on a series of reactions which is now called the light independent stage of photosynthesis. The diagram shows one such experiment. The apparatus was set up as shown and brightly illuminated. The clock was started on the introduction of radioactive hydrogen carbonate ions.



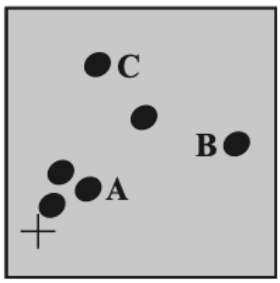
Autoradiograms from one such experiment are shown below:



After 5 seconds



After 10 seconds



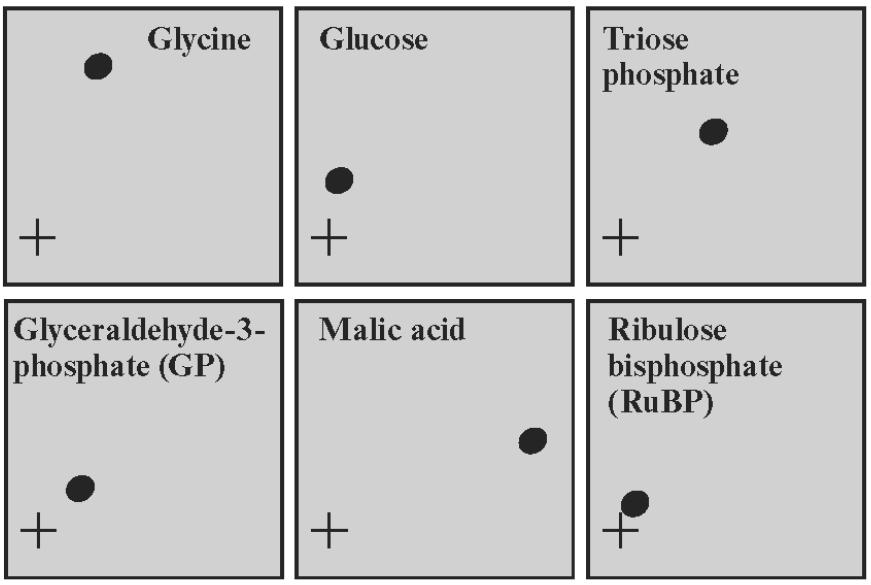
After 30 seconds

(a) What is the main difference between these three autoradiograms? [1]

.....

.....

(b) To identify the substances represented by the dark spots, Calvin made autoradiograms of known substances. He then compared their positions with those of the dark spots. The results of some of these are shown below.



Use these autoradiograms and the ones shown in part *(a)* to identify compounds represented by spots **A-C**. [1]

Spot	Name of compound
A	
B	
C	

(c) Use the autoradiograms to determine which were the first and second substances formed. [2]

First .....

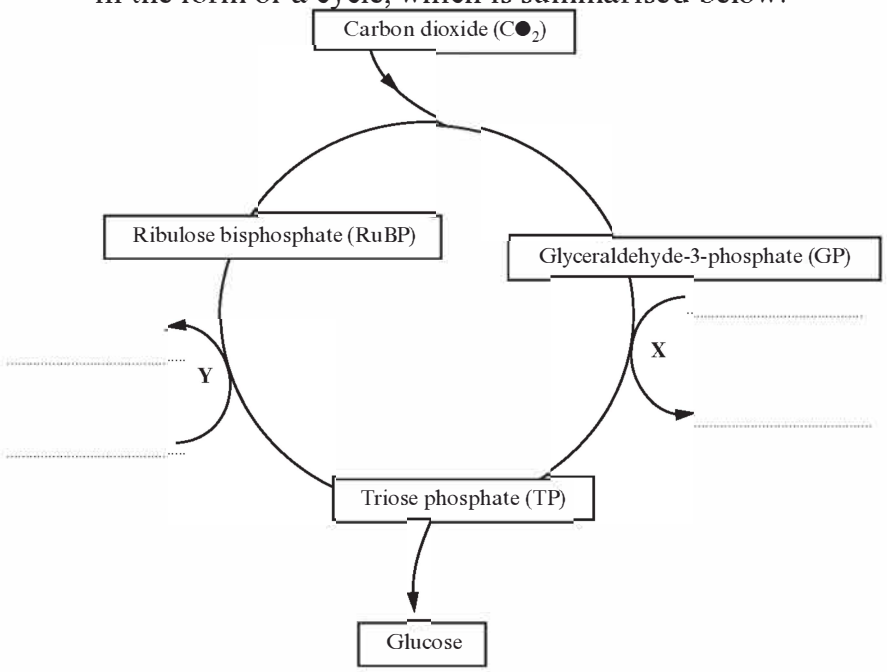
Second .....

(d) Glycine is an amino acid. Which chemical element would have been needed in the mineral solution in order for the algae to have made this compound? [1]

.....

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(e) Calvin worked out that the ribulose bisphosphate is regenerated so that the reactions are in the form of a cycle, which is summarised below:



Compound **X** is a hydrogen carrier and compound **Y** is the universal energy currency in cells.

(i) Complete the diagram to show how compounds **X** and **Y** change during the cycle. [2]

(ii) Which series of reactions provides the compounds **X** and **Y** in chloroplasts? [1]

.....

(iii) State precisely where the production of **X** occurs in chloroplasts. [1]

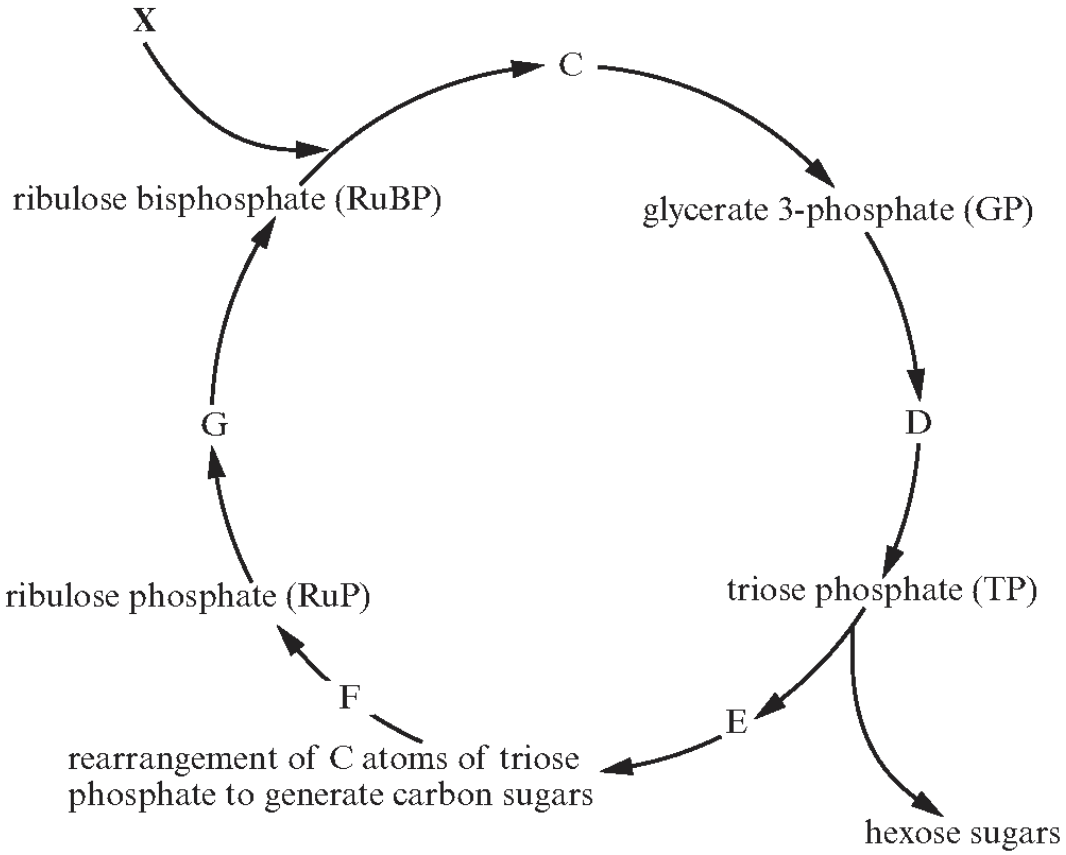
.....

.....

(f) How many molecules of triose phosphate would be needed to synthesise three molecules of glucose? [1]

(Total 10 marks)

8. The diagram summarises the light independent reactions of photosynthesis (Calvin cycle).



(a) Name the molecule which enters the cycle at point **X**. [1]

.....

(b) State the **two** products of the light dependent stage of photosynthesis that are required in the Calvin cycle. [2]

.....

.....

(c) Using the above diagram, give the letters of the two steps where the chemicals named in *(b)* are required. [2]

.....

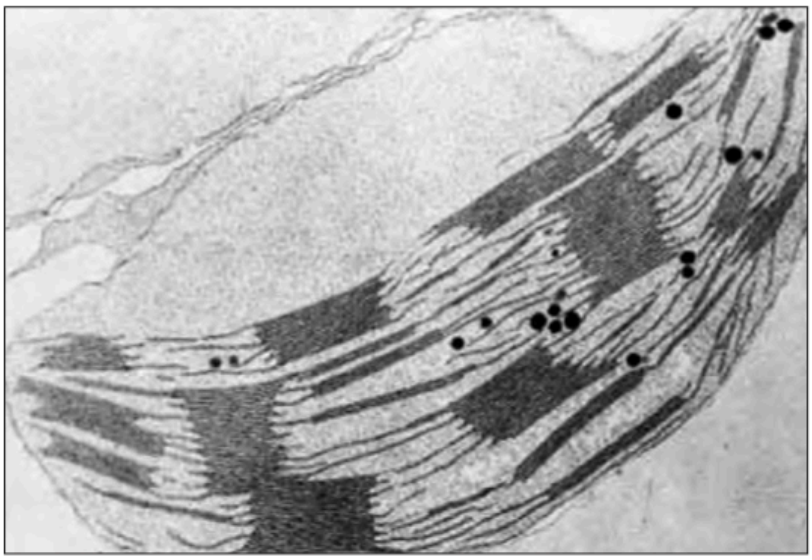
(d) State **one** possible fate of the hexose sugars produced. [1]

.....

(Total 6 marks)

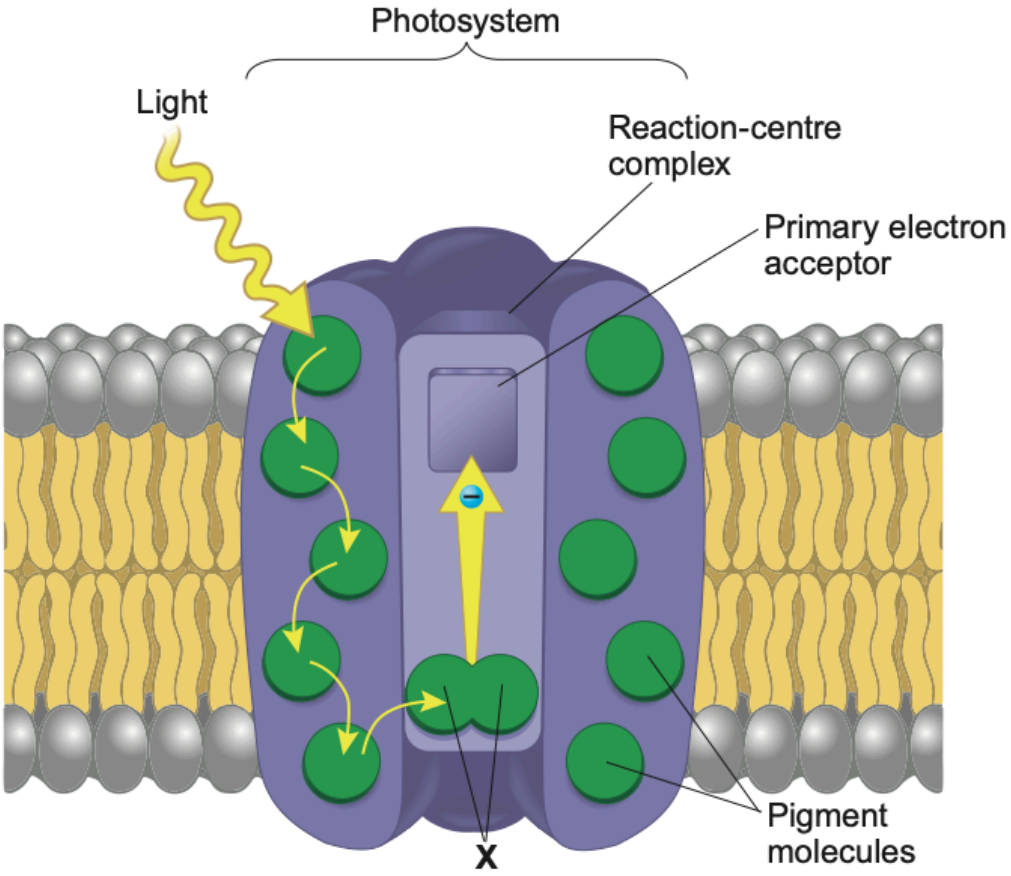
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9. The electron micrograph below shows a chloroplast, taken from a eukaryotic organism.



(a) (i) **Identify using a clearly labelled arrow** where photosystems are found on the electron micrograph above. [1]

The diagram below represents one photosystem.



(ii) Identify the pigment found at **X**. [1]

.....

(b) Explain the role of photosystems in the light dependent stage of photosynthesis. [3]

.....

.....

.....

.....

.....

.....

(c) Following the synthesis of carbohydrate, a number of inorganic ions are needed to synthesise other biological molecules.

State **three** different biological molecules **and** the inorganic ions required to synthesise them. [3]

I. ....

II. ....

III. ....

(d) Herbicides inhibit photosynthesis in many ways.
One group of herbicides block electron transport, so chlorophyll continues to absorb light energy but cannot pass this energy on.
Light energy not used in electron emission damages chlorophyll leading to chlorosis.
Desiccation occurs because of the formation of oxygen free-radicals, which are highly destructive to cell membranes.

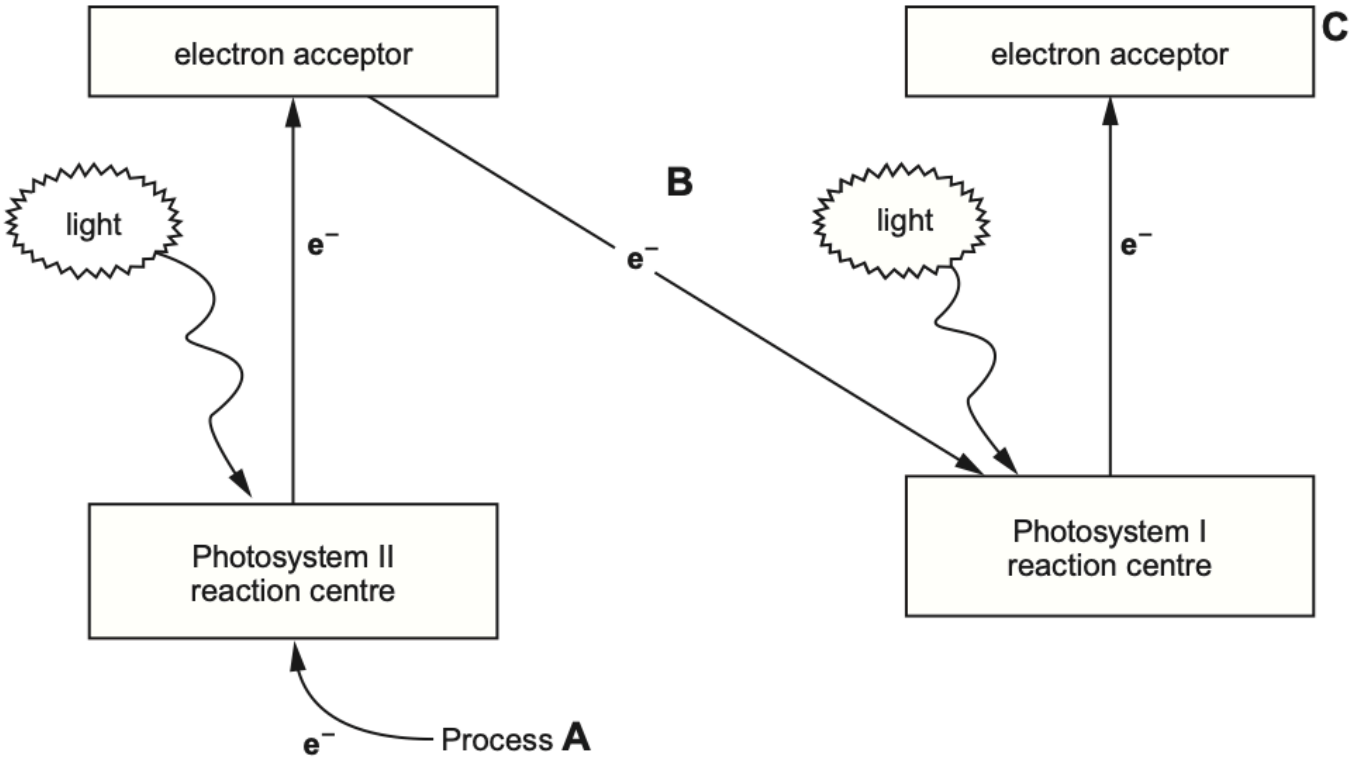
Use the information given and your own knowledge to explain how blocking electron transport from photosystems with this herbicide could lead to the death of a plant. [4]

.....

.....

10.

4. The light dependent stage of photosynthesis can be represented by a diagram called the Z-scheme, shown below.



(a) (i) **Describe** the process at **A** which replaces the electrons lost from photosystem II and explain how electrons are used at **B** and **C**. [3]

.....

.....

.....

.....

.....

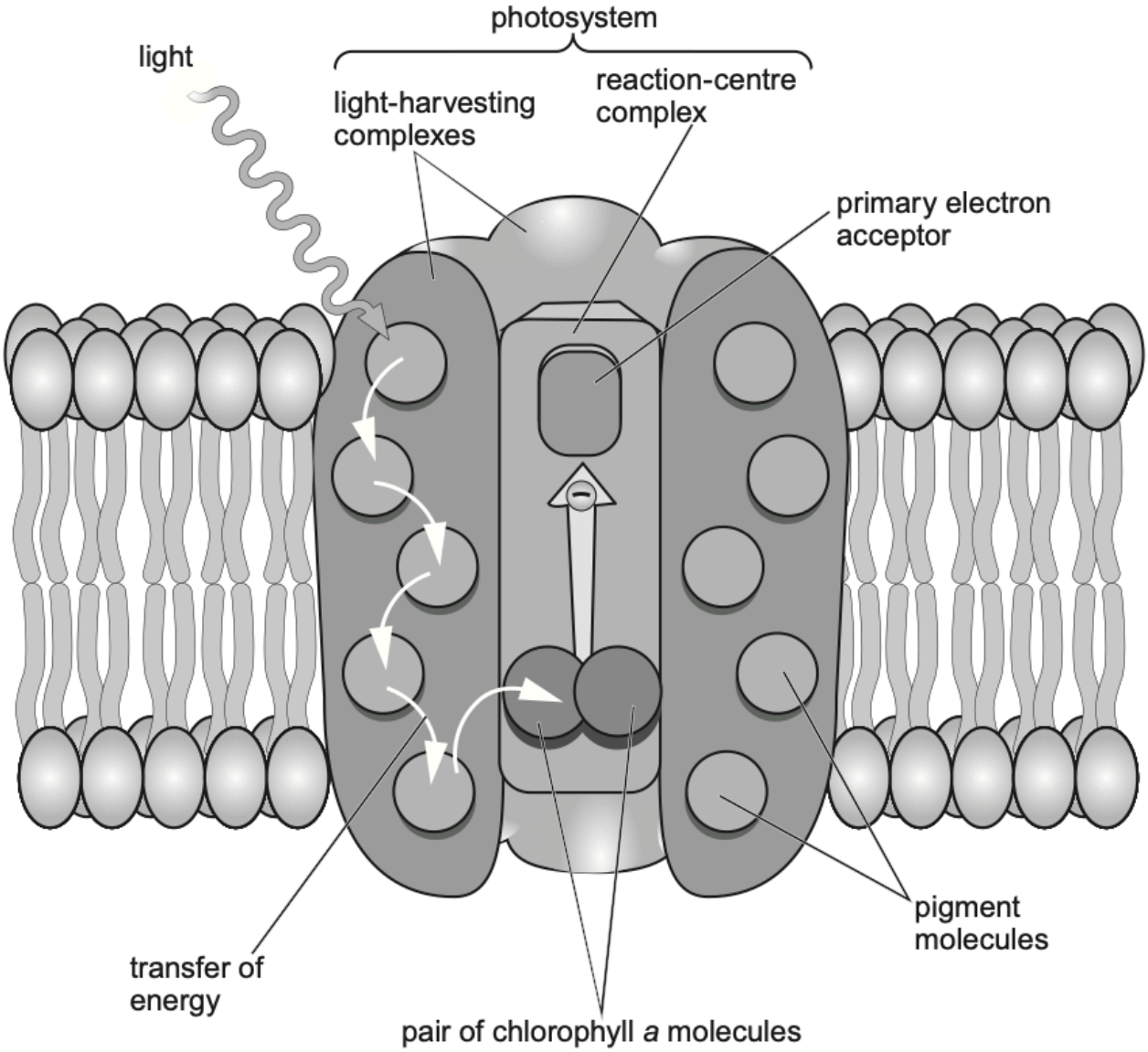
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(ii) **Draw a clear line** labelled **X** on the Z-scheme diagram above, to indicate the movement of electrons in cyclic photophosphorylation. [1]

(b) The modern representation of a photosystem is shown in the diagram below.



(i) Apart from chlorophyll *a*, name **three** *other* pigments you would expect to be present in a photosystem. [2]

.....

.....

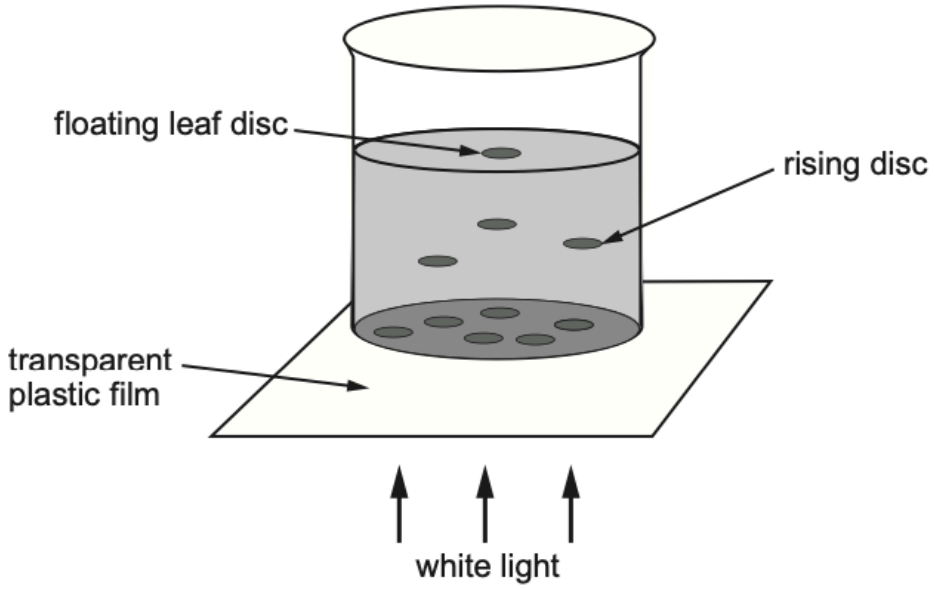
.....

(ii) State precisely where a photosystem would be found in a plant cell. [1]

.....

(c) An experiment was carried out to investigate the effect of leaf colour on the rate of photosynthesis. Leaves placed in water naturally float, but if small discs of leaves are punched out of the leaves and the air in the discs is replaced by hydrogen carbonate solution (a CO_2 source), they will sink.

The time taken for 15 light green leaf discs to float to the top of the solution when illuminated from below can be determined and gives an estimate of the rate of photosynthesis. This was repeated for dark green leaf discs.



The results of such an experiment are shown below.

Order of leaf discs rising	Time taken for each leaf disc to rise / seconds	
	Dark green colour discs	Light green colour discs
1st	102	296
2nd	157	324
3rd	186	358
4th	201	360
5th	240	420
6th	260	422
7th	287	665
8th	317	666
9th	396	805
10th	404	1000
11th	474	1108
12th	535	1173
13th	622	1674
14th	808	1821
15th	898	2388
Mean time	.....	898.7

(i) Calculate the mean time taken for the 15 dark green discs to float and **insert your answer in the table**. [1]

(ii) Explain what caused the discs to rise in the solution. [2]

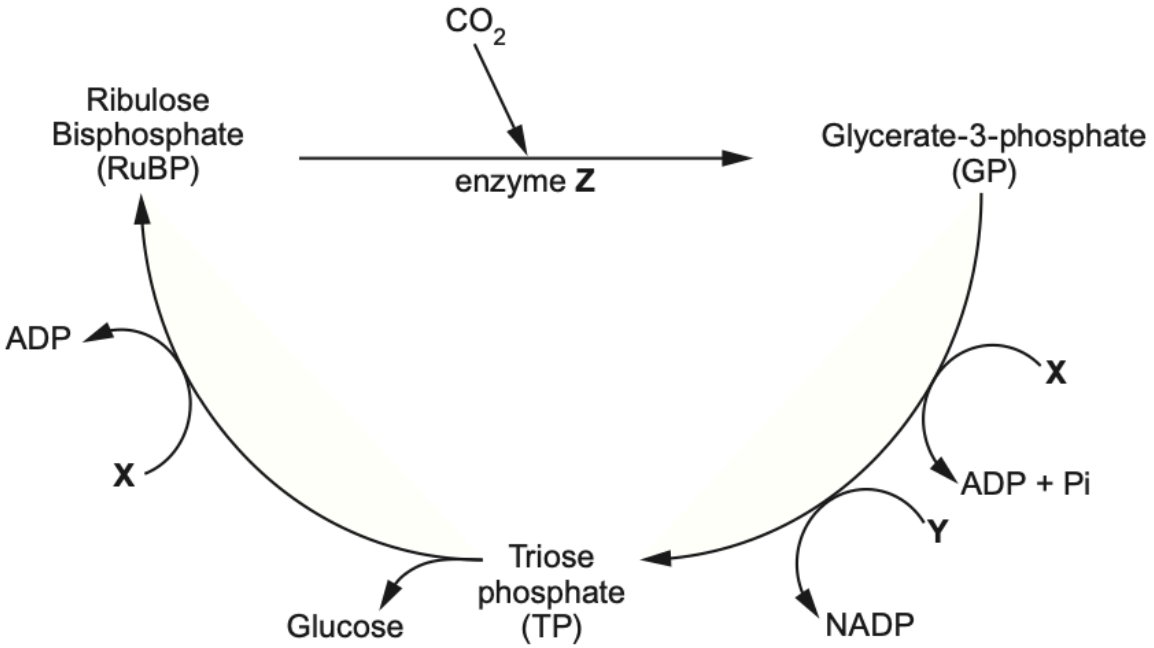
(iii) Explain why the darker green leaf discs rose faster than the lighter green discs. [4]

(d) (i) Describe how would you use the technique described in *(c)* to investigate the effect of light wavelength on photosynthesis. [4]

(ii) Predict the results that you would expect from this experiment. [2]

11. Tomatoes are an important food crop that can be grown in commercial greenhouses. The greenhouses often have cooling fans.

When a tomato plant is exposed to light the following reactions take place in the stroma of a chloroplast.



(a) (i) Identify substances **X** and **Y**. [1]

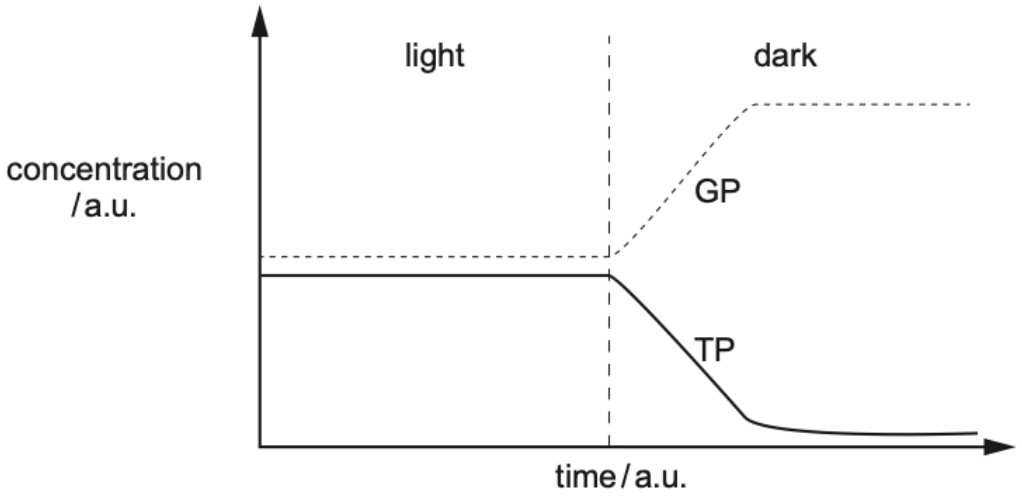
X .....

Y .....

(ii) Name enzyme **Z**. [1]

.....

(b) In the absence of light, the concentration of glycerate-3-phosphate (GP) in the chloroplast stroma increases. This is shown on the graph below.



Explain the shape of the graph for both GP and TP when the plant is in the dark. [5]

1.

Question		Marking details	Marks Available
(a)	(i)	**1 mark for both** Y Cyclic photophosphorylation Z Non cyclic photophosphorylation	1
	(ii)	(High energy) electrons/electron {carriers/acceptors};	1
	(iii)	NADP → NADPH(2)/ reduced NADP;	1
	(iv)	Oxygen/ O_2/ ½ O_2;	1
	(v)	Carbon dioxide/ CO_2;	1
	(vi)	Glucose;	1
(b)			4

Area	Letter	Name of region
Where the light dependent stage occurs	**C;**	Grana/Thylakoid;
Where the light independent stage occurs	**D;**	Stroma;

One mark for each box

(c) Synthesis of amino acids/proteins **using {a nitrogen source/ named nitrogen source}**; — Max 3
Synthesis of phospholipids with **phosphate;**
Synthesis of chlorophyll with **magnesium**;
Synthesis of {nucleotides/named nucleotide} with a **nitrogen source and phosphate source**;

Question 5 Total **[13]**

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2.

Question			Marking details	Marks Available
	(a)	(i)	A;	1
		(ii)	A <u>and</u> D;	1
		(iii)	C;	1
	(b)	(i)	{RuBP/ 5C compound} and carbon dioxide linked together / carbon dioxide is fixed with RuBP; RuBP carboxylase / RUBISCO {is the enzyme / catalyses the reaction}; unstable 6C {substance/compound} {initially formed/ splits into two 3C};	2 max
		(ii)	Glycerate 3 phosphate reduced; using reduced NADP; ATP also required (to supply energy) / Glycerate 3 phosphate is phosphorylated; {reduced NADP / ATP} from the light dependent reactions;	3 max
	(c)	(i)	some (triose phosphate) needed to {regenerate/ make more} RuBP;	1
		(ii)	six times;	1
			Question 3 Total	**[10]**

3.

Question			Marking details	Marks Available
(a)			It stops electrons from PS II being moved to PS I; So blocking the reduction of $NADP^+$ to NADPH; Cyclic Photo Phosphorylation only involves PSI; is not stopped as the electrons pass from PSI and return to PSI/ eq; And the carrier involved in this is not affected;	4
(b)			Plant cannot generate {$NADPH_2$/ NADPH/ reduced NADP} {so Calvin cycle cannot work/ description of part of process which is prevented}; {No glucose/ hexose sugar} will be formed; For respiration;	3
(c)	(i)		1. Ribulose bisphosphate; 2. Glycerate(-3-)phosphate; 3. Glyceraldehyde(-3-)phosphate/triose phosphate;	3
	(ii)		Catalyses {the reaction between RuBP and carbon dioxide/ to fix carbon dioxide} ;	1
	(iii)	X	ATP;	2
		Y	$NADPH_2$;	
	(iv)	A	CO_2 Fixation/ 6C intermediate/ RuBP binds to CO_2;	3
		B	Regeneration/resynthesis of RuBP;	
		C	Reduction;	
			Question 7 Total	**[16]**

4.

Question			Marking details	Marks Available
4	*(a)*		Any **2** from: Reaction centre / antenna complex; In a photosystem; In the thylakoid (membrane);	2
	(b)		19/68 or 20/68; 0.28 or 0.29; (2d.p.) ecf Xanthophyll;	1 1 1
	(c)	(i)	Absorption spectrum;	1
		(ii)	(Green) light is reflected (by the pigments);	1
		(iii)	Any **2** from: • {light / photons} can be absorbed over {a greater range of / more} wavelengths; Accept correct use of figures • More {light / photons} absorbed means more products from the light dependent stage; • {Greater rate of / faster} photosynthesis / Photosynthesis is more efficient;	2
	(d)		Any **3** from: • Light absorbed by (pigments in) {photosystems / PSI / PSII / description of photosystem}; • {Excites electrons / raises electrons} to higher energy level; • Electrons emitted from reaction centre/chlorophyll a; • Used to power proton pumps / generate an EC gradient; • Movement of protons through a stalked particle / ATP synthase allows ATP generation;	3
			Question 4 Total	**[12]**

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5. (a) absorbs light energy [1]

(b) (i) 440 nm [1]

(ii) any pigment / chlorophyll absorbs or uses a limited part of the spectrum / light wavelength; additional pigments increase range of wavelengths; from which energy can be obtained (any two) [2]

(c) all wavelengths except green are absorbed / green is reflected or transmitted. [1]

(d) since they follow a similar trend / pattern / shape; it suggests that the pigments / wavelengths responsible or used in light absorption are used in photosynthesis. [2]

(e) (i) A – light harvesting unit / complex / centre / antenna complex [1]

B – reaction centre [1]

(ii) cross in circle of reaction centre [1]

(iii) thylakoid membrane / granal membrane / intergranal membrane [1]

[Total 11 marks]

6.

Question		Marking details	Marks Available
(a)	(i)	Respiration Combustion; Both for 1 mk. Accept deforestation	1
	(ii)	Chloroplast;	1
	(iii)	Light independent; Calvin cycle; RUBP; Rubisco; (unstable 6 C substance) 2 mols of GP;	2
(b)	(i)	Produces carbohydrate / glucose / respiratory substrate;	1
	(ii)	Produces oxygen;	1
		Question 6 Total	**[6]**

7.

(a)	they have increasing numbers of spots (not: the number of spots)	**1**
(b)	A - GP, B-malic acid, C-glycine (all 3 for 1 mark)	**1**
(c)	First - GP; second-Triose phosphate	**2**
(d)	Nitrogen (not: nitrate)	**1**
(e) (i)	Y - ATP to ADP (+P); X-$NADPH_2$ to NADP	**1** **1**
(ii)	light dependent reactions/(non cyclic) photophosphorylation; (not: Z scheme/cyclic photophosphorylation)	**1**
(iii)	grana/thylakoids	**1**
(f)	6	**1**
		Total 10 marks

8.

(a) carbon dioxide [1]

(b) ATP;

Reduced NADP / NADPH / $NADPH_2$ [2]

(c) D;

G (any order) [2]

(d) energy source / cellulose / lipids / food store /

amino acids / proteins / pentose sugar / disaccharide.

[**accept:** named sugars] [1]

[Total 6 marks]

9.

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(a)	(i)		Clear labelled arrow (thylakoid/ grana/ photosystem) to any thylakoid membrane	1			1		
		(ii)		Chlorophyll a	1			1		
	(b)			A. Absorb {light (energy)/ photons} (1) B. Act as a transducer/ transferring light energy to high energy electrons/ excites electrons/ causing chlorophyll a to emit electrons/ pass energy to reaction centre (1) C. Which can be used to power proton pumps/ synthesise ATP/synthesise reduced NADP/ electrons passed down the electron transport chain (1)	3			3		
	(c)			Any **three** (x1) from: Amino acids/proteins — Nitrates (Sulfates) Phospholipids — Phosphates Nucleotides/ any example — Nitrates **and** phosphates Chlorophyll — Magnesium (ions) (nitrates)	3			3		
	(d)			Any **four** (×1) from: A. Destruction of chlorophyll- no PS/unable to absorb light (energy) (1) B. {No/ less} {red NADP/ ATP} for {Calvin cycle/ light independent reactions} (1) C. {No/ less} {carbohydrate/ named carbohydrate} synthesised for {respiration/ synthesis of biological molecules} (1) D. {No/ less} respiration, therefore {no/ less} ATP for {cell division/protein synthesis/ active transport} (1) E. Destruction of cell membranes – kills/dries out cells (1)			4	4		
				Question 3 total	**8**	**0**	**4**	**12**	**0**	**0**

10.

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(a)	(i)		A. Water is split to release electrons , protons and oxygen (1) reject reference to enzymes splitting water Accept equation B. ATP synthesis/ ADP + P(i) -→ ATP/ fuel proton pumps (1) C. $NADP^+ + 2e^- + 2H^+ \rightarrow NADPH + H^+$ (Accept $NADPH_2$) / reduction of NADP (1)	3			3		
		(ii)		Line from electron acceptor above photosystem1 to diagonal line	1			1		
	(b)	(i)		Chlorophyll b/c Carotene Xanthophyll **3 correct = 2 marks** **2 correct = 1 mark** **0/1 correct = 0 marks**	2			2		
		(ii)		Thylakoid (membrane) in a chloroplast	1			1		
	(c)	(i)		392.5 seconds		1		1	1	
		(ii)		Oxygen produced from {photosynthesis/ photolysis of water}(1) (O_2 fills the airspaces in the leaf so) the leaf is {less dense/ lighter/ more buoyant} (and so rises) (1)(must be in correct context)		2		2		2
		(iii)		**Any 4 (x1) from:** A. (the darker leaves rise more quickly because they have) more {chloroplasts/chlorophyll/ pigment} (in the palisade mesophyll) (1) B. So more {photons will be trapped/ light (energy) absorbed} /more energy transferred to high energy electrons (1) Ignore more wavelengths C. More light dependent stage/ or description of (1) D. More photolysis of water (1) E. More O_2 production (1)			4	4		4
	(d)	(i)		A. Change light wavelength/ or description e.g. using filters/ bulbs (1) B. Record the time taken for discs to rise (1) C. Keep hydrogen carbonate concentration constant/ temperature constant/ light intensity/ height of solution (1) D. same colour leaf/ {area/diameter/ size} discs/ species of plant (1)			4	4		6
		(ii)		{Less time/ faster} to rise at the {blue/ violet/ short/ approx. 350nm} **and** {red / longer/ approx. 650nm} wavelengths (1) {Slower to /More time to/ does not } rise in the {yellow/green/ approx. 500nm} wavelengths (1)		2		2		
				Question 4 total	**7**	**5**	**8**	**20**	**1**	**12**

11.

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths *	Prac **
	(a)	(i)		X ATP **and** **Y** Reduced NADP/ $NADPH_2$ / NADPH +H^+/ NADPH Not NAD	1			1		
		(ii)		RuBisCO/ carboxylase/ ribulose bi(s)phosphate carboxylase/ RuBP carboxylase	1			1		
	(b)			**Any five (x1) from:** A. (Initially), Carbon dioxide + RuBP reaction continues/ GP continues to be produced(1) B. GP cannot be {converted/ reduced} to TP (1) C. because ATP **and** reduced NADP are needed (1) D. ATP and reduced NADP {only produced in light/ not produced in dark}(1) E. (therefore) less TP available {to regenerate RuBP/ as it used produce glucose} (1) F. (Therefore) rate of reaction of carbon dioxide and RuBP decreases (1)		3	2	5		