Discuss how far the results of this investigation support her conclusion. (4)

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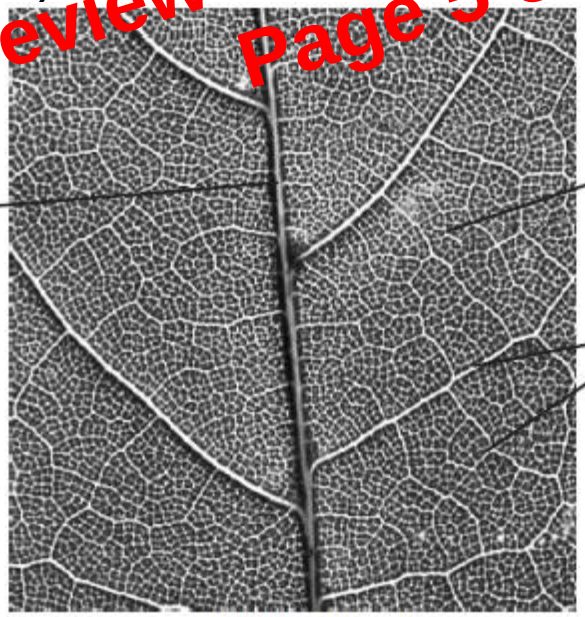
(Total for Question 5 = 12 marks)

2 The photograph below shows part of a leaf, as seen using a hand lens. **(June 2013)**



Magnification ×20

(a) Suggest why each of the following is important for the production of
carbohydrates in the photosynthetic cells.
(i) The thin lamina
(2)

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(ii) Vessels in the midrib
(2)

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(b) The photosynthetic cells contain many chloroplasts.
(i) Complete the table below by naming the part of the chloroplast where each
of the reactions, **R**, **S** and **T**, takes place. (3)

Reaction	Details	Part of chloroplast
R	ADP + inorganic phosphate → ATP	
S	RuBP + CO_2 → 2 × GP	
T	2 × GP → 2 × GALP	

(ii) Place a cross in the box next to the name of reaction **R**.
(1)
A carbon fixation
B hydrolysis
C phosphorylation
D photolysis
(iii) Place a cross in the box next to the name of the enzyme involved in reaction **S**.
(1)
A endonuclease
B phosphorylase
C RUBISCO
D transcriptase
(iv) Suggest how GALP, formed by reaction **T**, can be used to synthesise the
cellulose in plant cell walls. (4)

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..... **(3)**

(c) The rate at which plants produce carbohydrate by photosynthesis is known as gross primary productivity.
Put a cross in the box next to the equation that shows the relationship between gross primary productivity (GPP), net primary productivity (NPP) and respiration (R).

GPP + R = NPP GPP + NPP = R
GPP = NPP + R GPP = NPP – R **(1)**

(d) The table below shows the net primary productivity in four different ecosystems. The ecosystems in the table are listed in order of increasing distance from the equator, starting with tropical rainforest.

Ecosystem	Net primary productivity / kJ m^{-2} $year^{-1}$
Tropical rainforest	37 800
Temperate forest	25 200
Boreal forest	14 700
Polar tundra	2 400

(i) It is estimated that 85% of the energy available to primary consumers will not be available to secondary consumers. Calculate the energy that will be available to the secondary consumers in the **tropical rainforest**. Show your working.

Answer ..... kJ m–2 year–1 **(2)**

(ii) Suggest **two** reasons for the differences in the net primary productivity as the distance from the equator increases.

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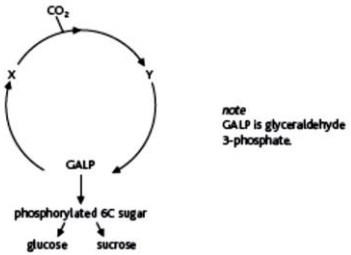
..... **(2) (Total 13)**

13. The diagram below shows an outline of the light-independent stage of photosynthesis,together with some of the products. **(EdTB)**



note
GALP is glyceraldehyde 3-phosphate.

a Using the information provided in the diagram, identify substances X and Y and state the number of carbon atoms present in each. **(2)**

X…… Y……

b Explain how substance Y is converted to GALP. **(2)**

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c. GALP is converted to a phosphorylated 6-carbon sugar which in turn can be converted to a number of products such as sucrose and glucose. Sucrose is translocated around the plant in phloem.
Describe how phloem tissue is adapted for this function. **(6) (Total 10 marks)**

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14. Photosynthesis is a complex metabolic process which can be influenced by many different environmental factors.
(a) Explain the term **limiting factor** with reference to photosynthesis.

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…… (2)

(b) An investigation into the effect of light intensity and carbon dioxide concentration on photosynthesis was carried out using pond weed. The pond weed was placed in a test tube that contained pond water and a quantity of sodium hydrogencarbonate. The light was provided by a lamp. The oxygen bubbles produced by the pond weed were directed into a length of capillary tubing.

The graph below shows how the rate of oxygen production of the pond weed changed with light intensity when immersed in two different concentrations of sodium hydrogencarbonate.

8. Bi-directional flow / flow in any direction ;
9. From {leaves / eq} to {growing regions / storage organs} / reference to source to sink ;
10. Oxygen by diffusion ; 5 **[12]**

16. (a) Light {intensity / wavelength} / photoperiod / carbon dioxide concentration / {soil / eq} / {watering / humidity} / temperature / {age / size / mass / eq} of plant; 1
[Reject amount]
(b) Prevent { reactions / respiration / photosynthesis / carbon fixing / uptake of carbon dioxide} / eq; 1
(c) 1. ATP production requires electron flow / ATP production reduced;
2. ATP produced in {light dependent reactions / photosystems /chloroplast membranes / thylakoids};
3. CO_2 fixation requires ATP / less CO_2 fixed;
4. RuBP regeneration requires ATP / cannot regenerate RUBP;
5. Correct reference to reduction of NADP;
6. Production of carbohydrate requires ATP / less carbohydrate produced;
7. Reduction of PGA / GP triose phosphate requires reduced NADP;
8. Conversion to PGAL requires energy from ATP / reduced NADP;
9. So less radioactive carbon fixed in products of photosynthesis / eq; 5 **[7]**

17. (a) Stroma of chloroplast / stroma 1

(b) NADPH / reduced NADP / $NADPH_2$ / $NADPH + H^+$ / NADPH + H; ATP; 2

(c) Idea of carbon dioxide fixation / carbon dioxide acceptor;
To form 6C {compound / intermediate / molecule} / to form {2 × 3C molecules / GP};2
(d) (i) RuBP increases and GP decreases;
Description of one curve (e.g. GP decreases and levels off, both quantities equal at 3.5 minutes, comparison of 2 gradients); 2
(ii) 1. [RuBP rises because] it is being regenerated / it accumulates / eq;
2. [RuBP rises because] less CO_2 {to combine with it / for fixation / eq};
3. [GP falls because] less is being formed;
4. [GP falls because] being used faster than it's being formed; 2 **[9]**

18. (a) 1. Factor which {controls / eq} the rate
2. Increasing this factor increases the rate (of photosynthesis);
3. Factor {not at optimum / nearest its {threshold / minimum} value / eq} 2

(b) [condition + control for two marks]
1. Temperature; Use water bath / description of heat filter / eq;
2. Carbon dioxide; adding sodium hydrogen carbonate / bubble through carbon dioxide / eq; 3. {Wavelength / colour} of light; Use same {light source / filter / gel};
4. pH; [not acidity / alkalinity] Buffer; 4
(c) 1. {Equilibrate / eq} before timing;
2.{Clear / remove} bubbles from capillary tube at start / eq;
3.Use syringe to move {oxygen / gas bubble} into capillary tube eq;
4.measure length of bubble / eq;
5.Correct reference to determining volume of oxygen / eq;
6.Correct reference to rate calculation;
7.Reference to repeats to give {mean /reliable} results / eq; 4
(d) 1. Reference to {filters / gets / coloured bulbs / eq}
2. Reference to appropriate qualification e.g. filters placed in correct position / keeping light intensity the same / all other factors the same 2 **[12]**

19. (a) 1. Light harvested / eq; 2. Reference to chlorophyll;
3. Reference to {accessory / eq} pigments;
4. Electrons excited / reference to higher energy level;
5. Reference to carriers / electron acceptors / electron transport chain;
6. Reference to energy release coupled to ATP production; 7. Photophosphorylation;
8. Reference to photolysis (as electron source); 5
(b) Sucrose content increased; Correct figure manipulation; 2
(c) 1.Less PGAL converted to RuBP / less RuBP reformed;
2. More available for {sucrose / glucose} production;
3. Enzymes for sucrose more active than for RuBP production; 2
(d) 1. Higher carbohydrate yield; 2. Sweeter crop / better quality crop;
3. Faster growth of crop / eq; 4. Increased profit; 2**[11]**

20. (a) 1. shape and quality of diagram;
ACCEPT round / oval clear diagram with a smooth, clear, complete outline.
2. double membrane i.e. has two lines clearly not cristae;
3. grana / thylakoids shown as at least two stacks joined by one line;
4. correctly labelled position of light dependent and independent reactions; 4
(b) 1. {light absorbed / energy absorbed / electrons excited / eq} in {photosystem /PS I / PS II / pigment system / P680 / P700};
2. (photosystems) {emit /eq} electrons;
3. electron from PSII pass along {chain of electron carriers / eq} to PS I;
4. ATP generated / eq; 5. electron from PS1 to NAD**P** to form NAD**P**H + H / eq;
6. using {H^+ / eq} from {photolysis /eq}; 7. oxygen formed; 4
(c) 1. oxygen {diffuses out (of leaf / photosynthetic tissue) / used in respiration};
2. ATP and NADPH + H {enter Calvin Cycle / enter light independent stage / used in synthesis of carbohydrate / used to reduce CO_2 / eq}; 2 **[10]**

21 . (a) 1. absorption spectrum shows wavelengths where light is absorbed by pigments / eq; 2. action spectrum shows activity at different wavelengths / eq;
3. reference to the link between peak absorption for a pigment and the photosynthetic rate; 4. indicates that pigments are involved in {photosynthesis / eq};
5. correct comparison between graphs (using whole range of wavelengths); max 3
(b) thylakoid (membrane) / granum / grana; 1
(c) 1. use of {chromatography paper / (silica) gel plates / eq};
2. using {solvent / named example} to {move / separate} pigments;
3. left to run until solvent {reaches / near to} {top / other end} of {paper / plate};
4. origin and solvent front marked;
5. reference to use of Rf values to identify pigments; max 4

(d) 1. (magnesium) {component / used in formation / eq} of chlorophyll;
2. less chlorophyll formed if magnesium deficient / eq;
3. {other pigments / carotenoids} still present / eq; max 2
[10]