Chapter 6

Plant nutrition

01. 0610_s19_qp_41 Q: 2

The rate of photosynthesis of terrestrial plants can be determined by measuring the uptake of carbon dioxide.

(a) Explain why plants take up carbon dioxide during photosynthesis.

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..... [2]

(b) The rate of photosynthesis of parts of individual leaves can be measured using a hand-held device as shown in Fig. 2.1.

Fig. 2.1

This apparatus allows air to flow through the transparent chamber that encloses part of the leaf. The apparatus measures the carbon dioxide concentration of the air entering and leaving the chamber.

Explain how the results from the apparatus can be used to calculate the rate of photosynthesis.

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..... [2]

(c) A student used the apparatus shown in Fig. 2.1 to investigate the effect of temperature on the rate of photosynthesis of the leaves of Chinese plantain, *Plantago asiatica*, at two different concentrations of carbon dioxide, **A** and **B**.

Fig. 2.2 shows the results of the investigation.

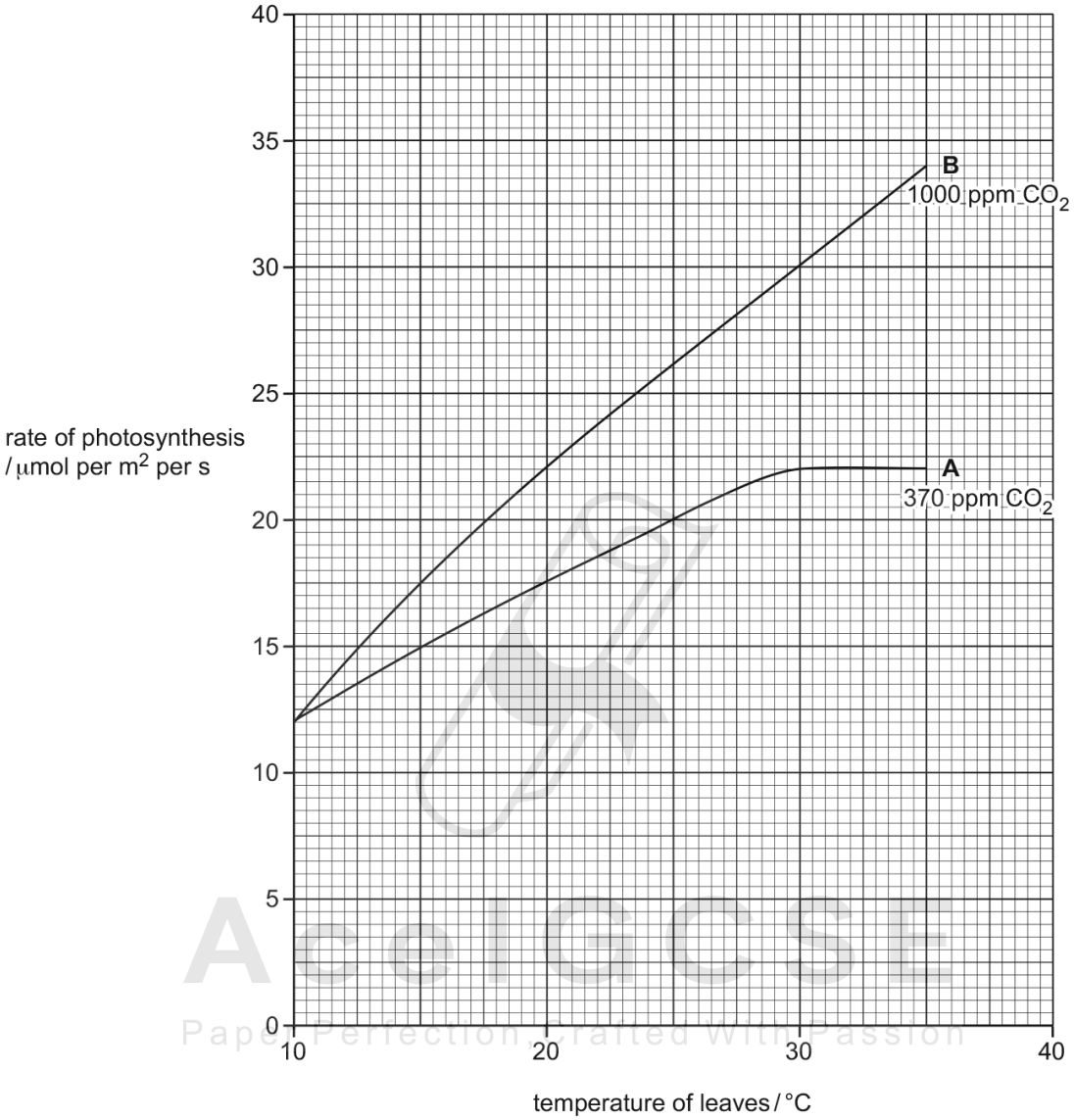

Fig. 2.2

(i) State **one** environmental factor that should have been kept constant in this investigation.

..... [1]

(ii) Describe the effect of temperature on the rate of photosynthesis when carbon dioxide concentration **A** was supplied.

Use the data from Fig. 2.2 in your answer.

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..... [3]

(iii) Calculate the percentage increase in the rate of photosynthesis at 30 °C when the carbon dioxide concentration was increased from **A** to **B** as shown in Fig. 2.2.

Show your working and give your answer to the nearest whole number.

..... %
[2]

(iv) Explain the effect of increasing temperature on the rate of photosynthesis for carbon dioxide concentration **B**.

Use the term *limiting factor* in your answer.

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..... [3]

(v) The student concluded that carbon dioxide concentration is the factor limiting the rate of photosynthesis between 30 °C and 35 °C for the results shown for **A** in Fig. 2.2.

State the evidence for this conclusion.

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..... [1]

02. 0610_s19_qp_43 Q: 2

(a) State the **word** equation for photosynthesis.

..... [2]

(b) Scientists investigated the effect of light intensity on the rate of photosynthesis in the leaves of eucalyptus trees at two different concentrations of carbon dioxide, **A** and **B**.

The results are shown in Fig. 2.1.

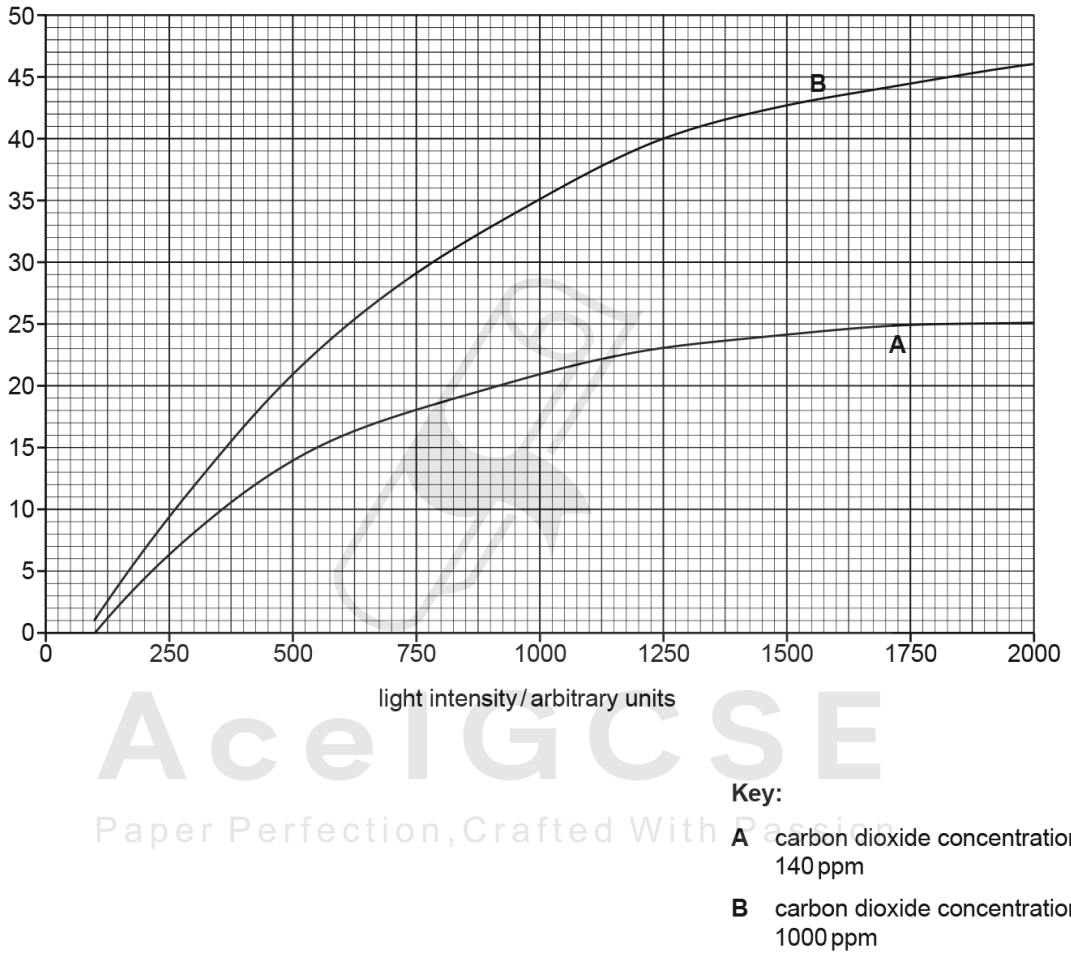

Fig. 2.1

(i) Suggest **and** explain why the scientists kept the temperature of the leaves at 20 °C while they recorded results.

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..... [2]

(ii) Calculate the percentage increase in the rate of photosynthesis at a light intensity of 1250 arbitrary units when the carbon dioxide concentration was increased from 140 ppm to 1000 ppm.

Show your working and give your answer to the nearest whole number.

..... %
[3]

(iii) Describe the effect of increasing light intensity on the rate of photosynthesis when the concentration of carbon dioxide was 140 ppm.

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..... [3]

(iv) Explain the effect of increasing light intensity on the rate of photosynthesis when the concentration of carbon dioxide was 1000 ppm.

Use the term *limiting factor* in your answer.

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..... [4]

[Total: 14]

(a) State the balanced chemical equation for photosynthesis.

$$\text{.....} \xrightarrow[\text{chlorophyll}]{\text{light}} \text{.....}$$

[2]

A student investigated the effect of different wavelengths of light on the rate of photosynthesis of the water plant, *Cabomba*.

The student used the apparatus shown in Fig. 6.1.

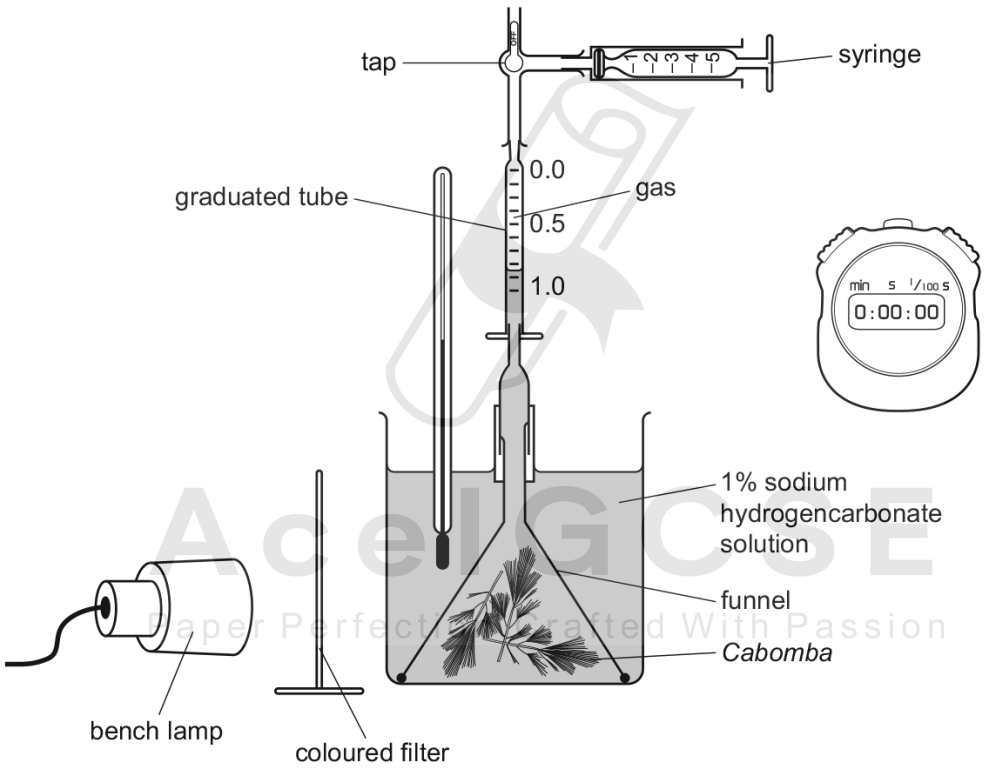

Fig. 6.1

(b) The student collected the gas produced by the plant for five minutes. The results are shown in Table 6.1.

Table 6.1

colour of filter	wavelength of light / nm	volume of gas collected / cm^3
violet	400	0.80
blue	475	0.80
green	550	0.20
yellow	600	0.40
red	675	0.90

Describe the effect of wavelength of light on the rate of photosynthesis as shown in the student's results in Table 6.1.

You will gain credit if you use data from the table.

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..... [3]

(c) State how the student would calculate the rates of photosynthesis from the results in Table 6.1.

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..... [1]

(d) State why the student:

(i) kept the lamp at the same distance during the investigation,

.....

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..... [1]

(ii) used sodium hydrogencarbonate solution.

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..... [1]

(e) State **three** uses in a plant of the carbohydrate produced in photosynthesis.

1.....

2.....

3.....

[3]

[Total: 11]

04. 0610_s17_qp_41 Q: 6

Students investigated the effect of mineral ion deficiencies on the growth of radish plants.

The seeds that were used in the experiment were from plants that had been self-pollinated for many generations and were therefore all genetically identical.

(a) Explain the advantage of using genetically identical radishes in this investigation.

.....

.....

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.....[2]

The radish seedlings were divided into four groups. Each group was grown in a different mineral ion solution as follows:

1 complete solution containing all the major mineral ions

2 solution with all the major mineral ions except **nitrate ions**

3 solution with all the major mineral ions except **magnesium ions**

4 solution with all the major mineral ions except **phosphate ions**

The apparatus used to investigate the growth of the plants is shown in Fig. 6.1.

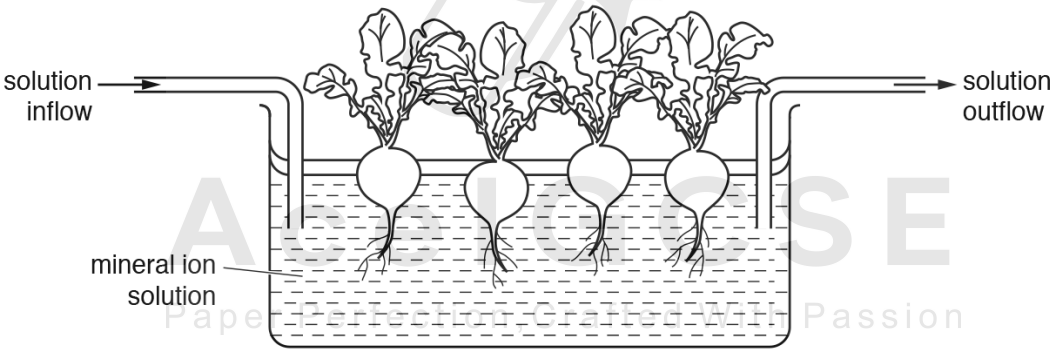

Fig. 6.1

(b) State **three** other environmental factors that could affect the growth of the seedlings.

1.....

2.....

3.....

[3]

The results of the investigation are shown in Table 6.1.

Table 6.1

group	mineral ion solution	number of plants	total dry mass of all plants/mg			mean dry mass of one plant/mg
			leaves	roots	total	
1	complete	8	1880	1110	2990	374
2	without nitrate ions	10	1410	750	2160	216
3	without magnesium ions	9	1600	260	1860	207
4	without phosphate ions	9	1670	140	1810	201

(c) Describe **and** explain the results for the radishes grown without nitrate ions (group **2**).

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.....[4]

(d) Describe the likely appearance of the radish plants grown in the solution without magnesium ions (group **3**) and explain your answer.

appearance.....

.....

explanation.....

.....

.....

[3]

(e) Phosphate ions are a component of DNA.

Suggest why the radish plants in group **4** grew less than the radish plants in the complete solution (group **1**).

.....

.....

.....

.....

.....[2]

[Total: 14]

(a) Name **one** feature of dicotyledonous leaves that distinguishes them from monocotyledonous leaves.

.....[1]

(b) Explain why a leaf is an organ.

.....

.....[1]

(c) Photosynthesis occurs in leaves.

State the balanced chemical equation for photosynthesis.

.....[3]

(d) Fig. 6.1 is an image of a section through a dicotyledonous leaf from a scanning electron microscope.

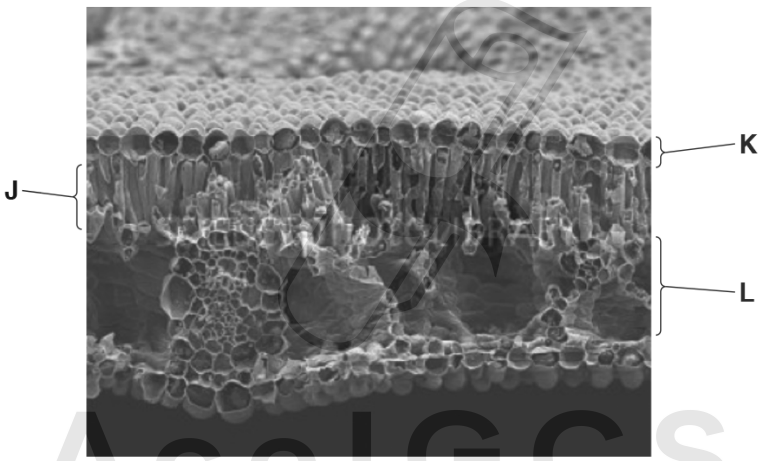

Fig. 6.1

Identify the layers labelled in Fig. 6.1 and explain how their adaptations allow photosynthesis to occur in the leaf.

(i) layer **J** .....

adaptation for photosynthesis .....

.....

[2]

(ii) layer **K** .....

adaptation for photosynthesis .....

.....

[2]

(iii) layer **L** .....

adaptation for photosynthesis .....

.....

[2]

(e) Plants need nitrate ions for growth.

Explain why.

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.....[3]

[Total: 14]

01. 0610_s19_MS_41 Q: 2

	Answer	Mark	Partial Marks
(a)	carbon dioxide is, raw material / substrate / reactant / AW ; concentration of carbon dioxide is higher outside leaf than inside (so carbon dioxide diffuses into the leaf) ;	2	
(b)	subtract the concentration of carbon dioxide at the end from the concentration at the start / AW ; divide by the time (taken) / per unit time ; ref. to taking (rate of) respiration into account ;	2	
(c)(i)	light intensity ; water (supply) ; humidity ;	1	
(c)(ii)	increases and, reaches a plateau / remains constant / 'levels off' ; increases (between 10 °C) to 30 °C / levels off at 30 °C ; any comparative use of figures for rate with units at least once ;	3	
(c)(iii)	36 ;;	2	
(c)(iv)	temperature is the limiting factor (over whole range) ; increased temperature increases, kinetic energy / KE, (of molecules) ; increases rate of diffusion of carbon dioxide (into leaf) ; temperature, influences / affects, (activity of) enzymes ; *idea of* more (effective) collisions between substrate molecules and enzymes (in plant) / more enzyme-substrate complexes formed ; more carbon dioxide is, fixed / used in photosynthesis / converted into sugar / AW ; carbon dioxide (concentration) is **not** limiting ;	3	
(c)(v)	***B** shows that:* rate of photosynthesis is, higher / continues to increase, if carbon dioxide is increased (at all temperatures / AW) ;	1	
(d)	*prediction:* rate of photosynthesis, remains constant / decreases / slows ; *any explanation one from:* enzymes / active sites, are denatured (at high temperatures) ; stomata close, so, little / no, carbon dioxide can enter leaves ; plant is adapted to survive at high temperatures ;	2	

02. 0610_s19_MS_43 Q: 2

	Answer	Mark	Partial Marks
(a)	carbon dioxide + water ⟶ ; glucose □ oxygen ;	2	
(b)(i)	temperature is a factor that affects the rate of photosynthesis ; *reference to* kinetic energy ; *idea of* effect of temperature, on enzymes / diffusion rate (of carbon dioxide) ; *idea that* temperature is a variable that should be standardised ; AVP ;	2	
(b)(ii)	74 ;;;	3	
(b)(iii)	rate (of photosynthesis) increases and, reaches a plateau / AW ; rate (of photosynthesis) increases until 1750 (a.u) / 25 □mol per m^2 per s ; any comparative use of figures for rate ;	3	
(b)(iv)	light intensity is the limiting factor, at all light intensities used / AW ; because rate of photosynthesis does not level off (even at high light intensities) ; carbon dioxide / temperature / chlorophyll / another factor, was not a limiting factor ; *correct reference* to (light) energy ; light is absorbed by chlorophyll ; AVP ;	4	

03. 0610_s16_MS_41 Q: 6

	Answer	Mark	Partial Marks
(a)	$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$;;	[2]	one mark for the correct chemical formulae one mark for balancing the equation correctly **R** word equation
(b)	as wavelength increases, rate (of photosynthesis) decreases and increases ; high rates in, blue and violet and red / 400–475 nm and 675 nm ; low(est) rate in, green and yellow / 550–600 nm ; *either* maximum rate = 0.9 cm^3, at 675 nm / red *or* minimum rate = 0.2 cm^3, at 550 nm / green ;	[max 3]	units must be used once in the answer **A** volume of gas for rate
(c)	divide the volumes by, five (minutes) / time ;	[1]	
(d) (i)	to keep the light intensity the same ;	[1]	**R** temperature **I** 'fair test' **A** 'control light intensity' / 'light intensity is a control(led) variable'
(ii)	to provide carbon dioxide / so carbon dioxide is not a limiting factor / so the only limiting factor is wavelength ;	[1]	
(e)	for, respiration / energy ; converted to sucrose ; used to make, nectar / fruits ; used to make, cellulose / lignin ; used in cell walls ; used to make, starch / oils / fats ; storage ; used to make, amino acids ; used to make, chlorophyll ;	[max 3]	**I** protein synthesis / growth / active transport **R** produces energy **I** 'makes food', but **A** 'stores food' for 1 mark
		[Total: 11]	

04. 0610_s17_MS_41 Q: 6

	Answer	Mark	Partial Marks
(a)	**1** variation (in radishes) is not a (confounding) factor ; **2** any differences are due to non-genetic factors ; **3** example of non-genetic factors – environment / mineral ions ; **4** so it was possible to make comparisons ;	**2**	**A** improves validity of investigation
(b)	**1** hhumidity (of air) ; **2** temperature ; **3** llight ; **4** carbon dioxide ; **5** pH (of nutrient solution(s)) ; **6** rate of aeration / oxygen supply / oxygen ; **7** depth of solution / volume of solution ; **8** spacing / density (of radishes / plants) ; **9** AVP ;	**3**	**I** water supply / moisture **A** warmth **I** gravity **R** ref. to soil e.g. wind (speed) e.g. pests / diseases
(c)	**1** less growth than the, control / complete medium / group 1 ; **2** leaf / root, mass per plant is less than, control / group 1 ; **3** comparative use of figures per plant, calculated / stated, from the table with units; **4** (nitrate (ions) / nitrogen) required to make, amino acids / proteins ; **5** any one use of proteins in plants ;	**4**	 **A** polypeptides
(d)	*appearance max 1* **1** yallow(–green) leaves / chlorosis / stunted / short ; *explanation for max 2* **2** magnesium is needed for chlorophyll ; **3** chlorophyll, makes plants *or* chloroplasts green / is a green pigment ; **4** cannot trap, enough / much, light for photosynthesis ; **5** less / no, photosynthesis / sugar production ; **6** less materials for, growth / making (new) cells ; **7** less sugar for respiration ;	**3**	 **R** chloroplast
(e)	**1** less / no, DNA / RNA (is produced) ; **2** (new) DNA is needed for cells to divide (by mitosis) ; **ora** **3** genes / chromosomes, are made of DNA ; **4** mitosis / cell division, is one way in which organisms grow ; **5** DNA / RNA, needed for protein synthesis ; **6** protein is needed for growth ; **7** AVP ;	**2**	 e.g. energy supply in cells needs ATP

	Answer	Mark	Partial Marks
(a)	(branching) veins; **ora** shape / broad (leaves); **ora**	1	**I** petioles
(b)	it is (made of a group of) tissues working together to perform specific function(s);	1	
(c)	$6CO_2 + 6H_2O$ (LHS); $C_6H_{12}O_6 + 6O_2$ (RHS); energy / light / chlorophyll;	3	
(d)(i)	palisade (mesophyll / tissue / cells / parenchyma); tightly packed / contain many chloroplast / stacked upright;	2	 **A** lots of chlorophyll
(d)(ii)	(upper) epidermis / epidermal cells; transparent / allows light to pass through / thin;	2	
(d)(iii)	spongy, mesophyll / tissue / cells / parenchyma / layer; air spaces / loosely packed / gas exchange / diffusion of gases;	2	Mark points are not linked
(e)	nitrates are useable source of nitrogen; needed to make amino acids; (amino acids) to make proteins; protein / DNA, needed for growth; to make DNA / RNA / nucleotides / bases; other suitable named use of organic nitrogenous compounds found in plants;	3	
		Total: 14	