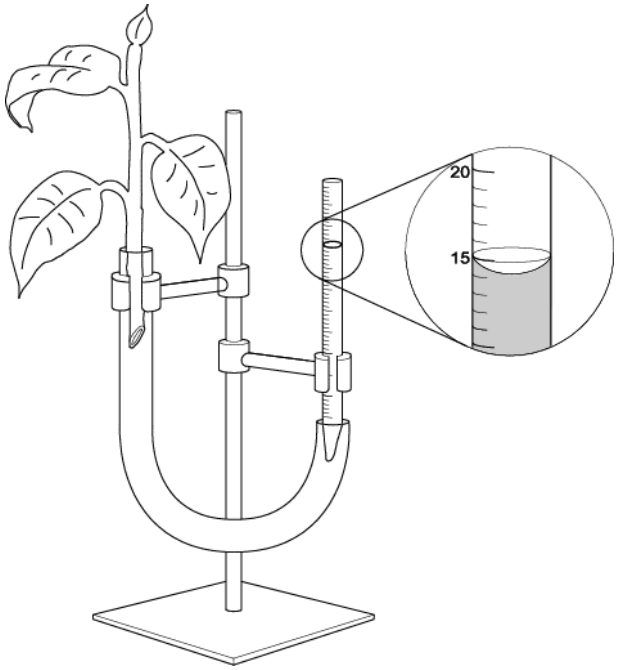
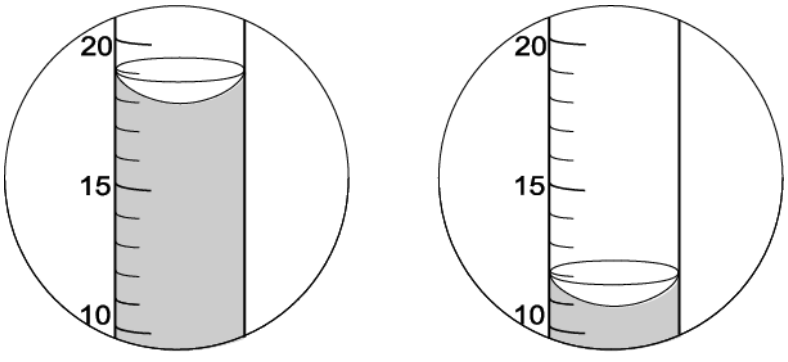
1(a). A student investigates the effect of temperature on the rate of water uptake by a plant.

She places a plant in the apparatus shown below. The temperature of the room is 35°C.



(i) The student measured the distance moved by the water level over a period of 30 minutes.

The diagrams show her results.



Air bubble before Air bubble after

Calculate the rate of water uptake.

Show your working.

Give your answer to two significant figures.

Rate of water uptake = _____ cm^3/min **[2]**

(ii) How could the student use this apparatus to investigate the rate of water uptake in windy conditions?

Other apparatus is available, too.

_____

_____ **[1]**

(iii) The volume of water taken up may not be an accurate measurement of the water lost in transpiration.

Suggest why.

_____

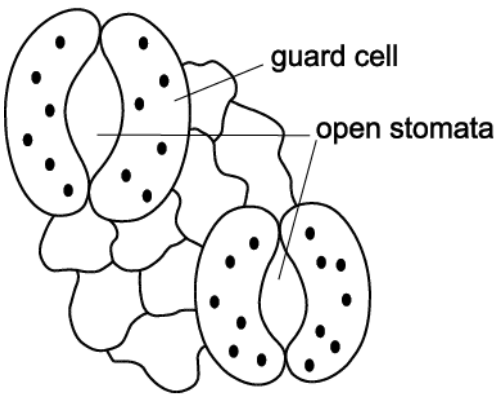
_____

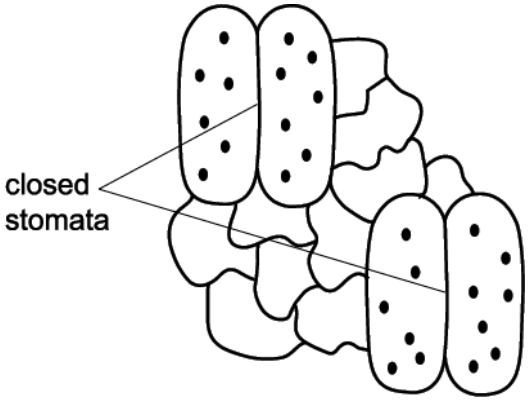
_____ **[2]**

(b). Stomata are small holes found mostly on the underside of leaves.

They can open and close. The opening and closing of the stomata is controlled by guard cells.

The diagram below shows the stomata and the guard cells.





Potassium ions from neighbouring cells enter the guard cells. This causes the stomata to open.

Explain how this mechanism works.

---

[2]

2(a). A student does an experiment to find out more about how the process of osmosis works.

The student was provided with ten pieces of potato, each about 5 cm long.

She was also given five dishes each containing a different **unknown** concentration of sugar solution.

The student put two pieces of potato in each dish and left them for 30 minutes. She then removed the potato pieces and re-measured their length.

The student recorded the results in this table.

Dishes of sugar solution	Length of potato (cm)				Change in mean length (cm)	Percentage change
	Original	After 30 minutes in sugar solution				
		Piece 1	Piece 2	Mean		
1	4.9	5.0	5.4	5.2	+0.3	
2	5.1	4.3	4.1	4.2	–0.9	–18.4
3	5.0	4.8	4.4	4.6	–0.4	–8.0
4	5.2	5.7	5.9	5.8	+0.6	+11.5
5	4.9	4.8	4.8	4.8	–0.1	–2.0

(i) The student has not finished working out the results.

Calculate the missing value and write it in the table.

[2]

(ii) The table below shows the concentration of sugar solution in each of the five dishes.

Use the results from the students' experiment to show which solution was in each dish.

Write down the correct dish number in the column headed **"Dish"**.

Sugar solution concentration (mol dm^{-3})	Dish
0.2	
0.4	
0.6	
0.8	

1.0	

[1]

(iii) The student measured the length of the pieces of potato as a quick way to obtain results.

Why does this method not measure the total change to the pieces of potato?

---

[1]

(iv) How could the student modify the experiment to show the rate of water movement by osmosis in pieces of potato?

---

[2]

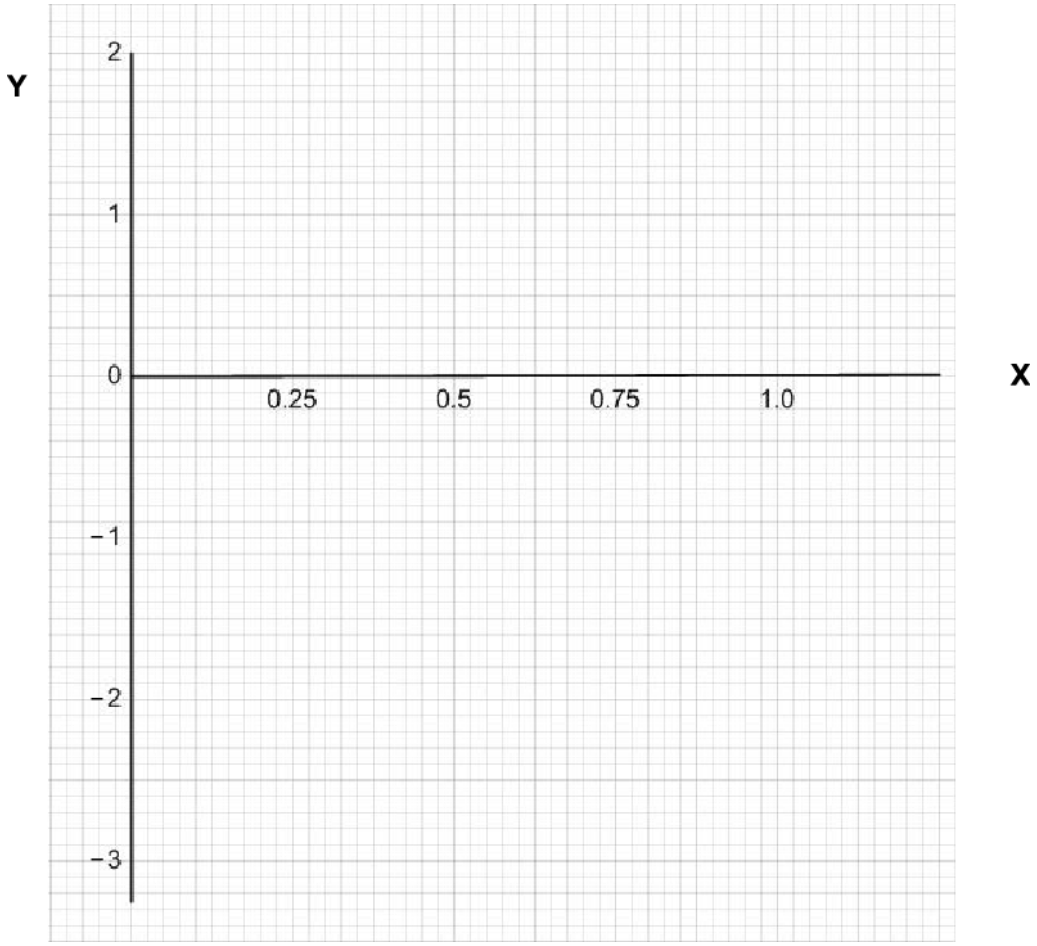
(b). Another student did a similar experiment.

These are his results.

Sugar solution concentration (mol dm^{-3})	Change in mean length (mm)
1.00	–1.9
0.75	–1.2
0.50	–0.5
0.25	+0.3
0.00	+1.0

(i) Use the information in the table to label the X and Y axis on the grid below.

[1]



(ii) Plot the student's results on the grid.

[2]

(iii) Draw a line of best fit.

[1]

(iv) Use your graph to find the concentration of the sugar solution where the potato pieces do not change in length.

sugar solution concentration _____ mol / dm^{-3} **[1]**

(v) What can you conclude, in terms of osmosis, at this concentration?

---

[1]

3(a). Victoria investigates the effect of different salt concentrations on cells.

Victoria weighs five pieces of potato.

She places one piece of potato into each of five different concentrations of salt solution.

After 20 minutes, she removes the pieces of potato and weighs each of them again.

Her results are shown in the table.

Concentration of the salt solution (mol)	Starting mass (g)	Final mass (g)	Difference in mass (g)	Percentage change in mass (%)
0.1	2.2	2.5	+0.3	
0.2	2.4	2.5	+0.1	+4.17
0.3	3.0	3.1	+0.1	+3.33
0.4	2.1	1.9	−0.1	−4.76
0.5	2.4	2.2	−0.2	−8.33

(i) Calculate the percentage change for the piece of potato placed in the 0.1 mol salt solution.

Show your working.

Give your answer to two decimal places.

percentage change = _____ % **[2]**

(ii) It is better to calculate the percentage change in mass rather than just using the difference in mass.

Explain why.

_____

_____

_____ **[2]**

(iii) What conclusion can Victoria make?

Put a tick (✓) in the box next to the correct answer.

Potato pieces in concentrations …

… greater than 0.4 mol lose mass. ☐

… lower than 0.3 mol do not change mass. ☐

… lower than 0.2 mol lose mass. ☐

… greater than 0.1 mol do not change mass. ☐

[1]

(iv) The data in the table can be used to work out the concentration of the cells in the potato pieces.

Use the data to give the range of concentration of the cells.

Range = _____ (mol) to _____ (mol) **[2]**

(b). Victoria wants to improve the quality of her data and to improve her confidence in the conclusions.

Suggest **three** improvements she could make to her procedure.

1

2

3

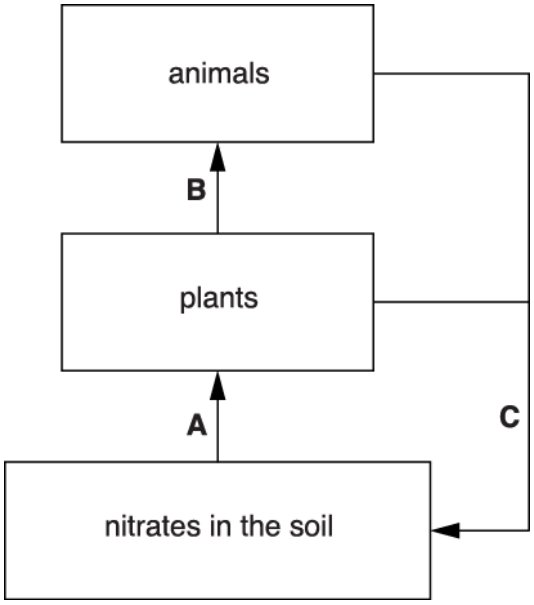
---

[3]

4. Sewage contains chemicals that can be broken down into nitrates.

Nitrates are found in the soil.

The diagram shows part of the nitrogen cycle.



Use the diagram to explain what is happening at arrows **A**, **B** and **C**.

The quality of written communication will be assessed in your answer.

[6]

5(a). Photosynthesis takes place in plants.

Pondweed cells contain structures that have different roles in photosynthesis.

Write the correct name for each **cell structure** alongside its role in **photosynthesis**.

One has been done for you.

role in photosynthesis	cell structure
contains the genetic code for making the enzymes needed	nucleus
allows oxygen to pass out of the cell	.....
contains chlorophyll and enzymes	.....

[1]

(b). In addition to the substrates needed for photosynthesis, plants need a source of nitrogen to grow.
Plants use **active transport** to absorb nitrogen in the form of nitrates from the soil.

(i) Complete the sentence about active transport.

Active transport is the overall movement of chemicals across a _____ requiring energy from the process of _____.

[1]

(ii) Some plants cannot grow very well in water-logged soils.

Such soils often **lack oxygen**.

A team of plant scientists conclude that

"Plants growing in water-logged soils have an increased chance of showing signs of nitrogen-deficiency."

Use your knowledge of active transport to explain this conclusion.

_____

_____

_____

_____ **[2]**

6(a). Plants need chemicals to survive.

Water enters and leaves plant tissues by osmosis.

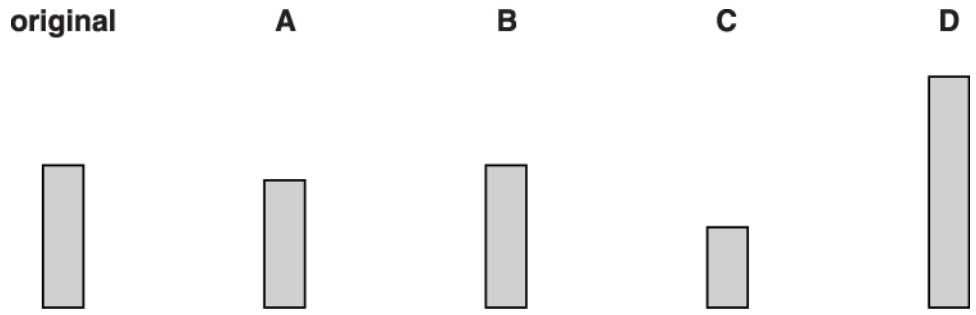
Kaye is investigating how plant tissue takes up water.

She uses four potato chips, **A**, **B**, **C** and **D**.

The chips are all cut to the **same length**.

Kaye puts the four chips into four different concentrations of sugar solution.

The diagram shows the original length of the chips and the length of each chip **after** soaking for 60 minutes in the sugar solutions.



(i) Write letters **A**, **B**, **C** and **D** in the table to show which chip was in each solution.

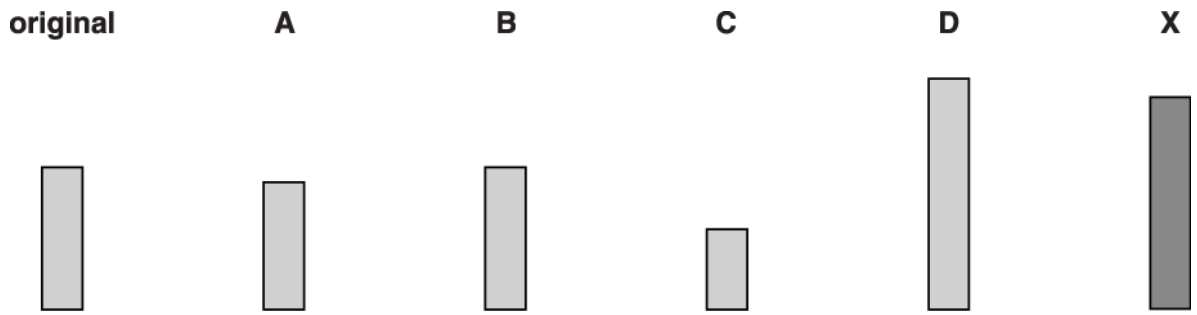
Concentration of solution in arbitrary units	Potato chip
0.0	
0.3	
0.6	
0.9	

[2]

(ii) Kaye has another potato chip, **X**, which has been in a different concentration of sugar solution.

Potato chip **X** was originally cut to the same length as the other chips.

The diagram shows potato chip **X after** soaking for 60 minutes in the sugar solution.



The label on the test tube containing chip **X** has rubbed off.

Use the results of Kaye's experiment to estimate the concentration of sugar solution (in arbitrary units) in the test tube containing chip **X**.

---

[2]

(b). Active transport is used in the absorption of nitrates by plant roots.

What is **active transport**?

Complete the sentences.

Active transport is the movement of chemicals from low concentration to high concentration

across a _____.

This requires _____ from the process of respiration.

[1]

(c). Suggest why plants growing in water-logged soil may not take up enough nitrates.

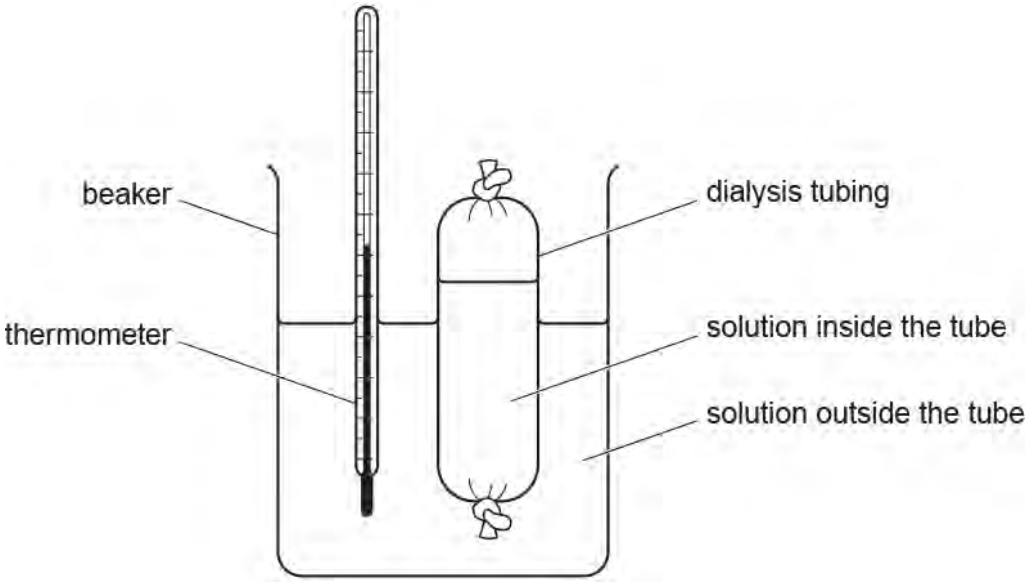
---

[2]

7(a). Eve sets up three experiments using dialysis tubing.

Dialysis tubing is a partially-permeable membrane.

Each experiment is set up as shown in the diagram:



What is the purpose of the thermometer?

Tick (✓) **one** box.

To control the temperature. ☐

To record the temperature. ☐

To measure the temperature. ☐

To stir the solution. ☐

[1]

(b). Eve wants to do each of her three experiments at exactly 30 °C.

Describe how Eve could ensure the temperatures of the solutions in each experiment are kept at exactly 30 °C.

---

[1]

(c). Eve sets up the solutions as shown in **Table 2.1**.

Amylase is an enzyme.

Experiment	Solution inside the tube	Solution outside the tube
1	starch + tap water	tap water
2	glucose + tap water	tap water
3	starch + amylase + tap water	tap water

Table 2.1

After 3 minutes she removes a small sample of each solution.

Describe how she could test each sample for the presence of glucose.

---

[2]

(d). She also uses iodine solution to test each sample for the presence of starch.

Her results are shown in **Table 2.2**.

Experiment	Sample from inside the tube		Sample from outside the tube	
	Test for starch	Test for glucose	Test for starch	Test for glucose
1	positive	negative	negative	negative
2	negative	positive	negative	positive
3	positive	positive	negative	positive

Table 2.2

(i) What conclusions can you make from Eve's results?

---

[4]

(ii) Eve repeats experiment 3, but this time she boils the amylase before using it.

Write a testable prediction for this repeat of experiment 3.

Explain the science behind your prediction.

Prediction ---

Explanation

[3]

(e). Eve sets up one more experiment as shown in **Table 2.3**.

Experiment	Solution inside the tube	Solution outside the tube
4	starch + tap water	tap water + iodine solution

Table 2.3

The molecules of iodine in the iodine solution are smaller than molecules of glucose.

Eve watches this experiment for 5 minutes.

Describe and explain the changes she is likely to observe during the 5 minutes.

[4]

8. State the function of stomata in plants.

---

[1]

9(a). Nina is learning about substances absorbed by plants. She finds out that plants absorb nitrate ions from the soil.

Explain why nitrate ions are essential for plant growth and survival.

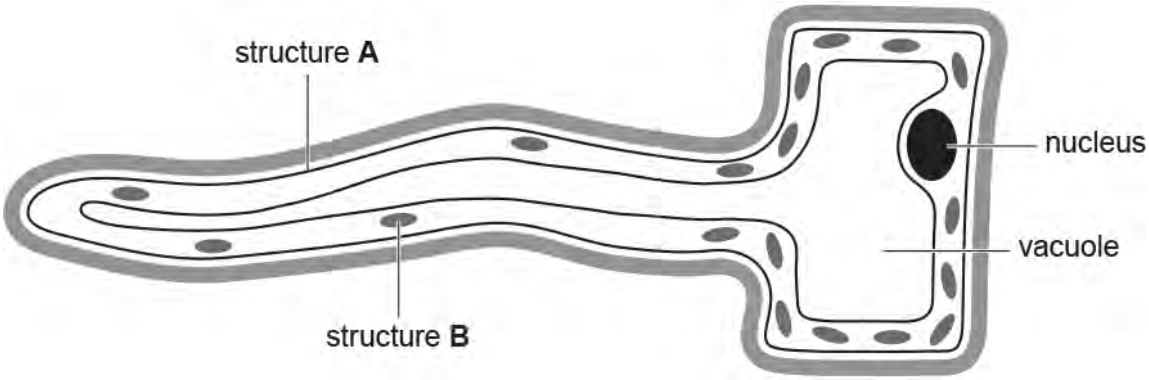
---

[2]

(b).

Nitrate ions are absorbed into a plant root through root hair cells.

Nina finds this diagram of a root hair cell.



(i) State the names of structures **A** and **B**.

A ---

B ---

[2]

(ii) Explain the roles of **A** and **B** in transporting nitrate ions into the root hair cell.

A ---

B

[2]

(iii) The shape of the root hair cell is an adaptation.

Explain how this adaptation helps the root hair cell to absorb nitrate ions more effectively.

[2]

(c). The root hair cells also absorb water from the soil.

Complete the sentences below to describe how water is transported through a plant.

Choose the correct words from the list.

Each word may be used once, more than once or not at all.

diffusion **flowers** **meristem** **osmosis**

phloem **stomata** **xylem**

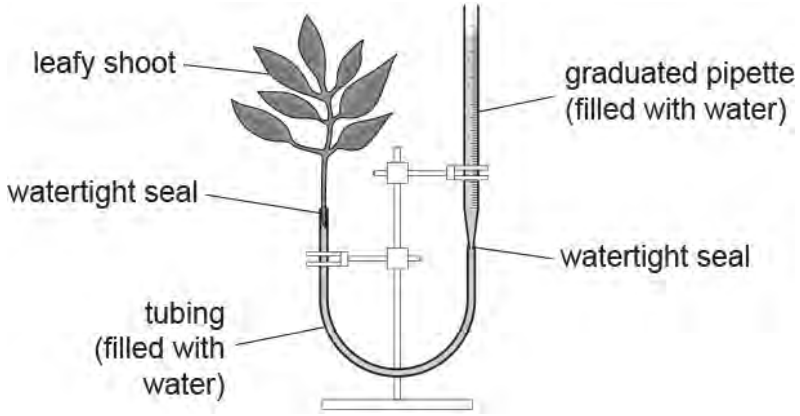
Water is transported from the soil into the root cells by .....

Water is pulled from roots to leaves through the ..... tissue in the plant stem.

Water molecules are lost from the leaves into the atmosphere because of ..... through open ..... .

[4]

(d). * Nina wants to investigate how changing the light intensity affects the rate of water uptake by a leafy shoot. She sets up a leafy shoot in a simple potometer as shown in the diagram.



Nina has access to other apparatus including:

fan	glass tank filled with water	lamp	metre ruler
	small heater	stopwatch	thermometer

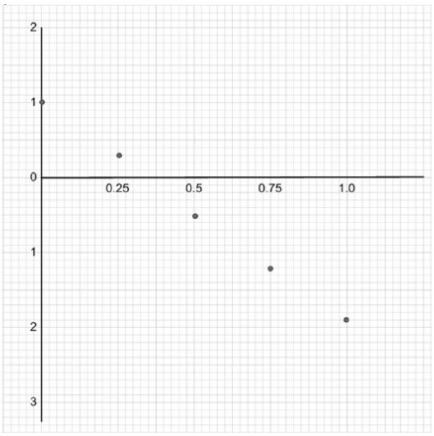
She does **not** have to use all the apparatus.

Describe the experimental procedure Nina should follow and how she should process her results.

[6]

END OF QUESTION PAPER

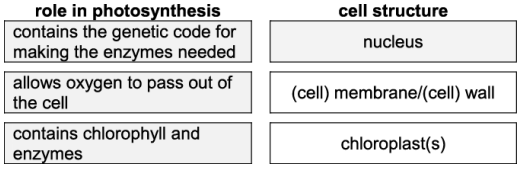
Question			Answer/Indicative content	Marks	Guidance
1	a	i	FIRST CHECK THE ANSWER ON THE ANSWER LINE IF answer = 0.23 award 2 marks 7 / 30 ✓ 0.23 ✓	2	ALLOW 1 mark for 7 / 30
		ii	Measure the rate of water uptake with a fan running on the shoot ✓	1	DO NOT ALLOW 'place plant / apparatus outside'
		iii	Any two from 1. Water may be lost from parts of the equipment that are not sealed ✓ 2. Some water is used for photosynthesis ✓ 3. If the plant is wilting, the plant will use water to restore turgidity ✓	2	DO NOT ALLOW incorrect use of water e.g. respiration
	b		Any two from Potassium ions (reduce the water potential) increase the concentration in the guard cells ✓ So water moves into the cell ✓ By osmosis ✓ Guard cells become turgid ✓	2	
			Total	7	
2	a	i	FIRST CHECK THE ANSWER IN TABLE. If answer = +6.1 award 2 marks (0.3 ÷ 4.9) × 100 (1) +6.1 (1)	2	DO NOT ALLOW answer if not given to 1 d.p.
		ii	4, 1, 5, 3, 2 (1)	1	
		iii	Does not take into account width (1)	1	
		iv	Set up experiment as above and re-measure every 10 minutes / other suitable time period (1) Find out how long it takes until there is now further change in length (1)	2	
	b	i	X = sugar concentration (mol / dm^{-3}) AND Y = change in mean length (mm) (1)	1	

Question			Answer/Indicative content	Marks	Guidance
		ii		2	5 plots correct = 2 3 or 4 plots correct = 1
		iii	Straight line through points (1)	1	
		iv	0.35 to 0.4 (1)	1	
		v	Idea that it is the same concentration / isotonic (1) Water movement is the same in both directions / no net flow (1)	1	
			Total	**12**	

Question			Answer/Indicative content	Marks	Guidance
3	a	i	13.64 (2)	2	Award 1 mark for $\frac{2.5-2.2}{2.2}$ **OR** $\frac{0.3}{2.2}$ **OR** 13.6 / 13.63 / 13.636363 (1) Look for answer in the table if nothing written in the space **Examiner's Comments** Marks were lost here by not giving the answer to 2 decimal places. Most common error was 13.63. Other errors included 13.636 recurring. Time needs to be spent practicing this skill (rounding). Many divided 0.3 by 2.5 or, more commonly, divided 2.5 or 2.2 by 0.3.
		ii	Potato pieces had a different mass / weight (at the start of the experiment); Idea that it allows comparison of the potato pieces / results are comparable;	2	**Ignore** accuracy / precision / fair test / reliability **Examiner's Comments** The question asked candidates why it is better to calculate the percentage change rather than just the difference in mass. They made correct reference to comparison. Differences in starting masses not as frequently quoted. Candidates made reference to accuracy, reliability in question and referred to what each measurement showed. Many candidates seemed to understand what was required but couldn't express it, giving vague answers such as 'more accurate' to use percentage/then it is out of 100. Few got full marks.
		iii	Greater than 0.4 mol lose mass	1	**Examiner's Comments** This question tended to be answered well even by lower scoring candidates.

Question			Answer/Indicative content	Marks	Guidance
		iv	0.3 (1) 0.4 (1)	2	**Accept** 0.31 **accept** 0.39 **accept** either order **Examiner's Comments** Candidates did not seem to use the data provided in the table to consider what the range could be, they focussed mainly on the range of concentrations used in the experiment. It was poorly answered by majority of candidates, many scoring 0 or 1 mark.
	b		*any three from* repeats (more) tests between 0.3 and 0.4 Keep surface area the same Keep temperature the same leave them in for longer same starting mass / weight same age / variety of potato OR use same potato correct ref. to more accurate measuring **apparatus** removal of excess solution by blotting pieces must be totally immersed in the solution / prevent evaporation of water	3	**Ignore** greater range / other concentrations **Ignore** size / volume **Examiner's Comments** The most common correct answer was 'repeat', and 'use the same starting mass' was the next more commonly seen answer. Many candidates wanted to test more concentrations or do more intervals, but they were not specific. Very few made reference to controlling temperature as a variable. No candidates made reference to evaporation or prevention of evaporation. Many candidates made reference to a bigger variety of concentrations in order to make experiment accurate, peer reviewing or getting someone else doing the experiment
			Total	**10**	

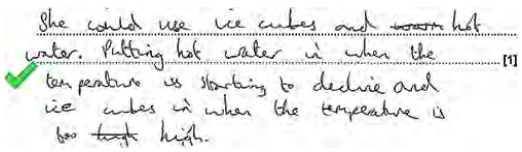
Question			Answer/Indicative content	Marks	Guidance
4			**[Level 3]** Candidates include a detailed explanation of all 3 stages Quality of written communication does not impede communication of the science at this level. (5 – 6 marks) **[Level 2]** Candidates include a detailed explanation of two stages Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks) **[Level 1]** Candidates include a detailed explanation of one stage Quality of written communication impedes communication of the science at this level. (1 – 2 marks) **[Level 0]** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	6	**This question is targeted at grades up to C** **Indicative scientific points may include:** stage A: • uptake of / absorption of / taking in / takes up / taking (nitrates into plants) **ignore** "passes into" / "goes in" • via roots / root hairs • active transport • (nitrates) used to make protein stage B: • plants eaten by animals • digestion / assimilation • transfer of nitrogen (compounds) / protein along food chain (ignore transfer of **nitrate** from plant to animal) stage C: • excretion / egestion / urine / faeces / waste • death • decay / decomposition / decomposers / fungi / bacteria • break down waste into nitrates • returns to the soil ignore denitrification / nitrogen fixation <u>Examiner's Comments</u> It was encouraging to see very detailed descriptions of the stages in the nitrogen cycle in the majority of student responses.
			Total	**6**	

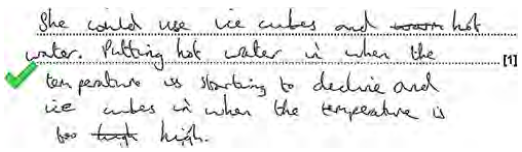
Question			Answer/Indicative content	Marks	Guidance
5	a			1	**both answers required for one mark** **Examiner's Comments** Many candidates scored a mark here. Those that did not score the mark usually wrote 'cytoplasm' instead of 'chloroplast'.
	b	i	(cell) membrane; respiration;	1	**both answers required for one mark** **Examiner's Comments** A significant number of candidates scored a mark here. The most common error was to suggest that active transport requires energy from photosynthesis. A few wrote 'cell' instead of 'cell membrane' and there were some descriptions of active transport given in the first gap, e.g. 'movement from a low concentration to a high concentration'.
		ii	*(link between respiration and energy):* anaerobic respiration / less aerobic respiration so less energy / ATP released (1) no / less energy for active transport / active uptake (1)	2	**do not allow** 'no energy' **allow** 'produced' **Examiner's Comments** Overall this question was not very well answered. Many candidates did not pick up on the idea that there is a lack of oxygen in the water-logged roots, despite it being clearly expressed in the question. Instead they proceeded to talk about the concentration of nitrogen and how that would affect the uptake. There were also frequent references to a lack of photosynthesis in the absence of oxygen. However, a significant number of candidates were able to identify that there would be less respiration but few referred specifically to less aerobic respiration or more anaerobic respiration. Only the very best candidates could then link this to a lack of energy released and make it clear that they understood that energy was required for active transport. This highlighted itself as being an area of the specification about which many candidates are very confused.

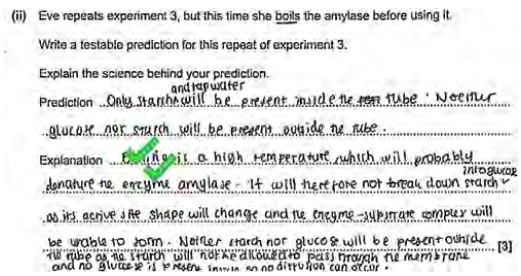
Question			Answer/Indicative content	Marks	Guidance
			Total	4	

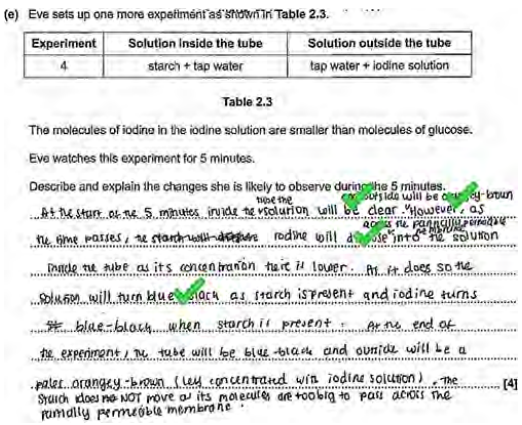
Question			Answer/Indicative content	Marks	Guidance
6	a	i	Concentration of solution in arbitrary units — Potato chip 0.0 — **D** 0.3 — **B** 0.6 — **A** 0.9 — **C**	2	4 correct = 2 marks 2 or 3 correct = 1 mark 1 or 0 correct = 0 marks
		ii	answer between 0.01 - 0.29 (2) between D and B **OR** close to D (1)	2	**ignore** ref. to units **ecf** accept correct value between D and B ? based on the values presented in (i) = 1 mark max. **Examiner's Comments** Relatively few candidates used the images and scenario to identify the correct labelling of the potato chip. However, for those who did this correctly they were able to move on to part (ii) and note the correct value for the unknown potato chip.
	b		membrane energy / ATP (1)	1	**both correct responses needed for 1 mark** **ignore** descriptions of membrane eg. permeable **ignore** oxygen **Examiner's Comments** Although some candidates completed this question correctly some struggled to identify the importance of the membrane and/or that energy was involved.

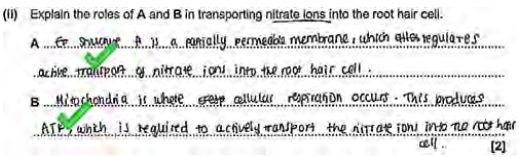
Question			Answer/Indicative content	Marks	Guidance
	c		**any two from** water-logged soils are low in oxygen ; anaerobic respiration takes place / **less** (aerobic) respiration ; **less** energy / active transport	2	OWTTE **ignore** general reference to active transport needs energy **reject** no respiration **ignore** leaching / dilution of nitrates **Examiner's Comments** Very few candidates applied their knowledge to the scenario of water-logged soils. Some completed the question well but most struggled, often referring back to the earlier question of active transport without substance.
			Total	7	

Question			Answer/Indicative content	Marks	Guidance
7	a		to measure the temperature ✓	1 (AO 1.2)	more than one tick = 0 marks Examiner's Comments This question was generally well answered although some candidates confused 'record' with 'measure'.
	b		place beakers in (electric/thermostatically-controlled) water bath ✓	1 (AO 2.2)	IGNORE mention of thermometer ALLOW description of water bath Examiner's Comments Only about half of the candidates gave the correct response of a water bath (or a description of such) as the means to keep the experiment at the correct temperature. Exemplar 3  She could use ice cubes and ~~warm~~ hot water. Putting hot water in when the temperature is starting to decrease and ice cubes in when the temperature is ~~too~~ high. [1] This response although not specifying 'water bath', does have an acceptable description of one, possibly reflecting the method that they have used in the laboratory. It gained 1 mark.

Question			Answer/Indicative content	Marks	Guidance
	c		add Benedict's solution ✓ look for a red-brown precipitate ✓	2 (AO 2.2)	ALLOW glucose testing strip with correct colour change DO NOT ALLOW red solution Examiner's Comments Candidates were very unsure of the correct reagent to use and the resulting colour to test for glucose. (Benedict's (reagent) with the resulting red precipitate). Exemplar 3  She could use ice cubes and ~~warm~~ hot water. Putting hot water in when the temperature is starting to decrise and ice cubes in when the temperature is ~~too~~ high. [1] This response although not specifying 'water bath', does have an acceptable description of one, possibly reflecting the method that they have used in the laboratory. It gained 1 mark.
	d	i	glucose (molecules) can diffuse through the tubing/membrane ✓ starch (molecules) too large to diffuse/move/fit through the tubing/membrane ✓ amylase breaks down starch ✓ starch is broken down into (molecules of) sugar ✓	4 (AO 3.2b × 4)	NO MARKS FOR DESCRIBING THE RESULTS ALLOW go through the tubing/membrane ALLOW maltose/glucose Examiner's Comments One of the problems encountered here was that candidates did not follow the rubric (conclusion) and described the results. Another problem here and also in (ii) & (e) was the incorrect references to osmosis when diffusion was required.

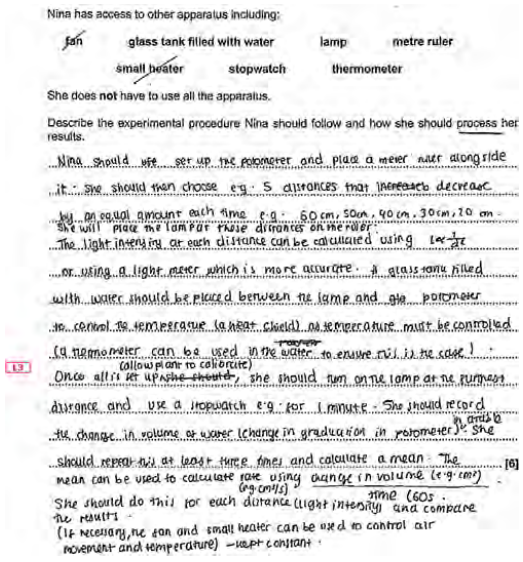
Question			Answer/Indicative content	Marks	Guidance
		ii	*Prediction*: the tests for glucose will be negative ✓ **Any two from:** *Explanation*: the amylase/enzyme has been denatured ✓ has (permanently) changed the shape (of the active site) ✓ by the high temperature /boiling ✓ no longer works/cannot bind ✓	3 (AO 2.1) (AO 1.1 ×2)	<u>Examiner's Comments</u> The first mark required a testable prediction to be stated. Very few candidates did so, some merely stating that glucose would not be present. A considerable number also stated that boiling the enzyme would make the reaction work at a faster rate and did not link the information about amylase and the effect that high temperature would have on it. Exemplar 4  (ii) Eve repeats experiment 3, but this time she boils the amylase before using it. Write a testable prediction for this repeat of experiment 3. Explain the science behind your prediction. Prediction Only starch and tapwater will be present inside the seen tube. Neither glucose nor starch will be present outside the tube. Explanation Enzymes is a high temperature which will probably denature the enzyme amylase - it will therefore not break down starch into glucose as its active site shape will change and the enzyme-substrate complex will be unable to form. Neither starch nor glucose will be present outside the tube as starch will not be allowed to pass through the membrane and no glucose is present inside so no diffusion can occur. [3] This response answers the explanation part well but the prediction is not testable. It gained 2 marks.
	e		**Any four from:** at the start, the solution outside the tube will be pale brown/red ✓ at the start, the solution inside the tube will be colourless ✓ the solution inside the tube will start to turn black / blue/black ✓ starting from the edges ✓ because iodine can diffuse through the tubing/membrane (molecules small enough)✓	4 (AO 2.2 × 4)	**Must be clear whether inside or outside of tube** Refers to colour of iodine **DO NOT ALLOW** 'through osmosis' <u>Examiner's Comments</u> The table in this question clearly had two places, inside the tube and outside the tube. Also it required the candidate to take

Question			Answer/Indicative content	Marks	Guidance
					into account the start as well as the final observations. Very few candidates described the situation at the start, and limited the marks available. Most marks that were credited were for the colour change from brown to (blue) black inside the tube. There was some confusion as to the correct colour change that should occur. Exemplar 5  (e) Eve sets up one more experiment as shown in Table 2.3. Experiment: 4 — Solution inside the tube: starch + tap water — Solution outside the tube: tap water + iodine solution Table 2.3 The molecules of iodine in the iodine solution are smaller than molecules of glucose. Eve watches this experiment for 5 minutes. Describe and explain the changes she is likely to observe during the 5 minutes. At the start of the 5 minutes inside the tube the solution will be clear. However, as the time passes, the starch will diffuse iodine will also diffuse into the solution inside the tube as its concentration start is lower. As it does so the solution will turn blue-black as starch is present and iodine turns it blue-black when starch is present. At the end of the experiment, the tube will be blue-black and outside will be a pale orangey-brown (less concentrated with iodine solution). The starch does not move as its molecules are too big to pass across the partially permeable membrane. [4] This response answers all four of the five available mark points available and gained 4 marks
			Total	**15**	
8			**Any one from:** Reference to gaseous exchange ✓ Movement of carbon dioxide/oxygen ✓ Transpiration/ loss of water (vapour) ✓	1 (AO 1.1)	<u>Examiner's Comments</u> Common errors seen in this question included water or sunlight entering the plant via the stomata.
			Total	1	

Question			Answer/Indicative content	Marks	Guidance
9	a		(nitrate ions are the plant's only source of) nitrogen ✓ to make amino acids/proteins/nitrogenous compounds ✓	2 (AO 1.1 × 2)	**ALLOW** examples e.g. enzymes / DNA **Examiner's Comments** This question required candidates to recognise that nitrates were the plant's source of nitrogen and that nitrogen was needed to make amino acids or other nitrogenous compounds.
	b	i	**A** (cell/partially-permeable) membrane ✓ **B** mitochondrion ✓	2 (AO 2.1 ×2)	**ALLOW** mitochondria **Examiner's Comments** Most candidates were able to recognise that structure A was the cell membrane. Fewer candidates identified structure B as a mitochondrion and many identified it as a chloroplast - failing to take into account that the question was about a root hair cell.
		ii	**A** (transports nitrate ions into the cell by) active transport (using carrier proteins) (against a concentration gradient) ✓ **B** provides ATP/energy (from cellular respiration) (for active transport) ✓	2 (AO 1.1 ×2)	**Examiner's Comments** Only a few higher ability candidates were able to demonstrate that nitrate ions had to be actively transported into the root hair cell and mitochondria provided ATP to enable this process to occur. Exemplar 1  (ii) Explain the roles of A and B in transporting nitrate ions into the root hair cell. A ...it is a partially permeable membrane, which also regulates active transport of nitrate ions into the root hair cell. B ...Mitochondria is where cellular respiration occurs - this produces ATP which is required to actively transport the nitrate ions into the root hair cell. [2] This response contains both marking points.

Question			Answer/Indicative content	Marks	Guidance
		iii	Increased/large surface area (to volume ratio) ✓ so there is increased/more active transport/absorption/uptake (of nitrate ions) ✓	2 (AO 1.1 × 2)	ALLOW quicker (but not quickly as comparison required) Examiner's Comments A number of candidates were able to link the shape of the cell to its ability to absorb ions more effectively. A lower number also linked this to the increased uptake of ions.
	c		osmosis ✓ xylem ✓ diffusion ✓ stomata ✓	4 (AO 1.1 × 4)	Examiner's Comments Most candidates were credited with at least three marks in this question. A number of candidates confused xylem and phloem tissue.
	d		*Please refer to the marking instructions on page 5 of this mark scheme for guidance on how to mark this question.* **Level 3 (5–6 marks)** A detailed description of the apparatus/procedure **and** variables that will be controlled. **AND** A detailed description of how the results should be processed or the measurements to be taken. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** A detailed description of apparatus/procedure or variables. **AND** A description of how the results should be processed or the measurements to be taken. *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some*	6 (AO 3.3a × 3) (AO 2.2 × 3)	**AO3.3a Developing an experimental procedure** Apparatus and procedure • use the lamp • to change/vary the light intensity • by placing it at different distances from the leafy shoot • use metre ruler • to measure distance of lamp from leafy shoot • use at least four different distances • use the stopwatch • repeat the experiment several times at each distance/light intensity **IGNORE** ref. to thermometer Variables to control or keep the same • same amount of time for each distance/light intensity and for each repeat (**ALLOW** example e.g. 30 min) • control the amount of ambient light e.g. by closing blinds • control air movement e.g. by closing doors/windows • control temperature by shining lamp

Question	Answer/Indicative content	Marks	Guidance
	evidence. **Level 1 (1–2 marks)** A description of the apparatus/procedure or variables. OR A description of how the results should be processed or the measurements to be taken. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** No response or no response worthy of credit.		through tank of water / use the tank of water as a heat shield **DO NOT ALLOW** use thermometer to <u>control</u> temperature **AO2.2 Applying understanding of measurement and data processing techniques to this type of investigation** Measurements to be taken For each distance/light intensity/repeat: • record the volume of water in the pipette at the start • record the volume of water in the pipette at the end (e.g. after 30 min) • how much water taken up / how much water decreased Processing the results • calculate the change in volume of water at each distance/light intensity • by subtracting the final volume from the starting volume • calculate the mean change in volume of water of all the repeats at each distance/light intensity • calculate the rate of water uptake by dividing the (mean) change in volume of water by the time • compare results for different light intensities/distances <u>Examiner's Comments</u> Over 50% of candidates were credited with a Level 3 mark and it was clear that this practical had been studied during the course. Amongst those candidates that did not achieve Level 3 were some who attempted to describe how they would investigate several factors, such as temperature, wind etc, despite the question asking for the effect of light. Some candidates did not observe that the graduated pipette should be used to

Question			Answer/Indicative content	Marks	Guidance
					measure the volume of water transpired and wrote about the method that they had probably used involving a capillary tube to measure the distance a bubble would move. Exemplar 2  Nina has access to other apparatus including: fan glass tank filled with water lamp metre ruler small heater stopwatch thermometer She does not have to use all the apparatus. Describe the experimental procedure Nina should follow and how she should process her results. Nina should use set up the potometer and place a meter ruler alongside it. She should then choose e.g. 5 distances that increase/decrease by an equal amount each time e.g. 50cm, 50cm, 40cm, 30cm, 20cm. She will place the lamp at these distances on the ruler. The light intensity at each distance can be calculated using $\frac{1}{d^2}$ or using a light meter which is more accurate. A glass tank filled with water should be placed between the lamp and the potometer to control the temperature (a heat shield) as temperature must be controlled (a thermometer can be used in the water to ensure this is the case) (allow plant to calibrate) Once all is set up/ready, she should turn on the lamp at the furthest distance and use a stopwatch e.g. for 1 minute. She should record the change in volume of water (change in graduation in potometer) in mm3 She should repeat this at least three times and calculate a mean. The mean can be used to calculate rate using change in volume (e.g. cm3) (eg cm3/s) She should do this for each distance (light intensity) and compare time (60s). the results. (If necessary, the fan and small heater can be used to control air movement and temperature) – kept constant. [6] This response perfectly covers all points required for Level 3, with 6 marks achieved.
			Total	18	