Required Practical 4, Membrane Permeability: AQA A Level Biology Exam

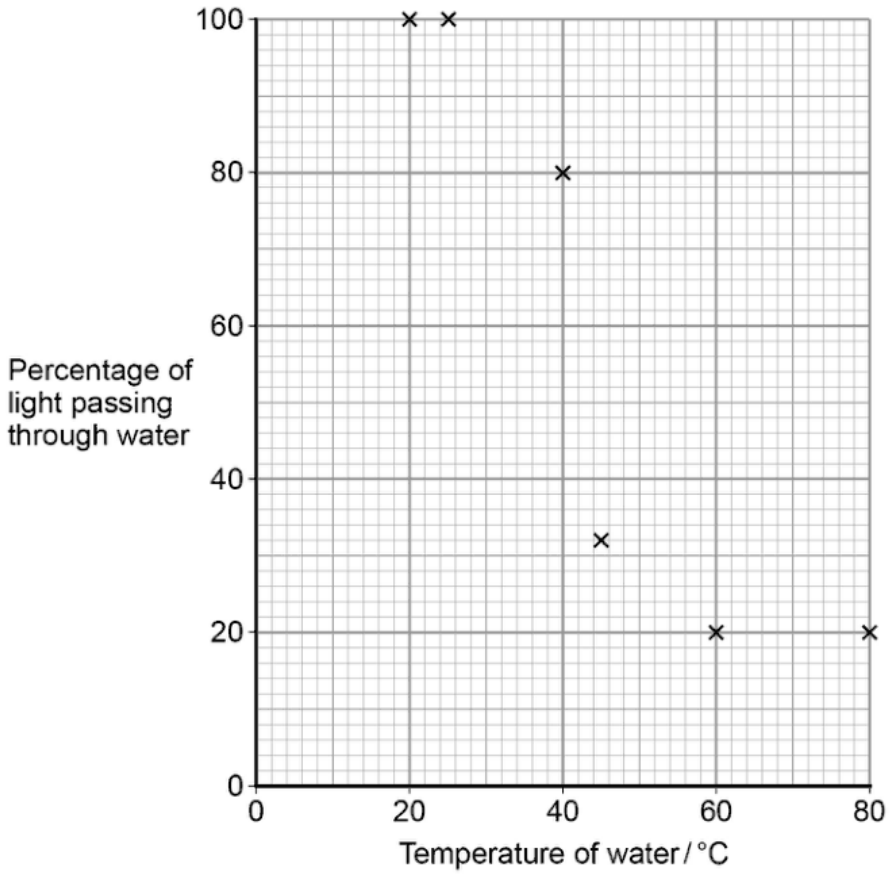
15 questions · 35 marks · about 46 minutes. Answer in the spaces, then check the mark schemes at the end.

Question 1 · information from earlier in the question

0 2 The cells of beetroot contain a red pigment. A student investigated the effect of temperature on the loss of red pigment from beetroot. He put discs cut from beetroot into tubes containing water. He maintained each tube at a different temperature. After 25 minutes, he measured the percentage of light passing through the water in each tube.

Figure 2 shows the student's results.

Figure 2



Questions, mark schemes and examiners' report extracts © AQA.

Question 1 · AS Paper 2 · June 2017 · Q02.4 · 2 marks

0 2 . 4 The decrease in the percentage of light passing through the water between 25 °C and 60 °C is caused by the release of the red pigment from cells of the beetroot.

Suggest how the increase in temperature of the water caused the release of the red pigment.

[2 marks]

Question 2 · information from earlier in the question

0 4 A student investigated the effect of ethanol, hydrochloric acid and temperature on the loss of red pigment from beetroot cells.

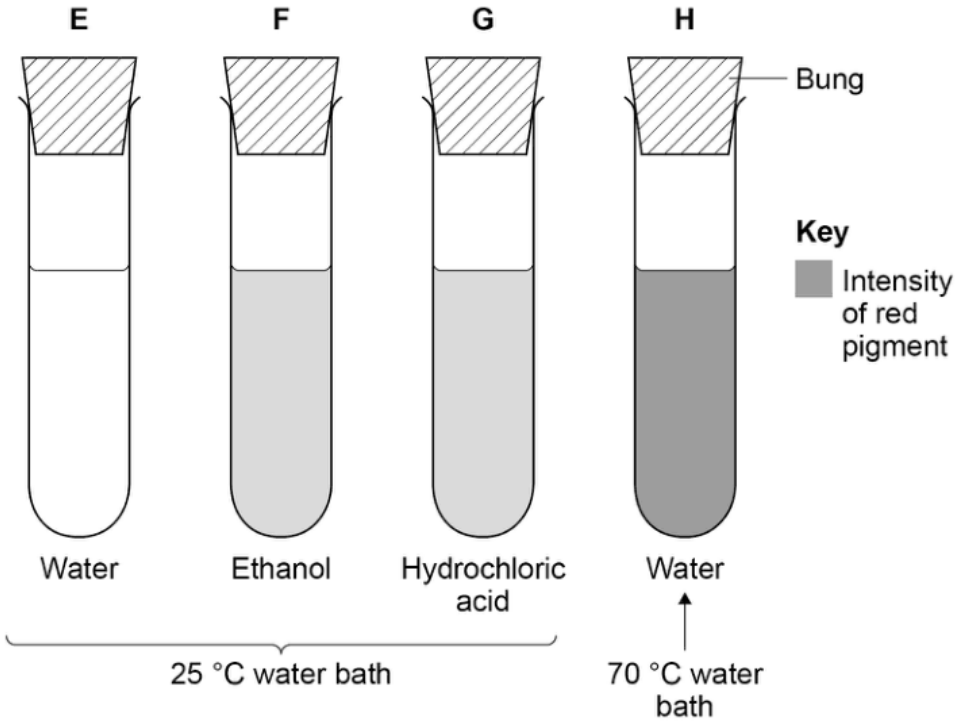
During the procedure, the student:

- added 10 cm^3 water into one test tube
- added 10 cm^3 ethanol into a second test tube
- added 10 cm^3 hydrochloric acid into a third test tube
- put the three tubes into a 25 °C water bath
- cut four cylinders of tissue from a beetroot
- put a cylinder into each tube and fitted bungs
- added 10 cm^3 water into a fourth test tube and put this tube into a 70 °C water bath
- placed the fourth cylinder into this tube and fitted a bung
- later removed the cylinders from the tubes
- estimated the intensity of red pigment in each solution by eyesight.

Questions, mark schemes and examiners' report extracts © AQA.

A different student used the same procedure and she controlled **all** variables appropriately. Her results are shown in **Figure 3**.

Figure 3



0 4 . 4 Using **Figure 3**, what can you conclude about the damage caused to beetroot cells by water, ethanol, hydrochloric acid and different temperatures?

Provide explanations for your conclusions.

[4 marks]

Questions, mark schemes and examiners' report extracts © AQA.

Question 3 · information from earlier in the question

0 4 Anthocyanins are coloured pigments found in the cell vacuole of some plant cells. Anthocyanins cannot move across undamaged cell membranes.

A student investigated how to extract anthocyanins from blueberries.

She mixed 10 g of crushed, fresh blueberries with 100 cm^3 of extraction solvent for 1 hour.

She investigated three different extraction solvents:

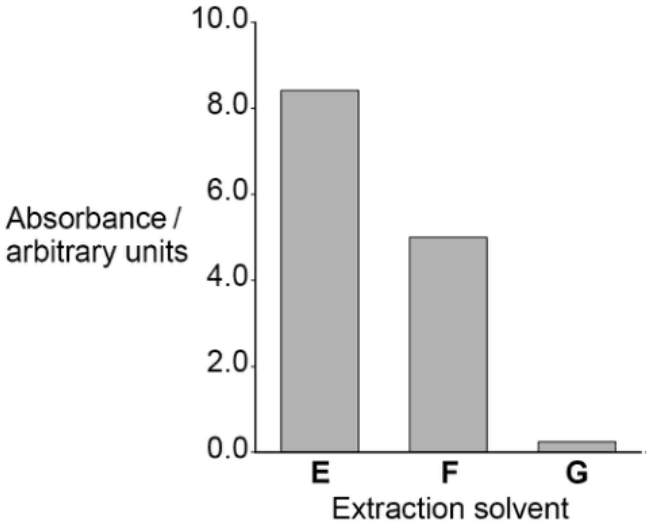
- **E** – Ethanol, water and acid
- **F** – Ethanol and water
- **G** – Water

Questions, mark schemes and examiners' report extracts © AQA.

0 4 . 3 After 1 hour, the student filtered the samples.
She placed the filtrate in a colorimeter and measured the light absorbance.

Her results are shown in **Figure 4**.

Figure 4



Use your knowledge of membrane structure to explain the results in **Figure 4**.

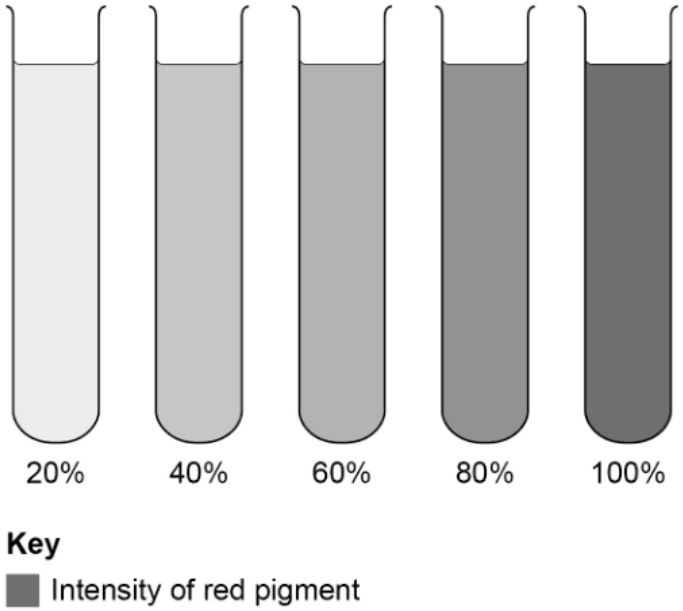
[4 marks]

Questions, mark schemes and examiners' report extracts © AQA.

Another student carried out the same investigation, ensuring that **all** variables were controlled.

Figure 11 shows a dilution series the student prepared from 100% red beetroot pigment solution.

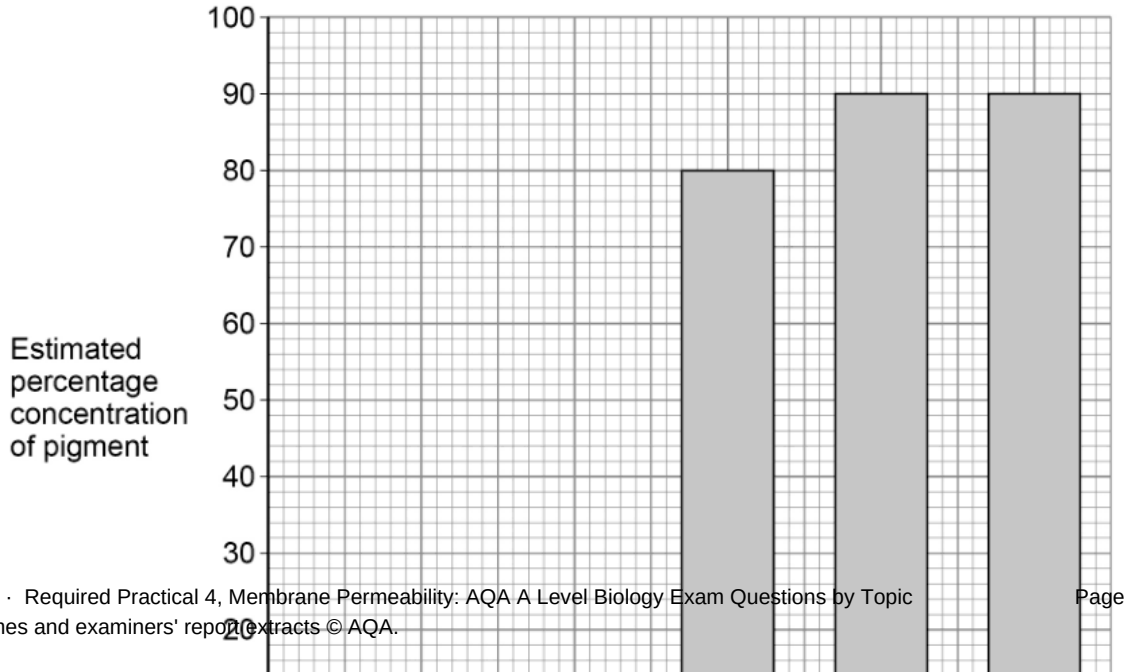
Figure 11



This student used the colours of the dilution series to estimate the percentage concentration of pigment in the boiling tubes at each temperature.

Figure 12 shows the student's results.

Figure 12



Questions, mark schemes and examiners' reports extracts © AQA.

Question 5 · AS Paper 1 · June 2025 · Q08.2 · 2 marks

0 8 . 2 A student investigated the effect of temperature on the permeability of cell-surface membranes in beetroot cells. Beetroot cells contain a red pigment that is not transported across intact cell-surface membranes.

The student:

- cut discs of beetroot tissue
- took five boiling tubes and placed two discs of beetroot into each boiling tube
- added water to the boiling tubes
- placed each boiling tube into a water bath at a different temperature for 30 minutes
- removed the discs and examined the water in each boiling tube.

Give **one** variable the student should have controlled in this investigation **and** explain why.

Do **not** refer to number of discs or length of time.

[2 marks]

Controlled variable _____

_____

Explanation _____

_____

_____

Question 6 · information from earlier in the question

0 4 A student investigated the effect of ethanol, hydrochloric acid and temperature on the loss of red pigment from beetroot cells.

During the procedure, the student:

- added 10 cm^3 water into one test tube
- added 10 cm^3 ethanol into a second test tube
- added 10 cm^3 hydrochloric acid into a third test tube
- put the three tubes into a 25 °C water bath
- cut four cylinders of tissue from a beetroot
- put a cylinder into each tube and fitted bungs
- added 10 cm^3 water into a fourth test tube and put this tube into a 70 °C water bath
- placed the fourth cylinder into this tube and fitted a bung
- later removed the cylinders from the tubes
- estimated the intensity of red pigment in each solution by eyesight.

Questions, mark schemes and examiners' report extracts © AQA.

Question 6 · AS Paper 2 · November 2020 · Q04.2 · 2 marks

0 4 . 2 Give **two** variables that the student did **not** control in her procedure.

[2 marks]

1 _____

_____

2 _____

_____

Question 7 · AS Paper 2 · June 2017 · Q02.1 · 2 marks

0 2 The cells of beetroot contain a red pigment. A student investigated the effect of temperature on the loss of red pigment from beetroot. He put discs cut from beetroot into tubes containing water. He maintained each tube at a different temperature. After 25 minutes, he measured the percentage of light passing through the water in each tube.

0 2 . 1 The student put the same volume of water in each tube.

Explain why it was important that he controlled this experimental variable.

[2 marks]

_____

_____

_____

_____

_____

_____

_____

Questions, mark schemes and examiners' report extracts © AQA.

Question 8 · information from earlier in the question

0 4 Anthocyanins are coloured pigments found in the cell vacuole of some plant cells. Anthocyanins cannot move across undamaged cell membranes.

A student investigated how to extract anthocyanins from blueberries.

She mixed 10 g of crushed, fresh blueberries with 100 cm^3 of extraction solvent for 1 hour.

She investigated three different extraction solvents:

- **E** – Ethanol, water and acid
- **F** – Ethanol and water
- **G** – Water

Question 8 · A level Paper 1 · November 2020 · Q04.2 · 2 marks

0 4 . 2 The student kept constant:

- the mass of fresh blueberries
- the volume of extraction solvent
- the time for the mixture to stand.

Name **two** other variables the student should have kept constant during this investigation.

[2 marks]

1 _____

2 _____

Questions, mark schemes and examiners' report extracts © AQA.

0 6 2,4-D is a selective herbicide that kills some species of plants but not others. 2,4-D disrupts cell-surface membranes but the extent of disruption differs in different species.

Scientists investigated the effect of 2,4-D on wheat plants (a crop) and on wild oat plants (a weed).

They grew plants of both species in glasshouses. They put plants of each species into one of two groups, **W** and **H**, which were treated as follows:

- Group **W** – leaves sprayed with water
- Group **H** – leaves sprayed with a solution of 2,4-D.

After spraying, they cut 40 discs from the leaves of plants in each group and placed them in flasks containing 10 cm^3 de-ionised water. After 5 minutes, they calculated the disruption to cell-surface membranes by measuring the concentration of ions released into the water from the leaf discs.

Their results are shown in **Table 3**.

The lowest significant difference (LSD), is the smallest difference between two means that would be significant at $P \leq 0.05$

Table 3

Group	Treatment	Mean concentration of ions in water / arbitrary units	
		Wheat	Wild oats
W	Water	26	45
H	2,4-D	27	70
Lowest significant difference (LSD)		7	10

0 6 . 1 Give **three** environmental variables that should be controlled when growing the plants before treatment with the different sprays.

[2 marks]

1 _____

2 _____

3 _____

Questions, mark schemes and examiners' report extracts © AQA.

Question 10 · A level Paper 1 · June 2017 · Q06.3 · 2 marks

0 6 . 3 The scientists incubated the flasks containing the leaf discs at 26 °C and gently shook the flasks.

Suggest **one** reason why the scientists ensured the temperature remained constant and **one** reason why the leaf discs were shaken.

[2 marks]

Temperature _____

_____

_____

Shaken _____

_____

_____

Question 11 · AS Paper 2 · November 2020 · Q04.1 · 1 mark

0 4 A student investigated the effect of ethanol, hydrochloric acid and temperature on the loss of red pigment from beetroot cells.

During the procedure, the student:

- added 10 cm^3 water into one test tube
- added 10 cm^3 ethanol into a second test tube
- added 10 cm^3 hydrochloric acid into a third test tube
- put the three tubes into a 25 °C water bath
- cut four cylinders of tissue from a beetroot
- put a cylinder into each tube and fitted bungs
- added 10 cm^3 water into a fourth test tube and put this tube into a 70 °C water bath
- placed the fourth cylinder into this tube and fitted a bung
- later removed the cylinders from the tubes
- estimated the intensity of red pigment in each solution by eyesight.

0 4 . 1 Give **one** way in which the student could ensure the first three beetroot cylinders were kept at 25 °C throughout her experiment.

[1 mark]

_____

_____

_____

Questions, mark schemes and examiners' report extracts © AQA.

Question 12 · information from earlier in the question

0 2 The cells of beetroot contain a red pigment. A student investigated the effect of temperature on the loss of red pigment from beetroot. He put discs cut from beetroot into tubes containing water. He maintained each tube at a different temperature. After 25 minutes, he measured the percentage of light passing through the water in each tube.

Question 12 · AS Paper 2 · June 2017 · Q02.2 · 1 mark

0 2 . 2 Describe a method the student could have used to monitor the temperature of the water in each tube.

[1 mark]

Question 13 · information from earlier in the question

0 4 A student investigated the effect of ethanol, hydrochloric acid and temperature on the loss of red pigment from beetroot cells.

During the procedure, the student:

- added 10 cm^3 water into one test tube
- added 10 cm^3 ethanol into a second test tube
- added 10 cm^3 hydrochloric acid into a third test tube
- put the three tubes into a 25 °C water bath
- cut four cylinders of tissue from a beetroot
- put a cylinder into each tube and fitted bungs
- added 10 cm^3 water into a fourth test tube and put this tube into a 70 °C water bath
- placed the fourth cylinder into this tube and fitted a bung
- later removed the cylinders from the tubes
- estimated the intensity of red pigment in each solution by eyesight.

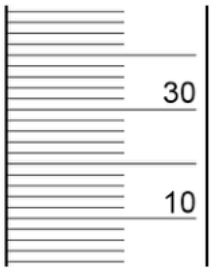
Questions, mark schemes and examiners' report extracts © AQA.

Question 13 · AS Paper 2 · November 2020 · Q04.3 · 2 marks

0 4 . 3 The student used a measuring cylinder to obtain 10 cm^3 of each solution.

Figure 2 shows some of the scale graduations on the side of this measuring cylinder.

Figure 2



What is the uncertainty of taking a reading of 10 cm^3 with this measuring cylinder?

Suggest how you could reduce the uncertainty calculated.

[2 marks]

Uncertainty ± _____ cm^3

Reducing uncertainty _____

_____

_____

_____

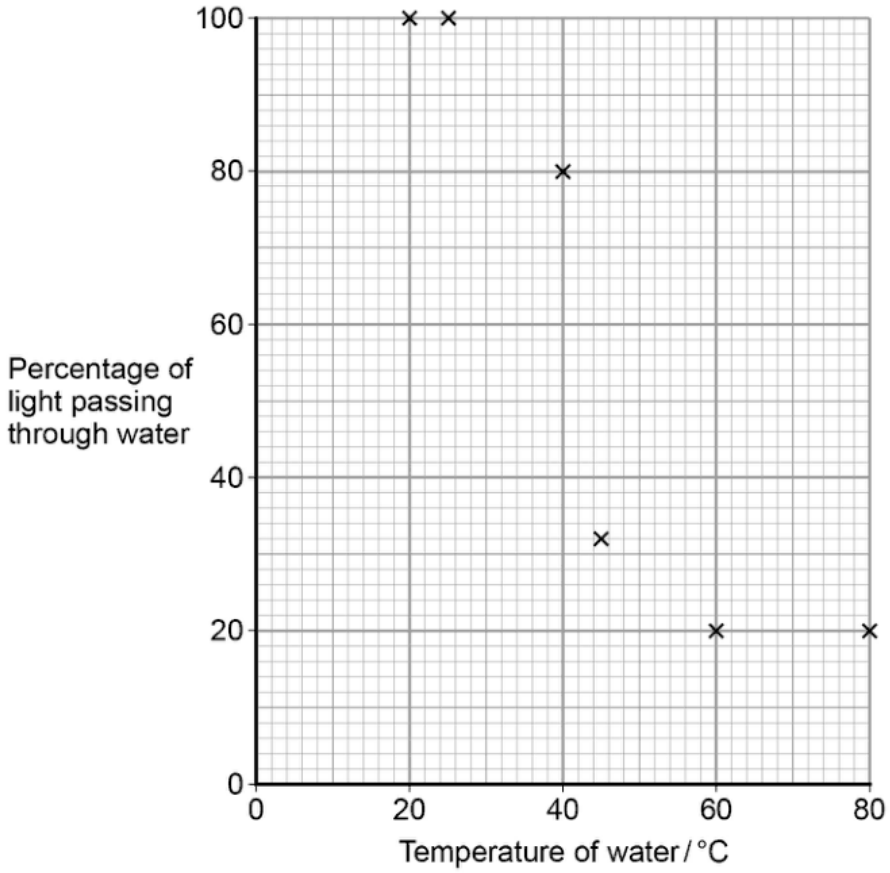
Question 14 · information from earlier in the question

0 2 The cells of beetroot contain a red pigment. A student investigated the effect of temperature on the loss of red pigment from beetroot. He put discs cut from beetroot into tubes containing water. He maintained each tube at a different temperature. After 25 minutes, he measured the percentage of light passing through the water in each tube.

Questions, mark schemes and examiners' report extracts © AQA.

Figure 2 shows the student's results.

Figure 2



0 2 . 3 Draw a suitable curve on **Figure 2**.

[1 mark]

Questions, mark schemes and examiners' report extracts © AQA.

Question 15 · information from earlier in the question

0 6 2,4-D is a selective herbicide that kills some species of plants but not others. 2,4-D disrupts cell-surface membranes but the extent of disruption differs in different species.

Scientists investigated the effect of 2,4-D on wheat plants (a crop) and on wild oat plants (a weed).

They grew plants of both species in glasshouses. They put plants of each species into one of two groups, **W** and **H**, which were treated as follows:

- Group **W** – leaves sprayed with water
- Group **H** – leaves sprayed with a solution of 2,4-D.

After spraying, they cut 40 discs from the leaves of plants in each group and placed them in flasks containing 10 cm^3 de-ionised water. After 5 minutes, they calculated the disruption to cell-surface membranes by measuring the concentration of ions released into the water from the leaf discs.

Their results are shown in **Table 3**.

The lowest significant difference (LSD), is the smallest difference between two means that would be significant at $P \leq 0.05$

Table 3

Group	Treatment	Mean concentration of ions in water / arbitrary units	
		Wheat	Wild oats
W	Water	26	45
H	2,4-D	27	70
Lowest significant difference (LSD)		7	10

Questions, mark schemes and examiners' report extracts © AQA.

Question 15 · A level Paper 1 · June 2017 · Q06.2 · 4 marks

0 6 . 2 Evaluate the use of 2,4-D as a herbicide on a wheat crop that contains wild oats as a weed. Use all the information provided.

[4 marks]

Questions, mark schemes and examiners' report extracts © AQA.

Mark schemes

Question 1 · AS Paper 2 · June 2017 · Q02.4 · 2 marks

02.4	1.	Damage to (cell surface) membrane;	2 max
	2.	(membrane) proteins denature;	
	3.	Increased fluidity / damage to the phospholipid bilayer;	

Questions, mark schemes and examiners' report extracts © AQA.

04.4	1. Water/25°C caused no damage/no pigment release (in E); 2. (Damage to) cell(-surface) membrane; 3. Ethanol/acid caused some/similar/identical damage **OR** 70°C caused most damage; 4. (By) ethanol dissolving phospholipid bilayer **OR** (By acid) altering membrane protein; 5. (By) 70°C denaturing/altering membrane protein **OR** (By) 70°C increasing fluidity/permeability of membrane;
TOTAL	

4 max	1. Accept no colour/intensity change for 'pigment' Accept 'high temperature' for 70°C 1. and 3. Accept description of 'pigment release' for 'damage' 2. Accept description of membrane, eg phospholipid bilayer/bilayer

Questions, mark schemes and examiners' report extracts © AQA.

Question 3 · A level Paper 1 · November 2020 · Q04.3 · 4 marks

04.3	1. Higher absorbance indicates more anthocyanin OR Higher absorbance indicates more membrane damage/permeability OR (**G** not zero because) some anthocyanin released when blueberries are crushed OR (**G** not zero because) some membrane damage when blueberries are crushed; 2. More membrane damage/permeability results in more anthocyanin release 3. (**E** and **F** greater than water because) phospholipids dissolve in ethanol; 4. (**E** greater than **F** because) acid denatures membrane proteins;	4	For 'anthocyanin' accept 'pigment'. 1. A direct comparative statement is not needed, can be taken from the answer as a whole. 1 and 2. Accept 'most' for 'more'. 4. Accept description of denaturation in terms of change in tertiary structure or breaking of hydrogen/ionic bonds.

Question 4 · AS Paper 1 · June 2025 · Q08.3 · 4 marks

08.3	MP1 must be credited to achieve maximum 4 marks. 1. As temperature increases, (percentage) concentration of pigment increases but levels off at 80°C; 2. As temperature increases, the membrane becomes damaged/more permeable; 3. Because the membrane proteins denature at high temperatures; 4. As temperature increases, fluidity of the cell membrane/phospholipids increases; 5. At 80°C the membrane is fully permeable **OR** At 80°C maximum damage to membrane;	4 max (2 x AO1, 2 x AO2)

Questions, mark schemes and examiners' report extracts © AQA.

08.2	Mark in pairs: 1 **and** 2 **OR** 3 **and** 4. 1. Volume of water; 2. (Varying volumes of water) affects the concentration/colour (of the resulting solution); 3. Diameter/thickness of disc **OR** Surface area of disc **OR** Volume of disc **OR** Mass of disc **OR** Same beetroot; 4. Affects quantity/amount of pigment **OR** Affects rate of release of pigment;	2 max (2 x AO2)

1. Ignore **amount** of water

3. Allow length for thickness
3. Ignore shape/size
3. Allow weight for mass
3. Accept 'beetroot' for disc

Questions, mark schemes and examiners' report extracts © AQA.

Question 6 · AS Paper 2 · November 2020 · Q04.2 · 2 marks

04.2	1. Length **and** diameter **OR** Surface area **OR** Volume **OR** Mass/weight (of cylinders); 2. Time in solution;	2	1. Ignore shape/size 2. Ignore 'time' if unqualified

Question 7 · AS Paper 2 · June 2017 · Q02.1 · 2 marks

02.1	1. (If) too much water the concentration of pigment (in solution) will be lower / solution will appear lighter / more light passes through (than expected); OR (If) too little water the concentration of pigment (in solution) will be greater / solution will appear darker / less light passes through (than expected); 2. So results (from different temperatures) are comparable;	2	1. Ignore reference to too much water so red pigment / solution too weak to measure

Question 8 · A level Paper 1 · November 2020 · Q04.2 · 2 marks

04.2	1. Temperature; 2. Agitation/mixing/stirring; 3. Source/age/type of blueberries; 4. Crushing of the blueberries; 5. Rinsing of the blueberries prior to mixing; 6. Concentration of ethanol/acid;	2 max	Do not accept pH. Accept 'Filtering method'.

Questions, mark schemes and examiners' report extracts © AQA.

6.1	1. Concentration of mineral ion/named mineral ion in soil; 2. Soil pH; 3. Temperature; 4. Light intensity/wavelength/duration; 5. Distance between seeds/plants; 6. Volume of water given; 7. CO_2 concentration; 8. Humidity;

2 max	1 and 2. Allow 'growing solution' for 'soil'. 2. pH alone is insufficient. 3. Allow 'colour of light' Reject 'amount' for mps 1, 4, 6 and 7. Ignore O_2 concentration **Three correct = 2 marks** **Two correct = 1 mark** **One or none correct = 0 marks**

Questions, mark schemes and examiners' report extracts © AQA.

Question 10 · A level Paper 1 · June 2017 · Q06.3 · 2 marks

6.3	1. (Maintain temperature) so that the rate of diffusion (of ions out of cells) remains constant **OR** (Maintain temperature) so no change in fluidity of phospholipids/kinetic energy of phospholipids; **OR** (Maintain temperature) so no change in shape/structure/denaturation of membrane proteins; 2. (Shaking) So all surfaces of the leaf discs are exposed (to water)/so all submerged; **OR** To maintain diffusion/concentration gradient (for ions out of leaf discs);	2	1. Ignore references to rate of enzyme catalysed reactions 2. Accept 'so that leaf discs do not stick together'

Question 11 · AS Paper 2 · November 2020 · Q04.1 · 1 mark

04.1	Measure temperature (in tube) at intervals **and** use appropriate corrective measure (if temperature has fluctuated);	1	Accept use thermometer/probe/ equivalent device for measure temperature

Question 12 · AS Paper 2 · June 2017 · Q02.2 · 1 mark

02.2	(Take) reading**s** (during the experiment) using a (digital) thermometer / temperature sensor;	1

Question 13 · AS Paper 2 · November 2020 · Q04.3 · 2 marks

04.3	1. 1; 2. Use instrument with closer/finer/smaller intervals/graduations/scale;	2	2. Accept correct numerical figure, eg <2 (cm^3) 2. Ignore 'higher resolution'

Questions, mark schemes and examiners' report extracts © AQA.

Question 14 · AS Paper 2 · June 2017 · Q02.3 · 1 mark

02.3	Point-to-point line drawn between co-ordinates (with a ruler); OR Smooth s-shaped line of best fit;	1	Reject <u>any</u> extrapolations below 20 °C or above 80 °C Any line should look smooth (not 'sketchy')

Questions, mark schemes and examiners' report extracts © AQA.

Question 15 · A level Paper 1 · June 2017 · Q06.2 · 4 marks

6.2	1. 2,4-D causes an increase in release of ions from wild oat cells **and** 2,4-D does not affect/has little effect on the release of ions from wheat cells; 2. (For wheat) Difference is less than LSD/7 **so** difference is not significant; **OR** (For wild oats) Difference is more than LSD/10 **so** difference is significant; 3. Loss of ions from cells (likely to) lead to cell/plant death/damage; **OR** Disruption of cell membrane (likely to) lead to cell/plant death/damage; 4. No evidence here about death of plants as a result of this ion loss; 5. No evidence here of other ecological/environmental impact;

4 max	1. Accept reference to 'concentration of ions in water' or 'disruption of the cell membranes' in place of 'release of ions' 1. Accept 'difference in release of ions from wild oats is 25 **and** difference in release of ions from wheat is