AQA A-LEVEL · 7402

BIOLOGY



MARK SCHEME

3.3.4.2 MASS TRANSPORT IN PLANTS

SCORE	PERCENTAGE
/273	%

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Q1.

(a) 1. Used to compare effect of other treatments / as a baseline;

Accept for 2 marks, substance (X) and not agar / block / water that caused the difference in the number of roots.

Do not accept unqualified reference to "compare results".

2. Shows / Measures effect of substance (X);
OR

Accounts for effect of substances produced naturally;

Accept measures effect of independent variable

2

(b) 1. (**D** shows) substance (X) is not required for (some) root growth / production of roots;
OR
Substances (already) present in stem cause (some) root growth;

2. Substance X moves through plant;

Accept X moves through stem / phloem

3. (**E** shows) substance (X) causes / increases / doubles number of roots / root growth;

3

(c) **In support of mass flow hypothesis**

1. (**F** shows) phloem is involved;

2. (**G** shows) respiration / active transport is involved (in flow / movement);

3. Because 4 °C / cooling reduces / slows / stops flow / movement;

4. The agar block is the source;

5. Roots are the sink;

Against the mass flow hypothesis

6. No bulge above ringing (in **F**);

7. No (role for) osmosis / hydrostatic pressure / water movement;

Accept no turgor pressure

8. Movement could be due to gravity;

9. Roots still grow without (intact/functioning) phloem;

10. No leaves / sugars / photosynthesis to act as a source;

Each point must be clearly made in the context of support or against.

Ignore sugar / sucrose

3 max for "support" and 3 max for "against"

4 max

[9]

Q2.

(a) **EITHER**

1. The radioactively labelled carbon is converted into sugar/organic substances during photosynthesis;

   For 'organic substance' accept named organic substance, eg glucose, sucrose, amino acid.

2. Mass flow/translocation in the phloem throughout the plant only in plants that were untreated/**B**/control
   OR
   Movement of sugar/organic substances in the phloem throughout the plant only in plants that were untreated/B/control;

   *Accept 'translocation/mass transport in the phloem past the heat treatment only in the untreated plant/**B**/control'.*

   Accept converse for heat-treated plant/A ie Movement of sugar/organic substances/mass flow/translocation in the phloem stops (beyond the heat treatment) in treated plants/A.

OR

3. Movement in phloem requires living cells/respiration/active transport/ATP;

4. Heat treatment damages living cells **so** transport in the phloem throughout the plant only in plants that were untreated/**B**/control
   OR
   Heat treatment stops respiration/active transport/ATP production **so** transport in the phloem throughout the plant only in plants that were untreated/**B**/control;

   Do not mix and match – award either mp1 and mp2 or mp3 and mp4.

2

(b) 1. (The water content of the leaves was) not different because (means ± 2) standard deviations overlap;

   For 'not different' accept 'difference is not significant' or 'difference due to chance'.

2. Water is (therefore) still being transported in the xylem (to the leaf)
   OR
   Movement in xylem is passive **so** unaffected by heat treatment;

2

(c) 1. Heat treatment has a greater effect on young leaves than old;

   Accept description of no/little/(slight) increase effect in old leaves and change in young leaves.

2. Heat treatment damages the phloem;

3. Fe^{3+} moves up the leaf/plant;

4. (Suggests) Fe^{3+} is transported in the xylem in older leaf;

5. In young leaf, some in xylem, as some still reaches top part of leaf;

6. (Suggests) Fe^{3+} is (mostly) transported in phloem in young leaf
OR
Xylem is damaged in young leaf
OR
Xylem is alive in young leaf;

7. Higher ratio of Fe^{3+} in (all/untreated) old leaves than (all/untreated) young;
Accept 'more at the top' for 'higher ratio'.

8. All ratios show there is less Fe^{3+} in the top than the lower part of leaves;

9. (But) no statistical test to show if the difference(s) is significant;
Accept '(But) no standard deviations to show if the difference(s) is significant'.

4 max

[8]

Q3.

(a) 1. Water lost from leaf because of transpiration / evaporation of water (molecules) / diffusion from mesophyll / leaf cells;
OR
Transpiration / evaporation / diffusion of water (molecules) through stomata / from leaves;
2. Lowers water potential of mesophyll / leaf cells;
3. Water pulled up xylem (creating tension);
4. Water molecules cohere / 'stick' together by hydrogen bonds;
5. (forming continuous) water column;
6. Adhesion of water (molecules) to walls of xylem;
2. Accept Ψ or WP

5 max

(b) 1. The DNA strands separate by breaking the H bonds;
OR
H bonds broken between (complementary) (DNA) bases;
2. (Only) one of the strands/template strand is used (to make mRNA/is transcribed);
3. (Complementary) base pairing so A → U, T → A, C → G, G → C;
4. (RNA) nucleotides joined by RNA polymerase;
5. pre-mRNA formed;
6. Splicing / introns removed to form mRNA;
1. Ignore 'hydrolysis' of bonds
1. Accept DNA "unzips" by breaking the H bonds
6. Accept 'non-coding' sections for introns

5 max

[10]

Q4.

(a) Correct answer 23.55 – 24 two marks;
For one mark
5.9

OR
94.2;

2

(b) 1. Method for measuring area;
e.g. draw round (each) leaf on graph paper and count squares;
2. Of both sides of (each) leaf;
3. Divide rate (of water loss / uptake from potometer) by (total) surface area (of leaves);

3

(c) Plant has roots
OR
xylem cells very narrow;

Ignore references to air bubbles / mass flow / photosynthesis

Accept xylem damaged when cut

1

(d) 1. Both small / similar size (so fit channel);
2. Have a similar shape (so bind to / fit channel);

1. Accept same height and width

Ignore refs to polar / non-polar

2. Accept Aquaporin complementary to oxygen(s)

2

(e) 1. Single-stranded RNA (has base sequence) complementary to PIP1 mRNA;
2. Binds to mRNA (of PIP1) / leads to destruction of mRNA;
3. Prevents / reduces translation (of PIP1);
4. Reduces photosynthesis/named process that uses water;

3. Less made is insufficient

3 max

(f) Not all of mRNA bound to single-stranded RNA / there is more mRNA than interfering RNA
OR
Not all mRNA destroyed / disabled;

Accept mutations in transgene,

Accept not all cells with transgenes

1

(g) 1. Loss of PIP reduces water **and** carbon dioxide movement;
2. Differences significant because SDs don't overlap
OR
Need stats test to see whether significant differences (or not);
3. Greater (proportional) effect on carbon dioxide transport;
4. Not all movement through PIP;

1. Accept converse for wild type

2. Reject references to results significant or not significant

2. Accept error bars for SDs

3 max

[15]

Q5.

(a) 1. Contents of phloem vessel pushed into insect's mouth by high pressure;

2. (High pressure in phloem vessel) caused by loading of sugars into phloem in leaf;

3. And (resulting) entry of water by osmosis.

3

(b) 1. Polysaccharides are insoluble;

2. So do not affect water potential of gut.

2

(c) 1. (Only few bacteria passed from parent, so) only a few (copies of) genes passed on (in bacteria);

2. May not / does not include all alleles (of genes, so diversity reduced)
OR
Small number of bacteria transmitted means unrepresentative sample.

2

(d) 1. Number / mass / density of insects per plant;

2. Stage of development / size of plants / insects;
Ignore any abiotic factor

2

(e) Draw around leaf on graph paper **and** count squares;

1

[10]

Q6.

(a) 1. Sand: to ensure no boron provided;

2. Dark: to ensure no sucrose produced in leaves / produced by photosynthesis.

2

(b) 1. Evaporates all water

2. (But) does not burn (organic compounds).

2

(c) Yes because in the presence of boron

1. Uptake of sucrose greater;

2. Transport to other parts of plant greater;

3. Correct use of data that supports MP1 or MP2.

No because:

4. No evidence that boron reacts with sucrose / that a sucrose-borate complex is formed.

4

(d) 1. Take thin (horizontal) sections of plant tissue / stem;

2. Place against photographic film in dark for several hours / carry out autoradiography.

2

[10]

Q7.

(a) 1. Water potential becomes lower / becomes more negative (as sugar enters phloem);
2. Water enters phloem by osmosis;
3. Increased volume (of water) causes increased pressure.

3

(b) 1. Rate of photosynthesis related to rate of sucrose production;
2. Rate of translocation higher when sucrose concentration is higher.

2

(c) 1. Rate of translocation does not fall to zero / translocation still occurs after 120 minutes;

2. But sucrose no longer able to enter cytoplasm of phloem cells.

2

[7]

Q8.

(a) 1. Facilitated diffusion involves channel or carrier proteins whereas active transport only involves carrier proteins;
2. Facilitated diffusion does not use ATP / is passive whereas active transport uses ATP;
3. Facilitated diffusion takes place down a concentration gradient whereas active transport can occur against a concentration gradient.

Since 'contrast', both sides of the differences needed

3

(b) 3.3:1.

Correct answer = 2 marks

If incorrect, allow 1 mark for 470–360 / 60 for rate in second hour

2

(c) 1. Group **A** – initial uptake slower because by diffusion (only);
2. Group **A** – levels off because same concentrations inside cells and outside cells / reached equilibrium;
3. Group **B** – uptake faster because by diffusion plus active transport;
4. Group **B** fails to level off because uptake against gradient / no equilibrium to be reached;
5. Group **B** – rate slows because few / fewer chloride ions in external solution / respiratory substrate used up.

4 max

[9]

Q9.

(a) 1. In source / leaf sugars actively transported into phloem;
2. By companion cells;
3. Lowers water potential of sieve cell / tube and water enters by osmosis;
4. Increase in pressure causes mass movement (towards sink / root);
5. Sugars used / converted in root for respiration for storage.

Accept starch

4 max

(b) Respiration.

1

(c) 1. (About) 30 hours;
2. Time between peak ^{14}C at top of trunk and bottom.

2

(d) Length of trunk (between top and bottom).

1

[8]

Q10.

(a) Stomata per mm^2 or cm^2
OR
Number per mm^2 or cm^2;

Accept: mm^{-2} or cm^{-2}.

Reject: per μm^2 or μm^{-2}.

Reject: the use of a solidus / as being equivalent to per.

Ignore: 'amount'.

1

(b) 1. Single/few layer(s) of cells;

Accept: more/too many/overlapping.

*'Single layer' without reference to cells/tissue should **not** be credited.*

2. So light can pass through;

2

(c) 1. Distribution may not be uniform
OR
So it is a representative sample;

Accept: more/fewer stomata in different areas.

Ignore: anomalies/random/bias.

2. To obtain a (reliable) mean;

Accept: 'average'.

2

(d) 1. Hairs **so** 'trap' water vapour and water potential gradient decreased;
2. Stomata in pits/grooves **so** 'trap' water vapour and water potential gradient decreased;
3. Thick (cuticle/waxy) layer **so** increases diffusion distance;
4. Waxy layer/cuticle **so** reduces evaporation/transpiration.
5. Rolled/folded/curled leaves **so** 'trap' water vapour and water potential gradient decreased;
6. Spines/needles **so** reduces surface area to volume ratio;

*1, 2 and 5. Accept: humid/moist air as 'water vapour' but **not** water/moisture on its own.*

1, 2 and 5. Accept: diffusion gradient as equivalent to water potential gradient.

1, 2 and 5. Accept: less exposed to air as an alternative to water potential gradient.

*6. Accept: spines/needles **so** 'reduce area'.*

2 max

(e) 1. Water used for support/turgidity;
2. Water used in photosynthesis;
3. Water used in hydrolysis;
4. Water produced during respiration;

2 max

[9]

Q11.

(a) Starch (max 3)

1. Helical/ spiral shape **so** compact;
2. Large (molecule)/insoluble **so** osmotically inactive;

Accept: does not affect water potential/ψ.

3. Branched **so** glucose is (easily) released for respiration;

Ignore: unbranched.

4. Large (molecule) **so** cannot leave cell/cross cell-surface membrane;

Cellulose (max 3)

5. Long, straight/unbranched chains of β glucose;
6. Joined by hydrogen bonding;

Note: references to 'strong hydrogen bonds' disqualifies this mark point.

7. To form (micro/macro)fibrils;
8. Provides rigidity/strength;

5 max

(b) 1. (At source) sucrose is actively (transported) into the phloem/sieve element/tube;

Accept: 'sugar/s' for sucrose but reject other named sugars e.g. glucose.

Accept: co-transport (with H^+ ions).

2. By companion/transfer cells;
3. Lowers water potential in phloem/sieve element/tube **and** water enters by osmosis;
4. (Produces) high (hydrostatic) pressure;

Accept: pressure gradient.

5. Mass flow/transport towards sink/roots/storage tissue;

Accept: sieve element/tube.

6. At sink/roots sugars are removed/unloaded;

Accept: at sink/roots sugars are used in respiration/stored.

5 max

[10]

Q12.

(a) (i) ***(Both)***

1. Are polymers / polysaccharides / are made of monomers / of monosaccharides;

2. Contain glucose / carbon, hydrogen and oxygen;
3. Contain glycosidic bonds;
4. Have 1−4 links;

Neutral: references to 'unbranched', insoluble, formed by condensation, flexible and rigid

Are made of the monomer glucose = MP 1 and 2 = 2 marks

5. Hydrogen bonding (within structure).

Ignore reference to H bonds between cellulose molecules

2 max

(ii) (Starch)

1. Contains α / alpha glucose;

Assume 'it' refers to starch

Accept: converse arguments only if linked directly to cellulose

Accept: forms α glycosidic bonds

2. Helical / coiled / compact / branched / not straight;
3. 1,6 bonds / 1,6 branching;
4. Glucoses / monomers same way up;
5. No H-bonds between molecules;
6. No (micro / macro) fibres / fibrils.

2 max

(b) (i) 1. No / few organelles / very little cytoplasm / cytoplasm at edge / more room / hollow / large vacuole / large space / thick walls;

Accept strong walls for thick walls

2. (So) easier / more flow / (thick / strong walls) resist pressure.

Easier flow may be expressed in other ways e.g. lower resistance to flow

2

(ii) 1. Mitochondria release energy / ATP / site of respiration;

***Q** Reject: 'produce energy'*

but accept produce energy in form of ATP

2. For active transport / uptake against concentration gradient.

Note: no mark is awarded for simply naming an organelle

OR:

3. Ribosomes / rough endoplasmic reticulum produce(s) proteins;

Concept of making proteins needed

4. (Proteins) linked to transport e.g. carrier proteins / enzymes.

2

[8]

Q13.

(a) 1. Protein synthesis **and** cell wall synthesis **and** cell expansion stop at −0.7 / at a *higher* water potential than other two;

If all 3 are correctly identified in marking point 1, accept 'the others / the other two' in marking point 2, and vice versa

2. Photosynthesis **and** stomatal opening stop at -1.5 / at a *lower* water potential than other three;

Correct processes must be named in at least one of marking point 1 or marking point 2

Where reference to water potential differences are made, they must be comparative, eg 'higher'

2

(b) 1. Stomata allow uptake of carbon dioxide;

2. Carbon dioxide used in / required for photosynthesis;

2

(c) 1. Growth involves cell division / cell expansion / increase in mass;

Marking point 1 is for the principle

2. Protein synthesis stops **so** no enzymes / no membrane proteins / no named protein (for growth / division);

Marking points 2, 3 and 4 require appreciation of 'why' before credit can be awarded

'named' protein must relate to proteins involved in growth or cell division

3. Cell wall synthesis stops **so** no new cells can be made;

Full credit is possible without a statement of the principle (marking point 1)

4. No cell expansion / increase in mass **because** (cells) stop taking up water;

3 max

[7]

Q14.

(a) Any **three** from:

1. Light;

2. Carbon dioxide;

3. Type of soil;

4. Minerals / nutrients;

Accept named example

5. Water (in soil);

6. Humidity (of air);

7. pH (of soil)

8. Planting density;

Idea of equally spaced

3 max

(b) Already levelled out (before 20 °C);

1

(c) Young leaves (may) have different number of stomata (per mm^2) / number of stomata (per mm^2) changes during development (of leaf);

Accept reference to density of stomata

1

(d) Any **two** from:

Points 1 and 2 need context of 'more'

1. Molecules have more kinetic energy;

   Accept KE

2. Faster diffusion of water / more evaporation of water (as temperature increases in leaf);

   For this point, diffusion must relate to movement of water

3. For this point, diffusion must relate to movement of water

2 max

[7]

Q15.

(a) 1. The more recent the sample the greater the concentration;

Accept converse

This could be expressed by reference to time e.g. 'concentration has increased since 25 000 years ago

2. Increases most in last 5000 years / more or less constant / slight increase between 30 000 and 15 000 years ago;

2

(b) 1. Variation in data / spread of data;

Reject references to range e.g. 'range of data'

2. Around the mean;

Both marks are possible in the context of using the data

2

(c) 1. Yes as pine leaves not in organic matter of the same age;

2. No as organic matter would be the same age as the pine leaves;

Accept either approach

1 max

(d) Can get more CO_2 for photosynthesis;

More CO_2 enters leaf is insufficient.
Accept light-independent (reaction) as equivalent

1

(e) Any **three** from:

1. (Overall data show) negative correlation;

Do not allow description of correlation because in question stem

2. Little change in number of stomata in last 10 000 years;

3. Small sample size;

4. Only one species studied;

5. Other factors / named factor may have affected number of stomata;

6. Evidence does not support the conclusion between 30 000 and 25 000 years ago / between 5000 years ago and present day;
Accept reference to either one of these age ranges

7. Appropriate reference to standard deviations (in comparing means);
E.g. no overlap between 15 000 and 10 000 years ago

3 max

(f) Any **three** from :

1. Thick cuticle;

2. Small leaves / low surface area;
Accept other ways of describing 'small', e.g. 'needle-like'

3. Hairy leaves;

4. Sunken stomata;

5. Rolled leaves;

3 max

[12]

Q16.

(a) Open / use tap / add water from reservoir;

1

(b) 1. Seal joints / ensure airtight / ensure watertight;
Answer must refer to precautions when setting up the apparatus
Ignore: references to keeping other factors constant

2. Cut shoot under water;

3. Cut shoot at a slant;

4. Dry off leaves;

5. Insert into apparatus under water;

6. Ensure no air bubbles are present;

7. Shut tap;

8. Note where bubble is at start / move bubble to the start position;

2 max

(c) 1. Water used for support / turgidity;

Accept: water used in (the cell's) hydrolysis or condensation (reactions) for one mark. Allow a named example of these reactions

2. Water used in photosynthesis;

3. Water produced in respiration;

4. Apparatus not sealed / 'leaks';

2 max

(d) As number of leaves are reduced (no mark),

Accept: converse arguments

1. Less surface area / fewer stomata;

3. Less evaporation / transpiration;

4. Less cohesion / tension / pulling (force);

3

[8]

Q17.

(a) (i) 1. Stomata open;

Allow converse

2. Transpiration highest around mid-day as middle of day warmer / lighter;

2. Allow 'Sun is at its hottest'

3. (Increased) tension / water potential gradient;

Ignore 'pull, suck'

3

(ii) (Inside xylem) lower than atmospheric pressure / (water is under) tension;

Accept cohesion tension. Ignore vacuum

1

(b) (i) High pressure / smoothes out blood flow / artery wall contains more collagen / muscle / elastic (fibres) / connective tissue;

Accept converse for pulmonary vein

Incorrect function of artery disqualifies mark

1

(ii) 1. (Aorta wall) stretches because ventricle / heart contracts / systole / pressure increases;

1. Allow expand

2. (Aorta wall) recoils because ventricle relaxes / heart relaxes / diastole / pressure falls;

2. Allow spring back

Reject any reference to contract / relax in MP1 and 2

3. Maintain smooth flow / pressure;

3

(iii) Aorta 1.2 / largest SD;

Allow pulmonary vein provided candidate relates standard deviation to mean

1

(c) Formation

1. High blood / hydrostatic pressure / pressure filtration;

2. Forces water / fluid out;

2. Reject plasma, ignore tissue

3. Large proteins remain in capillary;

Return

4. Low water potential in capillary / blood;

5. Due to (plasma) proteins;

6. Water enters capillary / blood;

7. (By) osmosis;

7. Osmosis must be in correct context

8. Correct reference to lymph;

6 max

[15]

Q18.

(i) 1. Increases then decreases;

Allow peak / maximum at any time between 13.00 - 14.00 or 7.8 - 8.0;

2. Peak / maximum at 13.00 / 14.00 (hours) / 7.8 - 8.0;

2

(ii) 1. Maximum / overall rate is higher (in branches);

Allow converse for all marking points.

2. Reaches maximum / peak earlier (in the day) (in branches);

3. Starts higher / ends lower (in branches)

2

(iii) 1. Movement starts / peaks earlier in branches / higher up;

2. Creates tension / 'negative pressure' / 'pull'

2

[6]

Q19.

(a) Light;

Humidity / moisture in air;

Air movement / wind;

Temperature;

2 max

(b) Decreases chance of error / larger difference in mass / improves accuracy / precision;

Neutral: Reliability, references to anomalies.

1

(c) 1. Stomata open, (water) transpired / evaporates / diffuses out (via) water potential gradient / leaf has higher water potential;

2. Water potential / diffusion gradient reduces (during investigation) as water not being replaced / no water supply;

3. Stomata close / closing;

Must clearly indicate that stomata are open for third marking point. However, allow correct descriptions of guard cells being turgid or flaccid as being equivalent to stomata being open or closed. 'Loss through stomata' on its own is not sufficient.

Neutral: Any reference to 'loss by osmosis'.

3

(d) Stomata (on upper surface) covered / stomata close due to lack of light / (grease provides) longer diffusion pathway;

Less evaporation / transpiration / diffusion out;

Accept: Evaporation / transpiration / diffusion 'stops' for second point as this could be referring to upper surface.

2

[8]

Q20.

(a) (i) 1. Removes water vapour / moisture / saturated air;

2. Increases water potential gradient / more diffusion / more evaporation;

2

(ii) 1. Increases kinetic energy so water molecules move faster;

2. Increases diffusion / evaporation;

2

(b) (i) Positive correlation / as light intensity increases so does rate of water movement / follows same pattern / directly proportional;

1

(ii) 1. Stomata open and photosynthesis increases / transpiration increases;

2. More water pulled up due to cohesion between water molecules / by cohesion tension;

2

(iii) 1. Water pulled up trunk / moves up at fast rate under tension;

2. Sticking / adhesion (between water and) cells / walls / pulls xylem in;

Adhesion is not a specification requirement.

Accept cohesion in this context

2

(c) **Elastic tissue**

1. Elastic tissue stretches under pressure / when heart beats then recoils / springs back;

2. Evens out pressure / flow;

Do not allow credit for expands / contracts / relaxes in this context.

From a marking viewpoint ignore all specific references to arteries and arterioles. Consider all points as applying to both.

2 Do accept controls

Muscle

3. Muscle contracts to reduce diameter of lumen / vasoconstriction / constricts vessel;

4. Changes flow / pressure;

Epithelium

5. Epithelium smooth;

6. Reduces friction / blood clots / less resistance;

6

[15]

Q21.

(a) Light (intensity) / temperature / air movement / humidity;

1

(b) Prevent air entering / continuous water column;

Allow answer in context of shoot, xylem or potometer.

1

(c) Distance and time;

Reject 'amount bubble moves'

1

Radius / diameter / area (of capillary tube);

1

(d) (used to provide) turgidity / support / description of;

(used in) photosynthesis / (produced in) respiration;

Apparatus not sealed / 'leaks';

2 max

(e) (i) Returns bubble (to start);

1

(ii) Increases reliability (of results) / anomalous result can be identified;

Q *Ignore references to validity / precision / accuracy etc.*

1

[8]

Q22.

(a) Single layer of cells / few layers of cells;

So that light that can pass through / cells absorb light;

2

(b) Method of determining area of field of view / area seen using microscope;

Count number of stomata in field of view;

Repeats and calculation of mean;

3

(c) Water vapour accumulates / increased humidity / reduced air movement (around stomata);

Water potential / diffusion gradient reduced;

2

[7]

Q23.

(a) 235–240;;
(one mark for an answer between 200-300 based on 2 - 3 stomata in 0.01mm^2
Alternatively, one mark for calculating the area of the rectangle correctly as 0.016 – 0.017mm^2)

2

(b) grows in arid / dry conditions;
less surface area;
(rate of) transpiration / water loss would be reduced;

3

[5]

Q24.

(a) 1. (when light intensity is increased) tension in the xylem becomes greater / more negative / stronger;

2. (this increase) takes place over ≈100 second;
3. then levels out;
4. stomata open (more);
5. increased evaporation / transpiration;
6. therefore the water potential of leaf cells becomes more negative / lower;

7. therefore more water moves from xylem to surrounding cells;
8. down a water potential gradient;
9. correct ref. to hydrogen bonds / cohesion;

5 max

(b) humidity will affect (the rate of) evaporation / transpiration;
increased humidity / humid conditions decreases rate of water loss;

2

[7]

Q25.

(a) 1. Diameter of trunk minimal at warmest / brightest time of day / midday = warmest / brightest;
2. Stomata open in light → more water loss;
3. Water evaporates more when warm / more heat energy for water evaporation;
4. Hydrogen-bonding between water molecules / cohesion (/ described) between water molecules;
5. Adhesion (described) between water molecules and walls of xylem vessels;
6. (Xylem) <u>pulled</u> inwards by faster flow of water / <u>pulled</u> in by tension;

6

(b)

Feature	Explanation
Think cuticle / wax layer	waterproof / impermeable;
Sunken stomata	saturated layer of still air outside;
Hairy	saturated layer of still air outside;
Leaves small / reduced to spines / needles	reduced S.A. for water loss;
Leaves roll up in dry weather	less S.A. for water loss / stomata covered / saturated region of still air;
Reduced number of stomata	reduced S.A. for water loss;
CAM (/ Crassulacean Acid Metabolism)	stomata closed in light / in warm / only open in dark / when cool;

3 features but no explanations – max 1 mark

max 3

[9]

Q26.

(i) (waxy so) impermeable to water / waterproof / stops water passing through;

1

(ii) reference to hairs / position of stomata (sunken stomata / stomata in pits)
<u>LINKED</u> to reduced air movement / trap layer of air /
trap water <u>vapour</u> (*reject water) /* maintains humidity;

reduces diffusion gradient / concentration gradient of water / water potential gradient;

OR

stoma can close;
reduces <u>area</u> for evaporation or transpiration;

2

[3]

Q27.

(a) shallow roots enable rapid uptake of rainfall (in **X** and / or **Z**);
widespread / shallow roots allow collection of larger volume water / over a larger area / rapid uptake of water (in **Z**);
swollen stem for water storage (in **X**);
deep roots for accessing deep groundwater (in **Y**);
small / no leaves so little transpiration;

3

(b) **Z**;
wide spread of roots for rapid water absorption;
(accept **X**; if linked to leaves channelling water to roots)
(ignore references to water storage abilities)
(accept other responses if justified)

2

[5]

Q28.

(a) long cells / tubes with <u>no end walls</u>;
continuous water columns;
no cytoplasm / no organelles / named organelle;
to impede / obstruct flow / allows easier water flow;
thickening / lignin;
support / withstand tension / waterproof / keeps water in cells;
pits in walls;
allow lateral movement / get round blocked vessels;

4 max

(b) (i) increase in transpiration rate / evaporation due to increase in temperature ;
increased (kinetic) energy of water molecules;

OR

increase in light (intensity) increases transpiration rate / evaporation;

greater stomatal aperture / more stomata open so increase in flow rate due to cohesion / attraction of water molecules;

2 max

(ii) adhesion / attraction of water molecules to walls of xylem;
results in tension as water pulled up stem;
pulling in walls;

2

[8]

Q29.

(a) (i) unrestricted / free / quick / easy water flow / continuous column / maintains transpiration stream;

1

(ii) resists tension in water (column) / provides support / strength / maintains column of water / adhesion / prevents water loss
(allow waterproofing in correct context i.e. not absorbing);

1

(b) (i) as total area of stomata decreases the rate of water flow decreases / decrease is proportional;
(reject proportional, 'as one goes up the other goes up' and 'same shape')

1

(ii) increasing / higher temperature causes increasing / higher rate of evaporation / transpiration;
(*not water loss*)

1

(iii) lower plateau (start and finish at same point);
(allow *if curve sketched on original graph, reject 'curve is lower'*)

1

(c) conserves water / reduces water loss / reduces transpiration / reduces evaporation; high humidity (in pit) / reduced water potential gradient / less water blown away / increased diffusion pathway;

2

[7]

Q30.

(a) 1. water evaporates / transpires from leaves;
2. reduces water potential in cell / water potential / osmotic gradient across cells *(ignore reference to air space)*;
3. water is drawn out of xylem;
4. creates tension *(accept negative pressure, not reduced pressure)*;
5. cohesive forces between water molecules;
6. water pulled up as a column;

4 max

(b) (i) same surface area of leaf / number of leaves / age / thickness of cuticle;

1

(ii) (environmental conditions) affect rate of transpiration / evaporation;

1

(iii) presence of grease reduces water loss;

1

(c) (i) 1.2 / 1.3g;

1

(ii) more stomata on the lower surface;
(thicker) waxy cuticle on the upper surface;

2

[10]

Q31.

(a) (i) rate of flow increases to max at 1200 and then decreases;

increasing transpiration / evaporation from leaves;
transpiration creates tension / increases transpirational pull;
water molecules are cohesive / stick together;
produces a water column;

3 max

(ii) (increase transpiration) produce a higher tension / reduces the pressure in the xylem reducing the diameter / adhesive forces between xylem and water;

1

(b) water moves in dead cells / xylem is non-living tissue;
the process is passive / no energy is needed;

2

[6]

Q32.

(a) increased humidity leads to decreased transpiration;
high humidity means more water in the air / increased saturation / increased water potential;
reduced diffusion gradient / water potential gradient;
slower rate of water loss / less evaporation;

3 max

(b) thick cuticle;
impermeable to water / waterproof;

sunken stomata;
reduces water diffusion gradient;

shape of leaf / rounded / small surface area;
small surface area : volume ratio;

(explanation must be linked to feature)

4 max

[7]

Q1.

In (a), most students (60.4%) were able to obtain at least one mark, either for explaining that treatment D was used to compare the effects of other treatments, or that it enabled the scientists to see the effect of substance X. A much smaller number of students included both of these ideas in their answer. A small number of students showed excellent awareness of how best to use a control when they subtracted the figure given for roots growing in D from figures obtained in other treatments. There were good discussions related to comparing treatments, and 'active substance versus agar alone'. Several made good use of terms such as `independent variable'.

Most students achieved a mark on question (b) for recognising that the presence of substance X increased root growth, so had successfully made a conclusion by analysing data. Many went as far as subtracting the figure for the 'control' from the result for treatment E. The limitation in many answers, however, and the reason why relatively few candidates achieved two marks was their inability to explain what was shown by the 'control'. Most tried to do this by describing the data (for example, '…while D only had 5 roots'), rather than make a conclusion along the lines of, 'D shows roots are still produced without the substance'. Fewer still achieved the mark for substance transport in the stem because substance movement was implied rather than stated explicitly.

The best answers to (c) provided a clear description of the evidence and linked it precisely and immediately to a context, either in support of, or against the mass flow hypothesis. However, only 0.6% of students scored all four marks. Many students gave detailed and accurate descriptions of the hypothesis, without linking their knowledge to the outcomes of the investigation and without applying what they knew of mass flow in the evaluation. The answers tended to be lengthy, but usually only made a single valid point, and in the majority of cases this was: "F shows phloem is required, so this supports the hypothesis". Very few students considered aspects of the mass flow hypothesis other than the requirement for intact phloem. Many correctly said bulging occurred above the ringed section according to the hypothesis, but bulging was not present in the figure, so students had not considered either the information given or applied their understanding with sufficient care. Many mentioned the idea of a source and sink, but rarely applied it to this investigation, so very few stated the agar was the source (to support the hypothesis) and roots were the sink. Some referred to leaves as the source of the assimilate, even though leaves were not shown in the figure. The small number of students who did refer to Treatment G chose to link vaguely their ideas of enzymes to explain these results, but they rarely referred to processes, like respiration or active transport which they should know are involved in mass flow.

Q2.

This question was all based on section 3.3.4.2 of the specification, linked to interpreting evidence from tracer experiments.

The majority of students limited their answer to question (a) to a description of the data rather than an explanation. They simply stated that radioactive carbon dioxide was not visible throughout the plant in A and therefore had not been transported through the phloem. As this question required the students to explain the results, all the marking points required use of the students' knowledge. The first point was for the idea that the radioactive carbon dioxide would be used in the leaf to produce sugar in photosynthesis. The second point was then that sugar is transported in the phloem. If the first point was not appreciated, then students could score the second marking point for appreciating that mass flow/translocation happens in the phloem and that is what has stopped in this case.

The alternative valid approach to the question for marking points 3 and 4 was not seen. Nearly 60% of students failed to make any headway in this question.

In question (b), many students could use the standard deviations to explain that there was no (significant) difference between the water content of the leaves. Some did suggest that this showed they were 'not very different' or were 'similar'; this was insufficient to gain credit. As with question (a), this part required students to explain the data, so answers required application of knowledge in the context of the question. Some did not sufficiently link their knowledge that water moves to the leaf in the xylem with these data to achieve the second marking point, i.e. that water is still moving into the leaf in the xylem.

Figure 2, in question (c), was a complex graph, with much to interpret. Many students did not relate this investigation to that in **Figure 1** and discussed heat-treatment half way up the plant that, therefore, affected young leaves at the top of the plant more than the old leaves at the bottom of the plant. This would gain marking point one and many students gained this mark for a description of the difference in effect of heat treatment on old and young leaves. Some excellent answers were seen, with students fully understanding the differences in transport mechanisms in old and young leaves, but many were thrown by the ratio data on the y-axis and struggled to access most of the marking points. Pleasingly, just over 10% of students were able to score at least three marks here.

Q3.

There was a wide range in the quality of the responses to question (a), with 16% gaining 4 or 5 marks and approximately the same percentage gaining zero marks. Many students did not seem to understand what is meant by the cohesion-tension hypothesis and complicated their answer with unnecessary and lengthy accounts of the movement of water across a root, root pressure and even translocation. Those who understood the scope of the question were frequently able to access the mark scheme, with most writing about hydrogen bonding between water molecules resulting in cohesion and water being pulled up the xylem as a continuous column. Many wrote about transpiration from the leaves though few explained how this would result in a lower water potential in the leaf cells. Only a small number of students referred to adhesion of water molecules to the walls of the xylem vessels.

Question (b) discriminated well, with approximately 20% of students gaining 4 or 5 marks and 28% gaining no marks (although quite a few of these may well have been as a result of students running out of time). Some excellent answers were seen in which students wrote logically and clearly using accurate scientific terminology, though even these students rarely gave the full information for complementary base pairing. A high percentage of students gained the 2 marks available for describing how the pre-mRNA formed is cut and spliced to form mature mRNA. The role of RNA polymerase was often incorrectly stated and students frequently stated that plant DNA does not contain introns.

Q4.

(a) 57% of students could do the calculation and obtained both marks. Some wrongly used the diameter of the capillary tube, rather than the radius. Others neglected to multiply by 4 in order to get the rate per hour. In either case, they could obtain one mark.

(b) This question discriminated well, but only 2.3% of students got all three marks. Many correctly suggested using graph paper to find the surface area of one side of a leaf, but then failed to multiply by 2 in order to get the total surface area. Some students described how they would find the rate of water loss using the potometer and didn't get as far as the leaves. Others described methods not using a potometer to find the rate of water loss. Some wrongly used mass/volume of water lost, rather

than rate of water loss.

(c) This was intended to be a relatively simple exercise in evaluating the method used. Only 17% of students noted that the shoot in the potometer has no roots, which is where water normally enters a plant.

(d) 56% of students obtained one mark by looking at Figure 2 and suggesting the molecules had either similar sizes, or similar shapes. Only 22% suggested both for two marks. There were many references to polarity (either polar or non-polar), but these were not credited. Some suggested that both contained oxygen, as seen in Figure 2, and this would bind to the aquaporin. This was given credit.

(e) Many students did not grasp the link between the ssRNA, coded for by the foreign gene, and blocking of translation by interference with mRNA. The question still discriminated reasonably well, but 63% of students scored zero. The observed outcome may also be due to this part of the specification not being as familiar to students as more traditional topics.

(f) Given the failure of many to comprehend what was required in (e), it was not surprising that only 28% of students obtained the mark in (f). Many were awarded a mark for suggesting that not all cells of the plant had been transformed by the foreign gene.

(g) Students performed better on this part. 18% obtained all three marks and only 10% failed to score. The question discriminated well. This evaluation proved safer ground for most, especially since SDs are actually shown in the graph. The frequency with which the mark points were awarded coincided with their order on the mark scheme.

Q10.

(a) Most students were unable to provide appropriate units to compare the distribution of stomata on leaves. The units used varied from nanometres to metres and these were often measurements of length or volume rather than area. A significant number of students were under the mistaken impression that ‘per’ can be represented by a solidus.

(b) Most students were able to obtain one mark in this question usually for explaining that light would be able to pass through a thin piece of tissue. Very few students obtained both marks by further explaining that a single/few layer(s) of cells was required for this to occur. Many students did not gain a second mark due to the use of imprecise terminology, others were clearly confused with references being made to ‘diffusion distance’, ‘water loss’ and ‘electrons’.

(c) Almost 80% of students were able to obtain at least one of the two marks available. Both mark points were seen in relatively equal numbers. A common error was to refer to variation in the number of stomata on different leaves rather than in parts of the same leaf. There were also frequent references to anomalies, not always in the correct context.

(d) The quality of the answers for this question was very disappointing. Consequently, 75% of students scored zero. Some students had not carefully read the question and described a range of xerophytic features of plants rather than those specifically related to leaves. Other students simply described two xerophytic features of leaves but did not provide explanations. However, most students did suggest two xerophytic features of leaves and gave explanations but these explanations lacked detail. Students often referred to ‘hairs trapping water’ rather than ‘water vapour’ and omitted any reference to water potential gradients. Another common response was

‘a waxy cuticle to reduce water loss’ which again lacks sufficient detail to gain credit. A common misconception was that small leaves reduce surface area to volume ratios rather than referring to needles or spines.

(e) This question was problematic for many students, with only a third gaining any marks. The most frequently awarded mark point related to the use of water in photosynthesis. However, almost the same number of students suggested that water was produced in photosynthesis. Slightly fewer students mentioned the use of water to provide support/turgidity. There were far fewer references to the production of water during respiration or its use in hydrolysis. Again, weaker answers suggested that water is used in respiration or provided vague references to water being used for growth. A significant number of students referred to leakage of water from a potometer evidently having misinterpreted the context of the question.

Q11.

(a) There was a considerable range in the quality of answers for this question. Some students provided detailed explanations of how the structures of starch and cellulose are related to their functions. At the other end of the spectrum, students referred to these molecules as polypeptides and provided details on protein structure. 10% of students gained full marks and almost 15% gained zero. Although many students appreciated the importance of starch being compact they did not always relate this to its helical/spiral structure. Most students stated that starch did not affect the water potential of cells due to its insolubility. Fewer students related the branching of starch to the faster release of glucose for respiration or discussed its inability to leave a cell. Generally, more students gained marks when describing the structure and function of cellulose. Most appreciated the strength of cellulose but a common error was to relate this to ‘strong hydrogen bonds’. However, a significant number of students gained credit for describing (micro/macro) fibrils.

(b) As in question 10.1, 10% of students obtained maximum marks. However, almost 30% of students scored zero in this question. The responses from students obtaining low marks included a number of factual errors; sugars being produced by sinks, phloem consisting of dead cells, the transport of sugars in the xylem, transport of glucose rather than sucrose, and transport of sugars using cohesion tension. Conversely, there were also some superb answers which included detailed explanations that went beyond the requirements of the mark scheme. This was particularly evident in the details provided on the loading of sugars from the source into the phloem via companion cells. Better answers contained extensive explanations of how co-transport is involved in this process. A significant number of students gained credit for explaining how the pressure gradient between the source and sink was established including the osmotic movement of water into the phloem. Surprisingly, few students obtained the mark for referring to the mass flow of sugars towards sinks. However, most students did describe the unloading of sugars at sinks.

Q12.

(a) This part discriminated more than was, perhaps, intended. In both (i) and (ii), many students did not read the question carefully enough and included comparisons of properties or function, rather than structure. For example, many wrote about starch and cellulose being insoluble but this is not a similarity of structure. About 40% obtained both marks in (i) and 60% in (ii).

(b) This required students to use the figure and apply some basic concepts. As in (a), some students did not read the stem of the question carefully enough and couched their answers in terms of structures I and J.

(i) Many students described (in various ways) the large open space in the sieve cell and some went on to suggest that this would lead to a (relatively) unrestricted flow; about 30% obtained 2 marks and 40% 1 mark.

(ii) This was where more students failed to score because of answers based around plasmodesmata (J), which are precluded by the stem of the question. Over 40% obtained 2 marks by linking energy from mitochondria to active transport. Some students missed one mark because the examiners rejected references to mitochondria creating or making energy.

Q13.

(a) Some of the lower-scoring students failed to access this question. Credit was available for stating that the relative processes stopped at particular values. Reference to processes happening at those values was insufficient, unless qualified by giving the range of values over which the processes happened. Some assessors incorrectly gave credit where positive, rather than negative, values were shown.

(b) This question proved accessible to most but some explanations were unnecessarily complicated by reference to transpiration.

(c) Many students found this question challenging. They were expected to suggest how growth was prevented when the processes stopped. Merely stating that they stopped was unworthy of a mark. Credit was inappropriately given by some assessors when the potential role of proteins as enzymes or membrane proteins, or the *naming* of a specific protein, had not been given. Some students failed to explain that a lack of cell wall synthesis would affect new cell production and consequently prevent growth. Higher-scoring students frequently achieved full credit.

Q14.

(a) Invariably, students could offer three appropriate environmental variables that scientists would have controlled. Some assessors credited what they considered valid, as a general reaction to control of variables, without considering the conditions that would apply as outlined in the resource materials with seeds sown in trays and kept in controlled conditions. Students who failed to achieve full credit were usually guilty of producing a stereotyped response.

(b) This question troubled many, but the higher scoring students recognised that the curve had already levelled out and, in effect, it would serve no purpose to continue at higher temperatures.

(c) Many students chose the wrong reasoning considering the growing conditions to be the relevant factor as opposed to potential differences in the number of stomata at different stages of leaf development.

(d) In marking point 1, ‘kinetic’ was underlined. This means that use of the term is essential before the marking point can be awarded. Students often identified the effect of a temperature increase on evaporation rate but few expressed this in terms of diffusion rate. As a consequence, most students failed to gain marking point 3.

Q15.

(a) In general, students made good use of the data, as required, answering this question. Weaker answers only identified the overall trend.

(b) There was some misinterpretation of this question by students. All that was required

was a description of what standard deviation shows, namely, the variation in, or spread of data about, the mean value. Some attempted to discuss standard deviation values related to the data obtained but there was no specific direction to do so in this case.

(c) Given that two possible approaches to this question were possible, the majority of students were able to make one acceptable line of reasoning.

(d) The link between carbon dioxide and photosynthesis was not apparent to a large number of students. Thus, they failed to gain the mark for this question.

(e) Although all responses were seen within the work that was moderated, most students could not make three relevant points – the mark allocation was the key for this – to justify whether the results supported the conclusion. It was rare to see recognition of a negative correlation, although some described such but were only repeating the question stem and, for doing so, there is no credit. This type of question reflects a weakness with the assimilation of resource material. The likelihood of another factor being responsible was the most common point made, but this supports the idea that many students produce rehearsed answers without showing a comprehension of what is in the resources.

(f) Many students finished strongly with a question relying on recall. The Marking Guidelines specifically referred to “thick” cuticle but some assessors credited reference to ‘waxy’ as an alternative.

Q16.

It appeared that some students had not used a potometer. The investigative and practical skills section of the specification for this unit clearly states that students require specific knowledge of the use of a potometer to measure the rate of water uptake. It also makes clear that students can be tested on this in the examination.

(a) Many students were aware that opening the tap would return the air bubble to the start. Students who appeared unfamiliar with a potometer usually made incorrect guesses from the diagram, e.g. ‘add water to the reservoir’, ‘remove the plant’ or ‘remove the bung’.

(b) 60% of students gained at least one mark. Better responses usually went beyond ensuring that the apparatus was airtight. The question asked for specific precautions that should have been taken when *setting* up the potometer. Despite this, weaker responses typically named factors that should be kept constant.

(c) Given that this question has been asked in a previous series, it is disappointing that over 60% of students scored zero. Better responses showed appreciation that water is used for support and photosynthesis and produced during respiration. However, weaker responses seemed to focus on the word ‘transpiration’ in the question stem. Consequently, references to the opening and closing of stomata, effects of environmental factors and not all water being used in transpiration were widespread. Similarly, some students thought that water is used in respiration, or produced during photosynthesis.

(d) This proved to be an excellent discriminator. Just under half of students scored at least two marks. This was usually for appreciating that removing more leaves meant fewer stomata, less transpiration and less tension. Unfortunately, weaker responses often did no more than describe the relationship between the number of leaves removed and the rate of transpiration. Some students had difficulty in applying their knowledge to an unfamiliar context. They wrote all they knew about cohesion-

tension, without linking this directly to the data in the table.

Q17.

(a) (i) There were many approaches used in trying to explain this. Better students were precise in answering, relating data given to stomatal action and transpiration. Some did not read the stem carefully and wrote about changes in pressure. Many others failed to make the link between flow in the xylem and transpiration. The idea of increased tension occured only rarely but most students showed an understanding of cohesion.

(ii) Most students made an attempt at this question but often made incorrect reference to root pressure and osmosis. There were some imprecise general discussions of water flow and transpiration, but there were also good answers showing clear understanding of principles. Again the best answers addressed the context of the question rather than producing generalisations. Many incorrect answers linked the negative values of water potential to negative pressure in the xylem.

(b) (i) Generally answered well, but answers often only described rather than explained the difference in wall thickness. A significant number of students wrongly referred to the artery wall as 'needing thick layer of muscle to pump the blood'.

(ii) There were frequent incorrect references to the aorta wall contracting or relaxing and to thickness increasing due to contraction. There were also many very general references to vasodilation or constriction. A frequently expressed incorrect idea was that the wall would become thicker with increasing pressure.

(iii) This question was answered well by the majority of students. Frequent inappropriate responses involved relating the function of the vessel to wall thickness rather than to the variations in wall thickness.

(c) The majority of students were able to score high marks on this question. Many gave well reasoned answers, although some failed to include precise detail. There were often good discussions relating to hydrostatic, water and osmotic pressures. Many students made good references to the role of the lymphatic system, although a common error was to state that the lymph nodes returned the surplus fluid to the circulatory system.

Q18.

(i) It was pleasing to note that the vast majority of students were able to describe the rate of water movement in the upper branches and gain both marks. Only 5% obtained zero on this question.

(ii) Many students gained one mark for the idea that the peak is higher in the upper branches. However, relatively few students described a second difference between the results in the trunk and upper branches. A significant number of students simply described one of the results and gained no marks.

(iii) Approximately half the students gained one mark by describing how tension is produced or by referring to water being pulled up the tree. Very few students referred to water movement starting in the upper branches for a second mark.

Q19.

(a) This was a straightforward question with over ninety percent of candidates gaining both marks and very few scoring zero.

(b) A third of the candidates gained this mark for clearly indicating that measuring water loss in milligrams would improve precision or accuracy. Incorrect responses often mentioned reliability, anomalous results, or calculating a mean.

(c) Some answers were limited to descriptions of the graph and scored zero, or referred in general terms to transpiration for one mark. Candidates scoring three marks often provided a clear, detailed explanation of the results including reference to changing water potential gradients and the opening and closing of stomata. A significant number of candidates also realised that water was not replaced in the leaves as they were detached.

(d) Most candidates gained one mark for indicating that there would be less transpiration or evaporation. Far fewer candidates, however, suggested that the grease had covered the stomata or had increased the diffusion pathway. Many candidates failed to get this mark as they simply stated that the grease provided a waterproof layer.

Q20.

(a) Many candidates appeared to understand the principles that were being tested in the two parts of this question but explanations often fell short of the required standard. In part (i) a reference was required to the dispersal of water vapour and the consequences of this on the diffusion or water potential gradient. Many less able candidates offered explanations in terms of moving air forcing water out of the leaf or involving water moving out of the leaf by osmosis. Those who appreciated, in part (ii), that an increase in temperature increased kinetic energy usually progressed to refer to an increase in the rate of movement of water molecules. Others, perhaps inevitably, attempted to link temperature with enzyme activity

(b) Most candidates followed the instruction in part (i) and described the relationship with sufficient precision to gain the mark. They were also able to link movement through the xylem to increased light intensity and stomatal opening with some success. However, by far the most popular response to part (ii) was to suggest that there would be an increase in the rate of photosynthesis and therefore more water would be needed by the plant. The terms cohesion and tension were frequently used in such a way as to suggest little real understanding. It was not uncommon to read about water molecules being pulled through the xylem because “they stick to each other by cohesion-tension”. The idea conveyed in part (iii) appeared to be unfamiliar to all but the best candidates. The structure of the question should have lead candidates to realise that it was testing the same basic principle. The question was worded in such a way as to encourage candidates to explain the lower diameter at 12.00. Many opted however to explain the converse of this and based their answers on suggestions involving storage of water in the xylem.

(c) Responses to this question were very disappointing as evidenced by the large number of candidates who were unable to gain credit. Many answers were very general and did little more than suggest, often at great length, that “strong” walls meant that blood vessels did not burst under pressure. Such answers often established this point for arteries, then repeated it for arterioles. Only the very best candidates appeared aware of the presence of muscle and elastic tissue within the walls and could describe the roles of these particular tissues. There was also much emphasis on valves. They were correctly described as not being present in arteries and arterioles but then discussed in terms of what they would have done if they had

been present. Those candidates who referred to the endothelium were generally able to point out its functions in reducing friction. There were others, however, who considered the lumen to be a fundamental component of the wall.

Q21.

(a) The vast majority of candidates was able to give one correct environmental factor that the student should have kept constant during the investigation.

(b) Answers to this question were generally disappointing with only a third of candidates appreciating that it was important to prevent air entering the shoot, xylem or potometer.

(c) Approximately half the candidates obtained a mark for indicating that distance and time have to be measured. Very few candidates obtained a second mark by indicating that the radius, diameter or area of the capillary tube had to be measured.

(d) Surprisingly, this proved the most difficult question on the paper. Seventy five percent of candidates scored zero with many candidates simply stating that not all the water is used in transpiration. Candidates obtaining one mark often referred to water being used in photosynthesis. Very few candidates obtained a second mark by indicating that water is used to provide support or that it may evaporate or 'leak' from the apparatus.

(e) (i) Most candidates simply suggested that the reservoir would allow water to be added. Fewer candidates gained the mark by linking this to moving the position of the bubble.

(ii) Most candidates gained this mark by indicating that repeat measurements would enable the reliability of the results to be assessed.

Q22.

(a) Most candidates appreciated that having a thin piece of epidermis would allow light to pass through the specimen. However, far fewer candidates could explain this in terms of a single or few layers of cells being present. A common misconception was that being thin enabled organelles to be identified.

(b) This proved to be the most demanding question on the paper with over 75% of candidates scoring zero. It was very evident that most candidates had little experience or recall of this type of practical work. Most candidates simply stated that the number of stomata on a leaf would be counted and divided by the area without any reference to using the slide. Almost invariably when candidates did gain a mark, this was for carrying out repeats and calculating a mean.

(c) Although many candidates gained one mark, a significant minority did not mainly due to poor or imprecise terminology. References to 'trapped water droplets' rather than water vapour or to 'concentration gradient' rather than water potential gradient were frequently penalised. Consequently, few candidates obtained both marks.

Q23.

(a) Very few candidates correctly worked out the area as $0.0167mm^2$ and many seemed to have a basic problem with calculating areas. It was common to see 0.1 x 0.1 = 0. l mm^2. Many candidates failed to gain credit by carrying out calculations that were not clearly identified. A common approach was to estimate the number of stomata in an area 0. 1mm x 0. 1mm, which gained credit if done correctly. Many gave answers

that were clearly incorrect, such as 20-25 or even 0.25!

(b) Most candidates picked up the 2 marking points but some failed to gain the second point by incorrectly stating that 'fewer stomata prevent water loss'. Few answers referred to the idea of there being a reduced surface area.

Q24.

(a) An increase in negativity, representing an increase in tension, was a stumbling block for many candidates. Having set off on the wrong foot they then found it more difficult to answer the question effectively, even though they often understood the mechanics of water transport quite well. Few candidates scored more than one mark for their description of the effects of increasing light intensity. A reasonable number of candidates lost their way in detailed descriptions of the mechanism of stomatal opening. As a result, few candidates scored all five marks although many gained some credit. The contribution of increased photosynthesis to tension is so small that credit could not be given for the suggestion.

(b) This question produced many simplistic responses which centred around the idea of 'a fair test'.

It appeared that many of the candidates knew the answer failed to gain marks for not being sufficiently explicit. Many answers made the connection between humidity and transpiration but went no further.

Q25.

(a) Most candidates used the graphs to link midday with high light intensity and high temperature. Better candidates related higher temperature to a high rate of water evaporation, but only a few commented on the relationship between high light intensity and stomatal opening. Most understood the principles of cohesion and adhesion with a fair proportion mentioning hydrogen bonding as the cause of these phenomena. While most realised that water was pulled up the plant, driven by transpiration from the leaves, explanations of how this would generate an inward pulling force on the xylem vessels were frequently not very clear. In some cases due to the use of the term 'pressure', it was difficult to decide what the candidate intended.

(b) While most candidates were able to give three adaptations of the leaves of xerophytic plants for reduction of water loss, explanations were often not very thorough. Others were excellent, stating that trapped layers of water vapour would reduce the water potential gradient and hence slow down diffusion of water molecules. Some, unfortunately, did not confine themselves to the constraints of the question and included inappropriate references to the root system or to water storage tissue in the stem.

Q26.

The role of the cuticle was well known. Some candidates failed to gain marks through incomplete answers such as 'the cuticle reduces transpiration' rather than relating water loss to the impermeable nature of the cuticle. In part (ii), most candidates were able to describe a feature that reduces water loss, but only the more able candidates explained how the feature reduces transpiration by affecting the water diffusion gradient.

Q27.

(a) Most candidates could identify three features which were adaptations to desert conditions. Some candidates were rather vague with responses like ‘lots of roots’, and many failed to identify which plant(s) they were referring to.

(b) Most candidates correctly identified **Z** as the resurrection plant and gained two marks. The most common error was suggesting plant **X** because of its ability to store water. This was not given credit.

Q28.

(a) This question produced a full range of marks with some candidates gaining full marks but a substantial number gaining no marks. This appeared to be a topic that was often overlooked by centres.

(b) Only the better candidates scored both marks in part (i). Many correctly linked an increase in temperature or light intensity with an increase in the rate of transpiration. Only the more able went on to explain this increase in terms of kinetic energy or stomatal aperture. Few related this to the flow rate. Part (ii) was answered well with many candidates able to relate the adhesion properties of water to the pulling in of xylem vessels. As in previous years, many candidates used the terms ‘cohesion’ and ‘tension’ very loosely with little understanding of their meaning.

Q29.

(a) Both parts of this question were answered correctly by the vast majority of candidates.

(b) (i) Many candidates achieved the mark for this question by correctly identifying the relationship in the given time period, but some failed to achieve it because they gave a general relationship which is not valid between midday and midnight: for example, ‘the relationship is proportional’ does not sufficiently explain the decreasing aspect of the relationship in the time given. Some candidates lost this mark by making an inappropriate link between the cause and effect: for example, ‘the total area of stomatal openings decreases when the rate of flow of water decreases’.

(ii) Relatively few candidates gave enough detail in their answer to achieve this mark. Often they failed to appreciate the temperature is likely to continue increasing between 8 am and midday. If they had this idea they often failed to link it to a process in which water is lost from a plant (by evaporation or transpiration). A lot of candidates recognised that there would be an increased rate of transpiration, but they gave the wrong reason for it: for example, because light intensity has increased or there is more photosynthesis taking place.

(iii) This proved to be a difficult question for many candidates who clearly understood what was required, but who expressed themselves without sufficient clarity to gain the mark: for example, ‘the curve is lower’, ‘the area of stomata is smaller’ were often quoted and gained no mark.

(c) Xerophytic adaptations are known well by the majority of candidates. Many achieved both marks.

Q30.

(a) There were some very good answers achieving maximum marks. However, many answers used very vague language, such as ‘water is pulled up by cohesion-tension’, with no description of what cohesion involves, or what creates the tension. Water was said by many to be ‘sticky’. This was the lowest level of answer accepted for a mark about cohesion. Root pressure was often included in the description of cohesion-tension, which cost candidates time but gained no credit.

(b) (i) Many candidates appear to confuse the concept of fair testing with reliability; both terms being used interchangeably.

(ii) More able candidates answered in terms of how an environmental variable could affect the rate of transpiration, or the rate of evaporation, rather than just stating ‘to keep water loss the same’.

(iii) Most candidates gave the correct answer.

(c) (i) Most candidates calculated the mass of water lost accurately.

(ii) Many candidates missed marks by failing to give a comparison between the upper and lower surfaces of leaves. There were many references to ‘pores’ rather than ‘stomata’, or a ‘waxy layer’ rather than a ‘cuticle’, indicating a poor knowledge of leaf structure.

Q31.

(a) (i) This question was answered well by only the better candidates. The description of water flow was not well done; often the information in the graph was not used to give an A level standard description. For example, although many candidates noted that it increased and decreased few wrote that water flow peaked at midday. To explain this pattern many answers used the phrase ‘cohesion tension’ very loosely. However, good answers explained clearly the relationship between the rate of transpiration, the movement of water and the cohesive properties of water molecules. There were many confused accounts which involved general descriptions of water flow and diameter changes which were not creditworthy. The fact that transpiration increased during the day was often missed, and the link between that and an increased tension was tenuous at best.

(ii) Very few candidates gained credit for explaining why the diameter of the branch decreased. A common misconception was that the change was due to lack of turgor. The effect of cohesion and adhesion confused many candidates with few making references to a reduction in pressure; far more candidates thought that there was an increase in pressure.

(b) Many answers correctly stated that picric acid would have no effect on xylem as this is non-living or dead tissue. Better answers went on to relate this observation to the passive nature of the transpiration stream.

Q32.

Again most candidates scored highly on this question, with many achieving maximum marks.

(a) Most candidates were able to describe the relationship between humidity and transpiration rate, and then to explain this relationship in terms of how high humidity increases the amount of water in the air, and therefore decreases the diffusion gradient, resulting in a slower rate of water loss. Marks were often not awarded for incorrect or vague explanations, such as ‘water is lost to the air by osmosis’ or ‘humidity affects the aperture of the stomata’.

(b) There were many excellent answers relating features evident in the diagrams with clear explanations of how each feature contributes to a lower rate of transpiration. For example, many candidates correctly recognised the thicker cuticle of the xerophytic leaf and explained how the waterproof property of the cuticle reduces water loss. A lack of precision often resulted in few marks, such as the vague statement that the cuticle reduces water loss with no explanation of how this is achieved. Sunken stomata reducing the diffusion gradient of water and the shape of the leaf resulting in a smaller surface area:volume ratio, were correctly identified as other explanations, but they were less common.