

Q1.

- 4 (a) (i) shade in xylem; (complete xylem star must be shaded) 1
- (ii) shade in phloem; (A. shading of just one phloem group) 1
- (b) ref to bending/provide support/strength; R. lignin unqualified  
R. prevents collapsing 1
- (c) osmosis/diffusion;  
down water potential gradient/from high/less negative to low/more  
negative water potential/AW; (R. osmotic potential/conc. gradients/  
less or more) through partially/selectively/differentially permeable  
membrane; R. semi-permeable **max 2**
- (d) transpiration pull/cohesion-tension/cohesion-adhesion/  
mass flow in xylem;  
into spongy mesophyll (cells);  
many cell walls/surfaces/large surface area; evaporation of water  
(from damp walls); into (substomatal/intercellular) air spaces; diffusion  
of water vapour/water as a gas/described; (e.g. movement of water  
vapour from high to low conc.) through stomata/cuticle (to air/  
atmosphere); **max 4**
- (ignore ref. to apoplast, symplast, vacuolar pathways)

**[Total 9]**

Q2.

3 (b)

- higher temperature and higher wind speed gives higher / greater / faster (rate of) uptake / transpiration / water loss / movement of, water / bubble;
- both conditions / AW increase water potential / diffusion gradient (between leaf and air);
- = *general points*

*temperature*

use of figs. (units required) to make a valid comparison;

- e.g. expts. 1 and 3 - 12 to 24 mm h<sup>-1</sup> } **A** appropriate
  - expts. 2 and 4 - 22 to 45 mm h<sup>-1</sup> } factor increase
  - expts. 3 and 5 - 24 to 64 mm h<sup>-1</sup> } e.g. rate doubles
- A** figs. once only in temperature or wind speed (see below)

ref to kinetic energy / speed of movement of molecules and rate of evaporation / transpiration / diffusion;

warm air holds more water vapour / molecules than cold air / AW; R water

*wind speed*

use of figs. (units required) to make a valid comparison;

- e.g. expts. 1 and 2 - 12 to 22 mm h<sup>-1</sup> } **A** appropriate
  - expts. 3 and 4 - 24 to 45 mm h<sup>-1</sup> } factor increase
- A** figs. once only in wind speed or temperature (see above)

*idea* that air blowing over the surface of / around the leaf takes moist air / water vapour / molecules, away / reduces transpiration shells;

(so) air, around leaf / outside stomata, does not become saturated / is less humid;

**4 max**

Question	Expected Answers	Marks
3 (c)	<p><i>in intact plant</i></p> <p>limited / less water available from the soil;            slower rate of water uptake / absorption by the roots;            (because) there is resistance to water movement across (root)            cortex / apoplast / cell walls / endodermis / Casparian strip;            water has to travel further / greater distances, in xylem vessels            under tension / in small vessels;            other factors (e.g. light intensity / humidity) could affect width /            size / opening of stomata;            (compared with controlled potometer investigation)  <b>A reverse arguments for potometer</b></p>	2 max
<b>[Total: 11]</b>		

**Q3.**

2 (a) (i)	<p>X to xylem vessel;</p> <p>S to phloem sieve tube element; R companion cell</p> <p>E to lower epidermal cell; (including guard cells) R cuticle</p> <p>D to palisade mesophyll cell;</p>	[4]
(ii)	<p><u>Award 1 mark for correct working;</u></p> <p><u>Award 1 mark for correct answer;</u></p> <p><b>Expect <math>120/0.5 = 240</math></b></p> <p>A <math>119 - 121/0.5 = 238 - 242</math> or <u>any working</u> that gives the correct answer</p> <p>R all others,</p>	[2]
(b)	<p>sucrose;</p> <p>amino acids; <b>A</b> two named amino acids for two marks</p>	[2]

- (c) lower/more negative, water potential; **A** ref to water potential gradient/xylem has a higher water potential **R** less water potential
- (of) spongy mesophyll cell/tissue; **R** leaf cells
- large surface area/many cell walls(of spongy mesophyll cells);
- (moves through) through cell walls/surfaces; **R** ref to appoplast/symplast
- evaporation of water;
- from spongy mesophyll cell walls;
- into (substomatal/intercellular) air space;
- diffusion of water vapour;
- through stomata;

[max 4]

[Total: 12]

#### Q4.

- 2 (a) (i) **G** sieve tube (element),  
**H** companion cell; [1]
- (ii) *vessels have*
- thicker walls;  
thickening in walls (e.g. spiral, annular, reticulate);  
wider lumen;  
no cytoplasm; **R** dead (not structure)  
pits;  
no cross walls / no sieve plates / no sieve pores;  
lignin; [max 3]
- (b) (sucrose) loaded at, source / leaf;  
role of companion cells;  
further detail, e.g.  $H^+$  pumped out, sucrose moves in through co-transporter;  
absorption of water / water enters by osmosis;  
hydrostatic pressure builds up;  
mass flow;  
(sucrose) unloaded at, sink / fruit / root / AW;  
gives a difference in pressure (between source and sink); [max 4]
- (c) sucrose used in respiration;  
stored as starch;  
used to make, cellulose; **A** used to make cell walls  
stored as / converted to, organic acids (in vacuoles);  
converted into named other substances; e.g. lipid / protein / AW [max 1]

#### Q5.

4 (a) (i) source = leaf/mesophyll/palisade/spongy qualified  
sink = flower/fruit/seed/stem/bud/root/tuber/storage  
organ/young leaf/meristem/pollen/nectary/AW ; [1]

(ii) C sieve, (tube) element/cell,  
D companion/transfer, cell ; [1]

**(b) source to cell C**

correct ref (sucrose) loaded ;  
H<sup>+</sup> pumped out, sucrose moves in through co-transporter ;  
role of companion cells in moving sucrose into sieve tube element ;  
sucrose diffuses down concentration gradient (anywhere) ;  
ref to plasmodesmata ; [max. 2]

**cell C to sink**

water enters by osmosis/water moves down its  $\Psi$  gradient ;  
hydrostatic pressure builds up ;  
(idea that sucrose) unloaded/used at sink ;  
water follows by osmosis ;  
idea there is a difference in pressure/pressure gradient (between source and sink) ;  
mass flow ; [max. 2]

(c) small surface area : volume ratio *ora* ;  
*accept* described

*idea of* distances too great for diffusion/diffusion rate too slow ;

*idea of*  
cells requiring, substances/named substances, are at a distance from site production/  
absorption ;

*idea of*  
mass or bulk transport/described ; [max. 2]

**[Total: 8]**

**Q6.**

5 (a) water moves down water potential gradient ; **A** high(er) to low(er)  
water potential / less negative to more negative water potential  
apoplast pathway / through cell walls ;  
symplast pathway / through, plasmodesmata / cytoplasm ;  
evaporation ;  
from spongy mesophyll cell walls ;  
into (substomatal / intercellular) air space ;  
diffusion of water vapour ; **A** diffusion of water if evaporation used in correct context  
elsewhere  
through stomata ; [4 max]

- (b) *explanation must correctly relate to structure before marks can be awarded  
any three from the following six pairs*

**either**

cellulose, cell wall / lining ;  
allows adhesion of water ;

**or**

thick (cellulose) cell wall ;  
prevents collapse / idea of providing support (under tension) ;

**either**

lignin ;  
waterproofing / prevents water loss ;

**or**

lignin ; **A** rings / spirals / thickening / AW (of walls)  
prevents collapse / idea of providing support (under tension) ;

no cytoplasm / lack of contents / hollow / empty lumen ; **R** dead  
less resistance to / unimpeded / uninterrupted / unhindered / ease of / AW, flow / AW ;  
**A** greater volume per unit time / faster rate **R** continuous, smooth

lack of end walls / continuous tube ;  
less resistance to / unimpeded / uninterrupted / unhindered / ease of / AW, flow / AW ;  
**R** continuous, smooth

pits / pores ; **R** holes  
lateral movement / movement around air bubbles / supplies (water) to (surrounding), cells /  
tissues ;

wide / large diameter / large lumen ;  
so large volume of water can be transported ;

[6 max]

[Total: 10]

Q7.

- 5 (a) **P** to one endodermal cell ;

**Q** to the cell wall of one of the four xylem vessels ;

**R** to cells immediately above the xylem ; **A** to one cell

[3]

- (b) Casparian strip / suberin, is impermeable (to water) ;  
blocks, apoplast pathway / pathway between cells / cell wall pathway ;  
ref. to passage cells ;  
water / (inorganic) solutes / minerals / ions, must pass through, endodermal cells / symplast  
pathway / symplast pathway described ;  
cell can select solutes / AW ;  
ref. to, active transport / carrier proteins ;  
ref. to presence of solutes (at base of xylem) causing increase in root pressure / AW [3 max]

(c) explanation must correctly relate to structure before marks can be awarded

any two from the following six pairs

sieve pores ;

allow easy flow (from sieve tube element to sieve tube element) ; **R** flow of water

sieve plate ;

(may) prevent sieve tubes from bursting / **AW** ;

cell (surface) membrane / plasma membrane ;

prevents loss, of sucrose / assimilates / phloem sap ;

little cell contents / **AW** ; **R** no cell contents

little resistance / **AW**, to flow ; **R** flow of water

plasmodesmata ;

allows flow, to / from, companion cells ;

thin walls ;

for, rapid / easy, entry of water (at source, to build up pressure) ;

[4]

[Total: 10]

Q8.

- 3 (a) (i) active, transport / uptake ; [1]  
carrier / transport, protein ; **A** pump protein **R** channel protein  
ref. (protein) changing shape / conformational change ;  
ref to specificity ;  
ATP / energy, required ; [max 2]
- (ii) ATP / ADP / DNA / RNA / nucleic acid / NADP / phospholipid ;  
**A** nucleotide / named nucleotide / nucleoside **A** phospholipid bilayer [1]
- (b) (i) W in the central X-shaped region ; [1]
- (ii) osmosis *in correct context* ; e.g. through, cell surface / partially permeable, membrane or  
into, cytoplasm / cell  
diffusion, into / through, cell walls ;  
  
from (region of), high(er) / less negative, water potential, to (region of), low(er) / more  
negative, water potential or down a water potential gradient ;  
  
transpiration pull ; [max 2]

(iii) through cortex / via cortical cells ;

*apoplast pathway*

(by) via cell walls (of adjacent cells) ; **R** if named as symplast pathway ;

*symplast pathway*

via cytoplasm and plasmodesmata ; **R** if named as apoplast pathway

ref. vacuolar pathway ;

ref. apoplast to symplast / pathway described, at endodermis ;

(via) passage cells ;

ref to, suberised / Casparian, strip ; *in correct context*

[max 4]

**[Total: 11]**

Q9.

3 (a) *max 3 if no attempt at comparison*

*evaporation*

1 formation of water vapour from water / conversion of water from liquid (form) to gas(eous form) ;

2 requires, energy / heat ;

3 (water loss) from, surface / cell walls, of (spongy) mesophyll (cells);

*transpiration*

4 idea of loss of water vapour, to external atmosphere / from the aerial parts of a plant ;

**A** from leaves

5 ref. diffusion, down water potential gradient / from high to low water potential / from less negative to more negative water potential ; **A**  $\Psi$  for water potential

6 through stomata ;

*air spaces*

7 correct ref. to, intercellular / air, spaces ; e.g. evaporation into air spaces, diffusion from air spaces through stomata

[max 4]



- (b) (i) *max 3 if no attempt at explanation*  
*penalise once for lack of units*  
*mp for describing shown by (D)*  
*mp for explaining shown by (E)*

*temperature*

- T1 (D) (mean) transpiration rate hot dry day lower than warm dry day ;  
 A lower than warm rainy day A lowest rate  
 T2 (D) comparative data quote to support ;  
 T3 (E) stomata close to prevent excess water loss / excessive water loss causes closure of stomata ; AW

*humidity*

- H1 (D) (mean) transpiration rate warm dry day higher than warm rainy day ;  
 A highest rate  
 H2 (D) data quote to support ;  
 H3 (E) decrease in / low, humidity increases rate of, transpiration / evaporation / diffusion ; ora  
 H4 (E) more steep / AW, water potential gradient ;

*stomatal density*

- S1 (D) peach (mean) transpiration rate, lowest / lower than, apple / sour cherry ;  
 S2 (D) data quote to support ;  
 S3 (E) ref. (far) fewer stomata ( $\text{mm}^{-2}$ ) so less water (vapour) lost ;

AVP ; e.g. ref. ABA and stomatal closure (T)  
 less water (vapour) leaves plant as only cuticular transpiration possible (T)  
 ref. to higher rate for apple (dry days) and suggestion that stomata are larger [max 4]

- (b) (ii) decreased / lower, rate during night ; ora  
 stomata closed at night ; ora  
 further detail ; e.g. closed to prevent water loss  
 closed as no photosynthesis  
 no light for photosynthesis  
 open (during day) for, gas exchange /  $\text{CO}_2$  in [3]

- (iii) peach / *Prunus persica* / *P. persica* ; [1]

- (c) (i) (repairing damaged DNA) reduces risk of cancer ; A prevents

further detail ; *in context of reducing risk*  
 e.g. because tobacco smoke contains mutagens  
 because tobacco smoke contains carcinogens  
 ref. to mutation (as result of damaged DNA) [2]

- (ii) reduces risk of, chronic bronchitis / emphysema / COPD ;

further detail ; *in context of reducing risk*  
 e.g. (reducing inflammation)  
 reduces risk of infection  
 prevents excess mucus production R if linked to emphysema  
 prevents alveolar wall breakdown R if linked to bronchitis  
 no / less, scar tissue forms [2]

[Total: 16]

Q10.

2 (a) potometer ; **A** transpirometer **R** photometer **R** spirometer [1]

(b) *idea that*

water taken up may not all be lost in transpiration / transpiration is water loss (as water vapour) from (aerial parts / leaves, of) the plant ;

example of use of water taken up ;; e.g.  
photosynthesis  
hydrolysis reactions  
maintaining turgidity / AW  
cell, elongation / increase in size

ref. to water uptake rate and transpiration rate differing because of (changing) environmental conditions ; **A** examples e.g. higher transpiration rate than uptake rate in hot and dry external conditions [max 2]

(c) (i) *if no mp 1 and 2, accept increased rate of transpiration for one mark*

- 1 increased rate of evaporation ; **A** description of evaporation  
**R** evaporation, from leaf / from stomata / through stomata
- 2 increased rate of diffusion ; *in context of water vapour out through stomata*
- 3 (rise in temperature), lowers (relative) humidity / decreases water potential of air (outside leaf) ;
- 4, 5 AVP ;; e.g. increased kinetic energy  
steeper water potential gradient established *in correct context*  
details of cohesion-tension theory linked to increased, transpiration / water uptake, rate  
increased rate of photosynthesis  
replacing water lost from cells in leaf [max 3]

(ii) humidity ;

wind (speed) ; **A** air movements  
light intensity ;  
(air) pressure ;

[max 2]

- (d) 1 stomata (must be) open for, gas exchange / uptake of carbon dioxide ; **A** release of oxygen
- 2 carbon dioxide for photosynthesis ; **A** oxygen from photosynthesis (when rate exceeds rate of respiration)
- 3 (most) water vapour, diffuses / AW, out, via / AW, (open) stomata ;  
**A** most transpiration occurs when stomata are open  
**R** if incorrect transport mechanism used e.g. osmosis [3]

**Total: 111**

Q11.

- 3 (a) **R** CO<sub>2</sub> diffusion is a consequence of transpiration  
 stomata open(ings) to allow carbon dioxide in ;  
 carbon dioxide required for photosynthesis ;  
**ignore** ref. to oxygen  
 water vapour diffuses out through stomata ;  
**A** water if evaporation (from mesophyll walls) described  
**A** water as a gas [3]
- (b) 1 both show, little/low/lowest, transpiration, at night/22.00 to 24.00/00.00 to 04.00 ;  
 2 both, increase to/peak, at mid day / 12.00 ;  
 3 ref. to second peak at 16.00 ;  
 4 both, dip/decrease, at 14.00 ;  
 5 transpiration (always) lower for trees at exposed site/ora ;  
 6 both decrease from 16.00 ;  
*for mps 1–4 and mp 6, allow a description at one site only*  
**R** if contradictory description given for the other site  
 7 comparative data quote to support above marking points ; ;  
 8 to compare the transpiration rate at two locations at the same time  
 or transpiration rate at one location at different times  
*to award data marks arbitrary units (au) must be used at least once* [max 5]
- (c) *identification of the following features*  
 1 stomata close (for longer), during the day/when hot/when dry ;  
 2 stomata in pits/sunken stomata ;  
 3 stomata only on lower surface of the leaf ;  
 4 hairs/trichomes ;  
 5 low number of/few(er)/less, stomata (per unit area) ;  
**ignore** 'less open stomata'  
 6 thick(er) cuticle;  
 7 reflective cuticle (on upper epidermis) ;  
 8 thick(er) epidermis/ more than one layer of epidermal cells ;  
 9 curled/rolled/AW, leaves ; [max 3]

[Total: 11]

Q12.

2 (a)

1	transport of water and mineral ions ; <b>A</b> minerals
2	elongated cells / cells end to end (to form) tubes for transport ; <b>A</b> (e)long(ated) tubes for transport
3	no, end / cross, walls or end / cross, walls broken down so minimal resistance to / unimpeded / free, flow of water ; <b>AW</b>
4	hollow / no cytoplasm / no contents / no organelles / empty, <i>ignore</i> dead so more space for greater volume to flow / greater volume per unit or minimal resistance to / unimpeded / free, flow of water ; <b>AW</b>
5	cellulose lining <b>A</b> cellulose walls so hydrophilic / adhesion of water molecules / for movement of water up stem / to maintain column of water / <b>AW</b> ; <b>A</b> hydrophilic lining, for movement of water up stem / to maintain column of water
6	lignified (walls) / walls contain(s) lignin <b>A</b> thickened walls <b>R</b> lined with lignin so prevents (inward) collapse / withstands negative pressure <b>R</b> prevents bursting

7	lignified (walls) / walls contain(s) lignin <b>A</b> thickened walls <b>R</b> lined with lignin so waterproof / prevents loss of water / prevents leakage / maintains column
8	additional ref. to lignin ; e.g. for support of plant spiral / annular, thickening allows elongation (of stem) for support of plant
9	pits / pitted walls to allow, sideways / lateral, movement (of water) or to connect to all parts of plant / <b>AW</b> ;
10	relevant ref. to diameter of lumen ; e.g. narrow, for adhesion <b>R</b> capillarity (relatively) wide to transport maximum volume of water

[max 5]

(b) *look for ora*

- 1 can observe living tissue ; **A** observing processes (e.g. like mitosis)
- 2 ref. portability ; e.g. ref. to size, easy to move, no requirement for special room (e.g. vibration-free )
- 3 ease of use, qualified ; e.g. no technical training required, slide preparation easier, takes less time
- 4 see (actual / natural / real-life) colour ;
- 5 ref. to, differential staining / staining particular types of tissue ;
- 6 fewer problems with artefacts ;
- 7 lower cost of, purchase / maintenance / running / AW ;

[max 2]

[Total: 7]

Q13.

- (d)
- 1 ref. to movement, down water potential gradient / from high(er) to low(er) ;
  - 2 apoplastic / cell wall, pathway from xylem to cell walls of (palisade mesophyll) cells ;
  - 3 ref. to osmosis ; *in context of* movement, into cell / through cell surface membrane / through tonoplast,  
**R** osmosis from xylem to vacuole
  - 4 symplastic / cytoplasmic, pathway (within cell) ;
  - 5 via plasmodesmata ; *in context of water arriving from adjacent cell*
  - 6 ref. to channel proteins / aquaporins ;
  - 7 solutes / named, in vacuole ;

[max 3]

Q14.

- 3 (a) stomata (are open) for gas exchange / CO<sub>2</sub> / O<sub>2</sub> uptake / release  
(for photosynthesis and respiration);  
large surface area / many cell surfaces;  
in spongy mesophyll;  
(so) evaporation from (damp) walls (into air spaces);  
(and) diffusion / loss down a conc. gradient, of water vapour;  
to air / atmosphere via stomata; **3 max**
- (b) ref cohesion / tension ( in context of xylem);  
hydrogen bonds;  
through (freely permeable) cell wall / apoplast pathway;  
through partially permeable membrane / AW (in context of  
cell B);  
osmosis;  
down water potential gradient / high / less negative to low /  
more negative water potential / AW; **3 max**
- (c) (i) B to A and C; **2**  
A to C;
- (ii) from cell surfaces through air through stomata; **1**
- (d) small leaves / small surface area / reduction of leaf surfaces /  
needle shaped leaves; R. spines  
rolled / curled leaves; R. folded  
shed leaves;  
sunken stomata / stomata in pits / crypts / grooves;  
stomata surrounded by hairs / hairy leaves;  
waxy / impermeable / thick, cuticle / thick leaves qualified; **2 max**

[Total : 11]

Q15.

- 1 (a) (i) A - Golgi (body/apparatus)/dictyosome; R Golgi vesicles  
B - (rough) endoplasmic reticulum/ER/RER; R SER  
C - mitochondrion/mitochondrial, matrix/envelope; **3**
- (ii) sieve plate(s); **1**
- (iii) sucrose/amino acid(s)/named amino acid; R sugar, glucose **1**

- (b) little/watery/peripheral, cytoplasm/no tonoplast/no vacuole/ few organelles/few ribosomes/so little resistance/AW e.g. easy transport/move more easily/minimum obstruction;

pores in sieve plate provide little resistance/permit continuous flow/allows movement/AW e.g. as above;

sieve plate braces/prevents cell bulging under pressure/collapsing;

plasmodesmata only between sieve tube element and companion cell allows pressure to build up;

plasmodesmata allows loading/AW e.g. sucrose to be transported in from companion/transfer cell;

(strong) cellulose walls prevent, excessive/too much, bulging/expansion;

mitochondria (and starchy plastids) for ATP, for repair/maintenance;

**R** reference to mitochondria in companion cells **3 max**

- (c) sucrose/sugars/assimilates, are pumped/loaded (by companion cells);

reference to pumping  $H^+$ ;

reference to co-transport/AW e.g.  $H^+$  carry sucrose with them;

mitochondria provide, ATP for active transport; **2 max**

## Q16.

- 3 (a) (i) tube-like / tubular / hollow / empty / no obstructions / no cell contents, so little resistance, easy movement ;  
**R** mass flow, continuous column  
wide / large diameter / large lumen, so large volume / amounts of water can be transported ;  
thickening of the walls, to prevent collapse (under tension) ; **[2 max]**
- (ii) evaporation of water inside, leaf / within mesophyll ;  
ref to mesophyll cell walls ;  
lowers water potential ;  
water moves down water potential gradient ;  
cohesion between water molecules /AW ;  
adhesion of water molecules to vessel walls / AW ;  
water pulled up under tension / transpiration pull ;  
transpiration, stream / column ; **A** continuous column  
(water moves up xylem) from high to low hydrostatic pressure ; **[4 max]**

- (b) nicotine,  
 increases heart rate / raises blood pressure / constriction of blood vessels /  
 increases stickiness of platelets (so cause clots ) /  
 decrease in blood flow to, hands / feet / fingers / extremities /  
 is addictive / damages, endothelium / lining of blood vessels ;
- carbon monoxide,  
 combines with haemoglobin to form carboxyhaemoglobin / reduces amount of oxygen that  
 can be transported in the blood ;
- carcinogens / named carcinogen (e.g. benzpyrene / phenol), cause mutations / AW ;
- tar,  
 inhibits / weakens action of / destroys / paralyses, cilia / stimulates, goblet cells /  
 mucous glands, to secrete more mucus ;
- A excess** [3 max]
- [Total: 9]**

**Q17.**

- 2 (a) treat refs to mechanisms as neutral**  
 (soil to) root hair ;  
 idea of across, cortex / cortical cells (root) ;  
 apoplast / along cell walls ;  
 symplast / via, cytoplasm / plasmodesmata ;  
 through, endodermis / endodermal cells, by symplast pathway ;  
 (because of) suberin / Casparian strip ;  
 ref to passage cells ;  
 apoplast into the xylem ; [4 max]
- (b) (i)** stomata are open (to allow diffusion / gas exchange) ;  
 (for) entry of CO<sub>2</sub> / release of O<sub>2</sub> ; AW  
 large surface area inside leaf (for gas exchange) ;  
cell surfaces / walls, in (palisade / spongy) mesophyll ;  
 moist / damp / wet ;  
 correct ref to evaporation ;  
 water vapour, diffuses out / AW; **A water if linked to evaporation** [3 max]



(ii) *adaptations*

(epidermal) hairs / trichomes ; **R** spikes, spines  
stomata in, pits / cavities / chambers ; **R** sunken stomata

reduced air movement / still air ;  
holds water vapour / has high(er) humidity / AW ; **A** holds moist air  
(therefore) less steep, water potential / vapour pressure / diffusion, gradient ;  
**A** qualified ref to diffusion shells between air inside leaf and air in pits ;

thick / waxy, cuticle (on upper, epidermis / surface) ;  
multilayered, epidermis / hypodermis ;  
thick walled epidermal cells ;  
cuticle reflects sunlight ;  
stomata only on lower surface / no stomata on upper surface ;

[3 max]

[Total: 10]

Q18.

- 4 (a)  $H^+$  pumped out ;  
creates an  $H^+$  gradient ;  
sucrose moves in with  $H^+$   
co-transport / through co-transporter ;  
energy / ATP, provided by mitochondria ;  
sucrose diffuses down concentration gradient ;  
through plasmodesmata ;

[4 max]

- (b) large surface area : volume ratio / to increase surface area ;  
gives large surface area of membrane ;  
(so) many, pumps or co-transporters ;

[2 max]

- (c) (i) higher / greater resolution / resolving power ; **ora**  
**A** 0.5 nm (0.0005  $\mu\text{m}$ ) compared with 200 nm (0.02  $\mu\text{m}$ )  
because of shorter wavelength ; **A** smaller  
more detail can be seen / much clearer (at the same magnification)  
/ can see two points that are close together ;  
can see cell structures that are not visible in the LM ;  
**A** e.g. ribosomes / membranes  
can see detail of structures just visible in LM with e.g. ;  
**A** mitochondrion / chloroplast

[2 max]

- (ii) long (length greater than width) ;  
sieve plates ;  
sieve pores ;  
some / less / peripheral, cytoplasm ;  
no nucleus / fewer mitochondria / less ER ;  
thin wall ;

[2 max]

[Total: 10]

Q19.

- 4 (a) loss of water vapour ;  
from leaves / aerial parts of plant ; **R** stomata unqualified  
*ignore evaporation* [2]
- (b) 1 rate for species **A** is always higher / ora for **B** ;  
*similarity*  
2 the rates of both species, increase and then decrease / reach a peak ;  
3 peak is, around midday / around noon / 11.30 to 12.30 ;  
*difference*  
4 rate for species **B** decreases earlier than that for species **A** ;  
**A** species **B** at ~11.45 **and** species **A** at ~12.15 +/- 5 mins  
5 steeper / faster, increase / decrease, for **A** ;  
6 comparative data quote for rates of transpiration ; +/- ½ a square  
**A**  $\mu\text{g min}^{-1}$  for unit [4 max]

- (c) *two adaptations plus explanation – explanation may be the same for each answer  
accept ora for species A*

- f1 sunken stomata ; **A** stomata in, pits / chambers / grooves  
f2 hairs / trichomes (on epidermis) ; **R** needles  
f3 rolled / curled / AW, leaves ; *ignore curved unqualified*  
e1 high humidity / retains moist air / high concentration of water vapour, to reduce diffusion  
gradient or water potential gradient / AW ;  
**R** 'moisture'
- f4 small leaves / leaves are spines / leaves are needles ; **R** spikes  
**R** 'no leaves'  
e2 reduce surface area (for transpiration) ;  
*reduce SA explained but unqualified by size of leaf = 1 mark (see F9)*
- f5 thick leaves ; **A** succulent  
e3 reduce surface area : volume ratio ;
- f6 thick (waxy) cuticle ;  
e4 decreases permeability / is impermeable / provides a barrier / ora ; **A** e5
- f7 reflective cuticle ;  
f8 several layers of hypodermis ; **A** layers of epidermis / described  
f9 epidermis with thick walled cells ;  
f10 few stomata / low stomatal density ;  
e5 reduce (rate of) diffusion of water ; **R** close of stomata [4 max]

Q20.

4 (a) (i) moist / AW, surface of mesophyll cells ;  
water evaporates / evaporation ; *in correct context*  
from spongy mesophyll cell walls ;  
into (intercellular) air spaces ;  
air within leaf is fully saturated ;  
water vapour diffuses through stomata ; A 'water' if evaporated  
  
down water potential gradient / from a high to a low water potential / from  
less negative to more negative water potential [3 max]

(ii) mass / water, loss increases from 0400 to 1600 and then decreases ;  
0.3–4.4 g h<sup>-1</sup> ; A other correct comparative data quote with units  
  
mass / water, uptake increases from 0800 to 1900–1930 and then decreases ;  
0.8–0.9 – 3.4 g h<sup>-1</sup> ; A other correct comparative data quote with units

rate of, mass / water, loss peaks before rate of water uptake ;  
A description related to light (mass loss) and dark (uptake)  
data quote for times of peaks for both rates ; 1600 and approx 1900

0600 to 1600 rate of mass loss, ref. to steeper gradient ;

(rate of) mass / water, loss is higher than uptake, between 0700 and approx 1830 ;  
A ora [4 max]

(b) cohesion-tension ;  
cohesion / AW between water molecules ;  
hydrogen bonds ; *accept here or for adhesion once only*  
transpiration pull / water is pulled up the xylem / water in a continuous column ;

**ignore** negative / hydrostatic pressure

adhesion to (cell) walls ;  
water molecules 'stick' to cellulose / cellulose is hydrophilic ;  
A lignin (although it is hydrophobic!)

[3 max]

[Total: 10]

Q21.

5 (a) 9  $\mu\text{m}$  ;;  
award one mark if 8.9 or 9.1  $\mu\text{m}$  given  
or  
correct measurement is divided by the magnification ( $\times 10\,000$ ) but conversion factor  
incorrect [2]

(b) explanation to max 4  
hydrogen ion /  $\text{H}^+$ , pumped / AW, out of, transfer cell / companion cell ;  
R if to sieve tube element  
active / using ATP / energy requiring ;  
hydrogen ion gradient build-up ; AW  
hydrogen ions, co-transport / with / AW, sucrose ; in context of into, transfer /  
companion cells  
diffusion / facilitated diffusion (of hydrogen ions and sucrose) through co-transporter  
(membrane protein) ;  
A through membrane protein if 'cotransport' already used  
sucrose, diffuses / AW, through plasmodesmata into sieve tube element ;  
  
ref. to Fig. 5.1  
mitochondria for ATP production ;  
ref to foldings of cell wall ;  
large surface area of cell membrane ;  
for more, protein pumps / co-transporter proteins ; [max 5]

(c) sucrose / assimilates / phloem sap, in sieve tube (elements) in, source / leaf  
low(ers) / less negative, water potential ;  
water enters, qualified ; e.g. by osmosis / from surrounding tissue ;  
  
increases the hydrostatic pressure ;  
  
sucrose unloaded at sink ;  
lowers water potential in surrounding tissue ;  
water moves out and decreases hydrostatic pressure (in source) ; allow ecf if  
hydrostatic not used  
  
pressure difference (causes flow) ;  
(pressure difference) forces sap through sieve tubes / causes mass flow (towards  
sink) ; AW [max 4]

[Total: 11]

Q22.

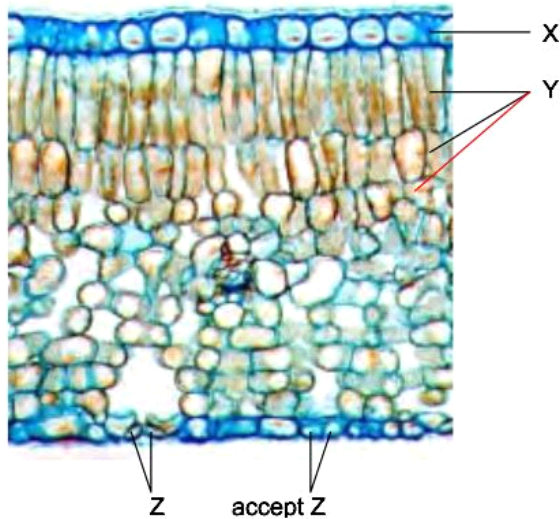
- 6 (a) line to nucleolus labelled C ;  
 line to Golgi apparatus labelled D ; R to vesicle  
 line to mitochondrion labelled E ; [3]

- (b) 1 hydrogen ion /  $H^+$ , pumped / AW, out of companion cell ; R if to sieve tube element  
 2 active / using ATP / energy requiring ;  
 3 against the concentration gradient ;  
 4 hydrogen ion gradient build-up ; AW  
 5 hydrogen ions, co-transport / with / AW, sucrose ; *in context of into companion cells*  
 6 diffusion / facilitated diffusion (of hydrogen ions and sucrose) through co-transporter  
 (membrane protein) ; A through membrane protein if 'cotransport' already used  
 7 diffusion of sucrose into (phloem) sieve tube (cell) ;  
 8 via plasmodesmata ; [max 4]

[Total: 7]

Q23.

- 3 (a) correct labelling



X ;  
 Y ;  
 Z ;

**A** names instead of labels

**A** if letters put on the appropriate structures without using label lines, letter must be within each cell

**ecf max one mark** if use brackets for X **and** Y enclosing upper epidermis and one, two or three layers of palisade mesophyll [3]

- (b) 1 (water) moves out of, cell / **Q**, by osmosis / down a water potential gradient ;  
 2 through the, cell (surface) / plasma, membrane ;  
 3 to, surface / cell wall of, the spongy mesophyll cell, cell **Q** ;  
 4 evaporates into (sub-stomatal) air space ; **A** water changes to water vapour  
 5 water vapour diffuses out through (open) stomata ;  
**A** moves out down a, water potential / water vapour concentration, gradient

*if evaporates, then do not insist on vapour*

[max 4]

- (c) thick (waxy) cuticle ;  
 large / big / thick, upper epidermis / upper epidermal cells ;  
 many / two / three, layers of palisade cells ;  
 thick leaf ;  
 densely packed with spongy mesophyll / many spongy mesophyll cells ;  
 fewer / small, air spaces ;  
 no, stomata / guard cells, on upper surface ; **ora** only on lower surface  
 many chloroplasts (within spongy mesophyll cells) ;  
**R** xeromorphic features **NOT** visible, e.g. sunken stomata

[max 3]

[Total: 10]

## Q24.

- 2 (a) (i) 1 diffusion through (freely permeable) cell wall;  
 2 membrane is partially permeable ; **A** selectively  
 3 osmosis across membrane (into cell)  
 4 (only) some water may pass between phospholipids (across membrane);  
 5 movement across membrane facilitated by aquaporins ;  
 6 ref. down water potential gradient / from high water potential to low water potential;  
**A** from a higher / to a lower, water potential *if in context*  
 7 AVP ; e.g. further detail about aquaporin (hydrophilic channel) [max 3]
- (ii) 1 increases permeability of membrane to water ;  
 2 *idea that* osmosis across bilayer does not supply cell rapidly enough with water (that needs to pass on to surrounding cells) ;  
 3 *idea that* phospholipids are relatively impermeable to water ;  
 4 *idea that* water cannot pass / only some water passes, through hydrophobic region of membrane / AW ; [max 1]

- (b) pathway via, cells of cortex / cortical cells, and endodermis / endodermal cells ;

*symplast pathway, described as*  
 cytoplasm and, plasmodesmata / vacuole(s) ;

*(out of cell to) apoplast pathway, described as*  
 cell wall pathway ;

Casparian strip / suberised cell wall, of endodermis, impermeable to water ;  
 (so) pathway only via, symplast / cytoplasm ;

AVP ; e.g. reference to pericycle  
 reference to passage cells of endodermis  
 vacuolar pathway (*unless given in mp 2*)

[max 3]

- (c) (i) stomata are open (to absorb carbon dioxide for photosynthesis) ; ora [1]
- (ii) rate of transpiration, (almost) always / AW, higher / higher at night, in A / mutant plants ; ora  
**A** expressed in terms of water loss  
 at night only cuticular transpiration / no stomatal transpiration ;  
*idea that* during day stomatal transpiration same for both ;  
 (so) differences because of less effective cuticle ;  
 comparative data quote ; [max 3]
- [Total: 11]

Q25.

- 4 (a) (x) 400 ;  
*if answer incorrect or not to nearest 100 allow one mark for correct working*  
 e.g. (scale bar) 19 000–21 000 divided by 50  
*award max one mark if a unit (e.g.  $\mu\text{m}$ ) is included* [2]
- (b) 1 thick(ened) / lignified, walls prevent, collapse ;  
**ignore** strengthened  
**A** withstands, compression / negative pressure  
**ignore** bursting
- 2 lignified (wall), prevents leakage / provides waterproofing ;
- 3 cellulose, wall / lining, allows adhesion of water (molecules) ;  
**A** hydrogen bonding / hydrophilic
- 4 (relatively) large diameter / large cross-sectional area / wide / large lumen ;
- 5 hollow / empty / no contents / no cytoplasm ;
- 6 no end walls / continuous 'tubes' / AW ;
- 7 elongated ;  
**A** if referenced to cells or vessels **A** cells end to end (to make tubes)  
*only allow mps 4–7 in terms of ease / efficiency of water movement*  
*mp 4 e.g. more space allows a greater volume to flow / greater volume per unit time*  
*or mp 5–6 e.g. minimal resistance to flow, allows unimpeded flow, allows free flow of water*
- 8 pits / pitted walls, to allow lateral movement ;  
**R** pores [max 3]
- (c) 1 water moves, down a water potential gradient / from a high(er) water potential to a low(er) water potential, accept  $\psi$  for water potential ;
- 2 apoplast pathway, described / used in correct context ;
- 3 symplast pathway, described / used in correct context ;
- 4 evaporation from mesophyll cell walls ;  
**A** surface of mesophyll cells
- 5 into air space(s) ;  
*must be linked to evaporation / water vapour*
- 6 water vapour diffuses (out) ;  
*accept if no vapour but follows from evaporation*
- 7 out / through / via stoma(ta) ;  
**R** 'evaporates from the stomata'
- 8 **AVP** ; ref. to water leaves unlignified terminals of xylem vessels [max 5]
- [Total: 10]

Q26.

- 3 (a) 1 large (size / volume / organism) ;  
**A** multicellular / many cells  
**A** larger
- 2 (so) small(er) / low, surface area : volume ;  
*as size increases, SA:V decreases = 2 marks*
- 3 diffusion (alone), not enough / too slow (to supply needs) ;
- 4 explanation ; e.g. surface too far from, centre / AW, of plant  
 distances too far to supply required, nutrients / substances  
 requires, supplies in bulk / mass flow
- 5 (so require) xylem and phloem, qualified ;  
 e.g. transport in different directions  
 xylem transports water (and mineral ions) and phloem transports, assimilates /  
 photosynthates / sugars / amino acids

[max 3]

- (b) (i) *cell A* = companion cell  
**A** companion ;  
*cell B* = (phloem) sieve tube element  
**A** sieve tube, sieve tube cell



[1]

- 
- (ii) *allow ecf from (i) for incorrect names of cells*  
*cell A / companion cell*

- 1 mitochondria for, aerobic respiration / oxidative phosphorylation / ATP,  
 production / AW ;  
**R** ATP energy  
**A** release / supply, ATP / energy (for the cell)  
*treat as neutral* cell B also has mitochondria
- 2 RER / many ribosomes, for, polypeptide / protein, production ;  
*if mps 1 and 2 not given, one mark for mitochondria and, ribosomes / RER*
- 3 ref. nucleus and, genes coding for (required) proteins / synthesis of ribosomes  
**or**  
 nucleolus synthesises ribosomes ;  
*cell B / sieve tube element*
- 4 (at least) one main structural feature ;  
**R** hollow  
 peripheral cytoplasm / AW e.g. pushed against walls  
 no nucleus / no RER / no vacuole / no Golgi / few organelles /  
 reduced ER / few mitochondria  
**R** no organelles
- 5 (to) minimise / reduce, resistance to (mass) flow ; AW  
 e.g. uninterrupted flow / more efficient transport of sucrose
- 6 (so) maximum volume transported (/unit time) ;  
**A** *idea of*
- 7 sieve plates, qualified ; e.g. stop bulging  
 allow mass flow / reduce barrier to flow  
 become plugged with, P-protein / callose, to prevent losses / after damage
- 8 no plasmodesmata (*as on Fig. 3.1*) to maintain pressure  
**or**  
 plasmodesmata (*not shown*) for diffusion of sucrose into sieve tube / AW ;

[max 5]



(c)

	<i>transport system in mammals</i>	<i>transport system in plants</i>
1	arteries, veins, capillaries <b>A</b> delivery to cells by arteries and capillaries	xylem and phloem ; <b>A</b> vascular bundle
2	heart / pump	no heart / no pump / (xylem and phloem) have different mechanisms for (mass) flow ; <b>A</b> transpiration pull in xylem / pressure gradients in phloem
3	double circulation	no double circulation / xylem unidirectional flow / phloem source to sink / <b>AW</b> ; <b>R</b> single circulation
4	closed circulation	not closed circulation / pits / plasmodesmata ; <b>A</b> open
5	one (circulatory) system / water and organic molecules transported in same vessels / <b>AW</b>	two (separate) systems / water transport in separate vessels to organic molecules ;
6	(all) living cells	living and dead cells ; <b>A</b> dead cells in xylem
7	transports, (respiratory) gases / oxygen / carbon dioxide	respiratory gases not transported ;

8	transports glucose <i>accept within correct list</i>	(phloem) transports sucrose ; <i>accept within correct list</i>
9	faster rate of flow	slower rate of flow ;
10	rate of flow controlled by, nervous system control of heart / action of heart / vasoconstriction and vasodilation / <b>AW</b> <i>accept ref. endocrine system</i>	rate of flow, not controlled by nervous system / (in xylem) controlled by external factors / (in xylem) controlled by transpiration rate ;
11	components include blood cells	cells not transported / <b>AW</b> ;
12	<b>AVP</b> ;;;	
13	homeostasis involved / concentration of dissolved substances controlled	no homeostasis / <b>AW</b> ;
14	ref. to defence e.g. immune system e.g. blood clotting organ-based valves present	no equivalent to immune system callose formation ; tissue-based ; no valves ;

[max 4]

[Total: 13]

Q27.

6 (a) look at any labelling on the diagram

cell contents / cytoplasm / not hollow ; I ref. to any organelles (not visible)

**A** xylem vessels are hollow

thin walls ;

**A** no, thickened walls / lignified walls / lignin

**A** xylem vessels have, thick walls / lignin

sieve plates / end walls / cross walls ;

**A** end walls not broken down

**A** xylem vessels have no end walls

**R** 'end' unqualified

I end plates / cell plates

no pits ; **A** xylem vessels have pits

I ref. to companion cells

[max 2]

(b) dissolved in, water / sap ; **A** in solution

mass flow ;

down (hydrostatic) pressure gradient / moves from high(er) to low(er) pressure (potential) ;

**A** symbol –  $\psi_p$

AVP ; e.g. from source to sink

loading by, companion / transfer cells, requires ATP / is active ;

I ATP required for mass flow

[max 2]

(c) answers may be general or in the context of phloem transport

active site (with shape) complementary to substrate ;

**A** description in terms of lock and key (either way round)

I structure

induced fit / described ;

substrate binds to active site / enzyme-substrate complex forms / ESC forms ;

ref. to specificity of enzymes ;

activation energy of reaction is lowered ;

example of how activation energy lowered ;

e.g. reactants held close together for bond formation

transfer of electrons

strain on bonds

alternative pathway

holding the substrate in such a way that the bonds needed to be broken are exposed

product released from, enzyme / active site ;

**A** enzyme can be used again / enzyme unchanged at end of reaction

[max 3]

**[Total: 7]**





