

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⁻¹ } **A** appropriate
 - expts. 2 and 4 - 22 to 45 mm h⁻¹ } factor increase
 - expts. 3 and 5 - 24 to 64 mm h⁻¹ } 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⁻¹ } **A** appropriate
 - expts. 3 and 4 - 24 to 45 mm h⁻¹ } 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) A reverse arguments for potometer</p>	2 max
[Total: 11]		

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>Expect $120/0.5 = 240$</p> <p>A $119 - 121/0.5 = 238 - 242$ or <u>any working</u> that gives the correct answer</p> <p>R all others,</p>	[2]
(b)	<p>sucrose;</p> <p>amino acids; A 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, [1]
D companion/transfer, cell ;

(b) **source to cell C**

correct ref (sucrose) loaded ;
H⁺ 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 Ψ 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** Ψ 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 (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 / 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** CO₂ 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 ; A minerals
2	elongated cells / cells end to end (to form) tubes for transport ; A (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 ; AW
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 ; AW
5	cellulose lining A cellulose walls so hydrophilic / adhesion of water molecules / for movement of water up stem / to maintain column of water / AW ; A hydrophilic lining, for movement of water up stem / to maintain column of water
6	lignified (walls) / walls contain(s) lignin A thickened walls R lined with lignin so prevents (inward) collapse / withstands negative pressure R prevents bursting

7	lignified (walls) / walls contain(s) lignin A thickened walls R 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 / AW ;
10	relevant ref. to diameter of lumen ; e.g. narrow, for adhesion R 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 / CO₂ / O₂ 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 CO₂ / release of O₂ ; 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 μm) compared with 200 nm (0.02 μm)
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⁻¹ ; 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⁻¹ ; 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 μm ;;
award one mark if 8.9 or 9.1 μm given
or
correct measurement is divided by the magnification ($\times 10\,000$) but conversion factor incorrect [2]
- (b) explanation to max 4
hydrogen ion / 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.

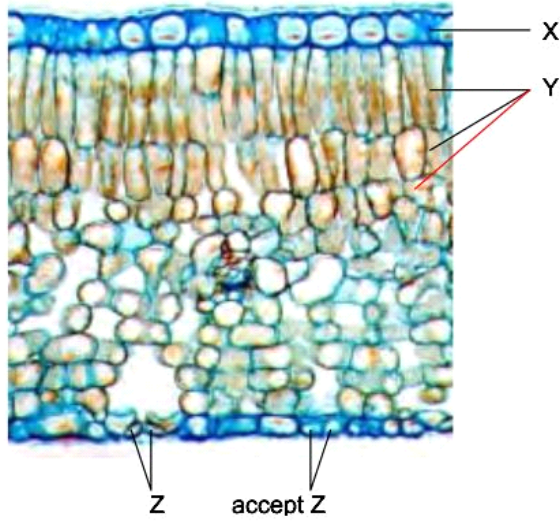
- 6 (a) line to nucleolus labelled C ;
 line to Golgi apparatus labelled D ; R to vesicle
 line to mitochondrion labelled E ; [3]

- (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. μm) 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 referred 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 ψ 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 A delivery to cells by arteries and capillaries	xylem and phloem ; A vascular bundle
2	heart / pump	no heart / no pump / (xylem and phloem) have different mechanisms for (mass) flow ; A transpiration pull in xylem / pressure gradients in phloem
3	double circulation	no double circulation / xylem unidirectional flow / phloem source to sink / AW ; R single circulation
4	closed circulation	not closed circulation / pits / plasmodesmata ; A open
5	one (circulatory) system / water and organic molecules transported in same vessels / AW	two (separate) systems / water transport in separate vessels to organic molecules ;
6	(all) living cells	living and dead cells ; A 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 / AW <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 / AW ;
12	AVP ;;;	
13	homeostasis involved /	no homeostasis / AW ;
14	concentration of dissolved substances controlled 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 – ψ_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]

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