Unit 2 · Water Relations

ANSWER KEY · FOR TEACHERS

Full marks 32

Give the marks for the points in the marking scheme; an answer in other words that says the same is right.

1 Key words

1. kinetic energy
2. diffusant
3. hypotonic
4. turgor pressure
5. imbibition
6. plasmolysis
7. tracheids
8. hydathodes

K · 4

Each carries 0.5 mark.

2 Label the diagram

1. nucleus
2. cell wall
3. plasma membrane
4. cytoplasm
5. tonoplast
6. vacuole (cell sap)

K · 3

Each carries 0.5 mark.

3 Multiple choice

i. **d.** hydathode — K · 1

The **hydathodes**, always-open pores at the tips and edges of the leaf, at the ends of the veins.

ii. **b.** it causes swelling (an increase in volume) — U · 1

The imbibant **swells**. Imbibition gives out heat (it is **exothermic**), it needs **hydrophilic** (water-attracting) molecules, and dead materials such as wood imbibe too.

iii. **b.** TP = 0, so DPD = OP — U · 1

The protoplast no longer presses on the wall, so its turgor pressure is zero, and DPD = OP − 0 = OP. (DPD = 0 belongs to a fully turgid cell.)

iv. **b.** nothing: its DPD is zero, so it is already fully turgid — A · 1

DPD = OP − TP = 10 − 10 = 0, the same as pure water's. With no difference in DPD there is no net movement of water. Its OP alone would draw water in, but its turgor pressure balances it exactly. A plant cell can't burst: its wall stops it.

v. **b.** a warm, dry, breezy, sunny day — A · 1

Light opens the stomata, warmth speeds evaporation, dry air makes the difference in vapor pressure large, and the breeze sweeps the vapor away. Each other choice has at least one factor that slows transpiration.

4 Short answers

a. MARKING SCHEME — K · 2

- ✓ Two solutions of different water concentration.
- ✓ A semipermeable membrane between them.

b. MARKING SCHEME — U · 2

- ✓ Unavoidable: stomata open for carbon dioxide also let water vapor out.
- ✓ Both useful (pull, cooling) and harmful (wilting, water wasted).

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c. MARKING SCHEME A · 2

- ✓ The soil water becomes hypertonic to the root cells' sap.
- ✓ Water leaves the roots by exosmosis (plasmolysis), so the plant loses turgor and wilts.

d. MARKING SCHEME U · 3

- ✓ Kidney-shaped guard cells with a thick inner wall and a thin outer wall.
- ✓ Turgid guard cells: the outer walls bulge and pull the inner walls apart, so the pore opens.
- ✓ Flaccid guard cells: the inner walls come together and the pore closes.

5 Numerical problem

ANSWER A · 4

DPD = OP − TP.

- P: 16 − 9 = **7 atm**; Q: 14 − 4 = **10 atm**; R: 11 − 6 = **5 atm**.

Water moves towards the **higher DPD**. Q has the highest, so water moves **from P into Q** and **from R into Q**: Q draws water from both its neighbors.

MARKING SCHEME

- ✓ DPD = OP − TP, and P's DPD 7 atm.
- ✓ Q's DPD 10 atm and R's 5 atm.
- ✓ Water moves from P to Q (towards the higher DPD).
- ✓ Water moves from R to Q.

6 Long answer

ANSWER U · 4

The **ascent of sap** is the upward movement of water and dissolved minerals from the roots to the leaves and other aerial parts, against gravity, through the **xylem**.
The **cohesion–tension theory** (transpiration pull theory) of **Dixon and Joly** (1894) rests on three things:

- **An unbroken column of water**: the vessels and tracheids form continuous, very thin tubes from root to leaf, full of water.
- **Cohesion and adhesion**: water molecules cling to one another (hydrogen bonds) and to the xylem walls, so the column can be pulled like a rope without breaking.
- **Transpiration pull**: water evaporates from the mesophyll cells and diffuses out through the stomata; the cells draw water from the veins' xylem, and the tension passes down the columns to the root, so the whole column rises.

The energy comes from the Sun, which evaporates the water; the plant spends none of its own.

MARKING SCHEME

- ✓ Definition: the upward movement of water and minerals in the xylem, against gravity.
- ✓ An unbroken column of water in the vessels and tracheids.
- ✓ Cohesion and adhesion let the column bear tension without breaking.
- ✓ Transpiration pull from the leaves puts the column under tension and lifts it.

7 Think

ANSWER HA · 3

No. Drops in neat rows at the **tips and edges**, at the ends of the veins, are **guttation**, not dew, which forms all over a cool surface.
On a humid night the grass can hardly **transpire**, but its roots keep absorbing water, so **root pressure** pushes liquid water out of the always-open **hydathodes**.
A tall mango tree has too little root pressure to push water so high, so it doesn't guttate.

MARKING SCHEME

- ✓ Not dew: guttation, drops at the tips and edges where the veins end.
- ✓ Little transpiration on a humid night, so root pressure pushes water out through the hydathodes.
- ✓ A tall tree's root pressure is too small to push water so high.

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8 Activity: Plasmolysis in a leaf peel

(not marked)

WHAT STUDENTS SHOULD FIND

In water every cell is full of colored sap, pressed against its wall. In salt, the colored protoplasts shrink and pull away from the walls, first at the corners, then into rounded masses: **plasmolysis**. In water again they swell back: **deplasmolysis**. After an hour in strong salt the cells have usually **died**, so their membranes are no longer selective and they can't recover.

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	10	11	8	3	**32**

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