34.1 Water potential: include solute and pressure effects

Name: _____ Class: _____ Date: _____ **Total: 10 marks**

KEY WORDS water potential • pressure potential

Objective

Water potential: include solute and pressure effects. Original classroom practice for IB HL; not an official IB paper.

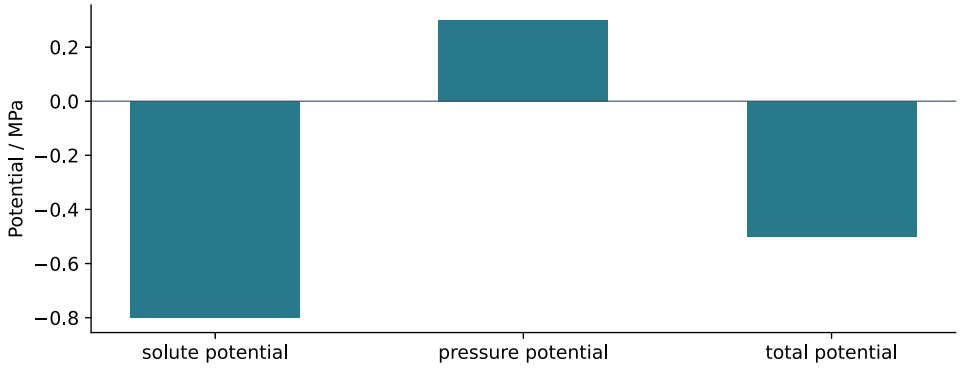
1 Key knowledge and worked examples

What would explain this observation?

- A plant cell can stop gaining net water even while its contents contain solute. The cell wall permits pressure to build, altering the **water-potential** balance.

Build the model

- Water potential describes the tendency of water to move relative to a chosen reference, with pressure units.
- In the simplified cell model, water potential equals solute potential plus **pressure potential** .
- Dissolved solute lowers solute potential; positive pressure can raise water potential.
- Net water movement through a water-permeable membrane is from higher to lower water potential.
- water potential: A pressure-equivalent measure of the tendency of water to move relative to a reference.
- pressure potential: The pressure contribution to water potential in the stated model.



Choose evidence that can test it

- Compare the complete water potentials of the two sides rather than solute concentrations alone.
- A turgid cell can have the same total water potential as its surroundings despite unequal solute potential.
- At equilibrium there is no net transfer, but water molecules can continue moving in both directions.

In the lab: Use provided potential values and labelled plant-cell models. State the reference and units before adding components. For school tissue investigations, control temperature, tissue dimensions, time and blotting, and estimate a zero-change point from repeated measurements. Do not claim the mass method separately measures cell pressure without further evidence.

Work from known quantities

- Known: a cell has solute potential −0.8 MPa and pressure potential +0.3 MPa, so total potential is −0.5 MPa.
- Surrounding solution is −0.2 MPa.
- Water tends to enter the cell because −0.2 is higher than −0.5.
- If the cell components change to −0.8 and +0.6 MPa, its total is −0.2 MPa, matching the surroundings in this simplified model.

Your turn: Solute potential is −0.7 MPa and pressure potential is +0.4 MPa. Find total water potential.

Check the conclusion and its limits

- More negative is lower, not higher.
- The additive cell model has stated boundaries and does not require pretending that every real tissue has one uniform value.
- Loss of turgor and cell-wall support differ from a rigid wall directly controlling solute concentration.

Not true: Solute concentration alone always determines water movement in a turgid plant cell. In a turgid cell the wall pushes back: pressure potential opposes the solute effect, and movement depends on the SUM. Solute concentration alone decides only when pressure potential is zero.

Key:

- Water potential describes the tendency of water to move relative to a chosen reference, with pressure units.
- Compare the complete water potentials of the two sides rather than solute concentrations alone.
- Watch for: more negative is lower, not higher.

■ **Write from a water potential of -0.7 megapascals**

- Solute potential is -0.9 MPa and pressure potential is +0.2 MPa. The surrounding solution is -0.4 MPa.
- Find the cell's water potential and the direction of net water movement.

2 Practice

2.1 A cell is at −0.6 MPa and its surroundings at −0.1 MPa. Which net movement is predicted? Choose one answer.

- **A** Into the cell
- **B** No possible movement because both values are negative
- **C** Out of the cell [1]

2.2 Solute potential is −0.7 MPa and pressure potential is +0.4 MPa. Find total water potential. Show the relation, substitution and units. [2]

2.3 Decide whether this claim is true and justify: In a turgid cell the wall pushes back: pressure potential opposes the solute effect, and movement depends on the SUM. [2]

2.4 A pressure-equivalent measure of the tendency of water to move relative to a reference: write the technical term. [1]

3 Exam-style questions

3.1 A model cell has solute potential−0.9 MPa and pressure potential+0.2 MPa; its surroundings are −0.4 MPa. Predict initial net water movement and pressure potential at balance if solute potential stays fixed. [4]

Solutions

2.1 A Water moves toward the more negative potential - from higher (-0.1 MPa) to lower (-0.6 MPa) - so it enters the cell. Negative values are normal here; “more negative is lower” is the rule to apply.

2.2 Total potential=solute+pressure=$-0.7+0.4=-0.3$ MPa.

2.3 True. True. In a turgid cell the wall pushes back: pressure potential opposes the solute effect, and movement depends on the SUM. Solute concentration alone decides only when pressure potential is zero.

2.4 water potential. water potential means A pressure-equivalent measure of the tendency of water to move relative to a reference.

3.1 Cell total-0.7 MPa; water enters from higher-0.4. At balance pressure=$-0.4-(-0.9)=+0.5$ MPa. The fixed-solute assumption is a simplification.

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