

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. Supported HL concept preparation; original classroom practice, not an official IB paper or assessed learner work.

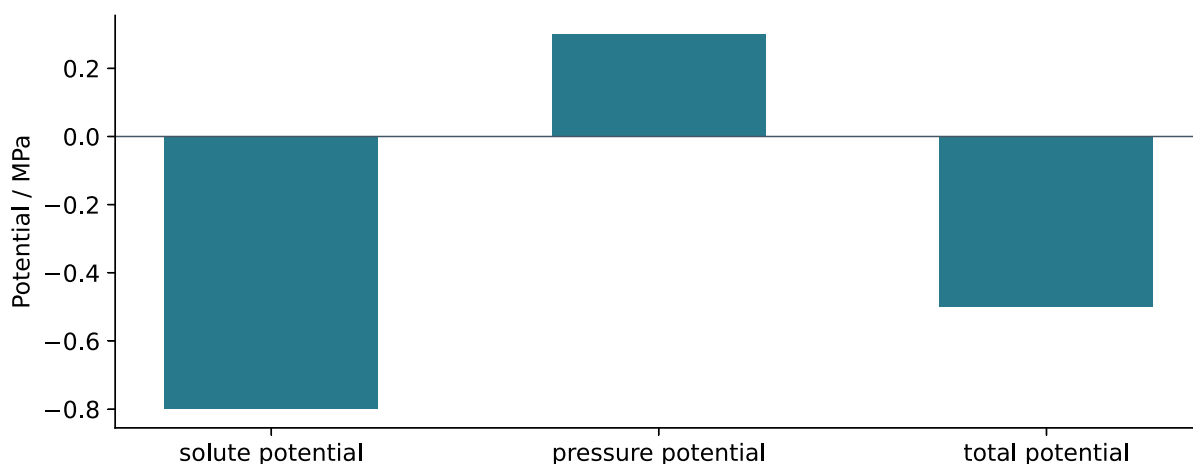
1 Key knowledge and worked examples

■ 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.
 - Start with a prediction. State the quantities or features you would compare, then decide what evidence could distinguish two explanations.
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■ 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.
- 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

- State the known values and their units. Choose the relation because its assumptions fit this case, then rearrange before substitution.
- 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.

Example:

Solute potential is -0.7 MPa and pressure potential is $+0.4$ MPa. Find total water potential. Use the same sequence: known quantities $\rightarrow$ model $\rightarrow$ relation $\rightarrow$ substitution $\rightarrow$ unit and interpretation.

■ 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.
- Return to the original observation. Explain what the result supports, which conditions it assumes, and one way to test a competing explanation.

Warn:

Solute concentration alone always determines water movement in a turgid plant cell. This claim is false: 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.

Key:

Water potential: include solute and pressure effects: 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.

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** Out of the cell
 - **C** No possible movement because both values are negative [1]
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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: Solute concentration alone always determines water movement in a turgid plant cell. [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 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.

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

2.3 False. 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.

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.