

Tonicity and Osmoregulation

Learning objectives 2.7.A Explain how concentration gradients affect the movement of molecules across membranes. 2.7.B Explain how osmoregulatory mechanisms contribute to the health and survival of organisms.

Name:

Date:

Period:

Use the tool **Which Way Does Water Go**. Work on the **Work out the potential** tab for Parts 1 and 2, **Put a cell in it** for Part 3, **Graph it** for Part 4, and **How organisms cope** for Part 5. Do every calculation on paper first — the tool is for checking, not for doing your working. Predicting: wherever a Part asks you to predict, write a specific number or word and one reason before you touch the tool, in the form “I think ... because ...”. A wrong prediction costs nothing; a prediction made after looking is not a prediction.

 If this is your first time with the tool, watch the short demo on the tool page before you start.



watch the demo



switch tab



scroll down



predict first



work it on paper



record from the tool



sketch a graph



score yourself

The purple bar in the margin names the AP science practice a question uses.

Part 1 • Substitute into $\Psi_s = -iCRT$

Work out the potential

Put a cell in it

Graph it

How organisms cope



Use the **Work out the potential** tab. It is the one showing when the tool opens.



For each row, work the calculation out on paper, then set the tool to the same values and check. **$R = 0.0831 \text{ L bar/mol K}$** and T in kelvin is degrees Celsius plus 273.

Solution	i	C (M)	T (K)	Ψ_s (bars)
Sucrose, 1.0 M, 22 °C				
Sucrose, 0.5 M, 22 °C				
NaCl, 1.0 M, 22 °C				
NaCl, 0.5 M, 25 °C				
CaCl ₂ , 0.5 M, 25 °C				
Pure water, 25 °C				

1. Two of those rows have the same molarity but different values of Ψ_s . Name them and explain the difference.

Part 2 • What the equation will not allow



Stay on the **Work out the potential** tab and scroll down to the section headed **What the equation will not let you do**.

2. Every value in your Ψ_s column is negative or zero. Explain why solute potential can never be positive.

3. State the water potential of pure water in an open container, and explain why that value is used as a reference point.

4. Set the pressure potential slider to 10 bars with a 0.5 M sucrose solution. Record Ψ_s and Ψ , and state the relationship between them.

5. Raising the temperature makes Ψ s more negative. Explain why, using the equation.

Part 3 · Predict the direction

Work out the potential

Put a cell in it

Graph it

How organisms cope



Click the **Put a cell in it** tab at the top of the tool. Keep the cell at **0.5 M** throughout.



Predict each row before you set the sliders: write the tonicity and the direction first, then check with the tool.

Outside	Tonicity (predict) <i>circle one</i>	Ψ outside	Ψ inside	Water moves <i>circle one</i>
0.0 M	hypertonic / isotonic / hypotonic			in / out / no net movement
0.1 M	hypertonic / isotonic / hypotonic			in / out / no net movement
0.5 M	hypertonic / isotonic / hypotonic			in / out / no net movement
0.9 M	hypertonic / isotonic / hypotonic			in / out / no net movement
1.5 M	hypertonic / isotonic / hypotonic			in / out / no net movement

6. State the rule that connects water potential to the direction water moves.

7. You made each prediction twice — once from the tonicity terms and once from the Ψ values. Explain why the two methods can never disagree.

Part 4 · Plant against animal

  Stay on the **Put a cell in it** tab; switch between the two cell types at each tonicity and record what happens to the cell itself.

Tonicity	Animal cell <i>circle one</i>	Plant cell <i>circle one</i>
Hypotonic	swells and may burst / no net change / shrinks and shrivels	turgid / flaccid / plasmolyzed
Isotonic	swells and may burst / no net change / shrinks and shrivels	turgid / flaccid / plasmolyzed
Hypertonic	swells and may burst / no net change / shrinks and shrivels	turgid / flaccid / plasmolyzed

8. State the healthy state for an animal cell and the healthy state for a plant cell, and explain why they are different.

SP 1 · CONCEPT EXPLANATION

9. Explain why a plant cell in pure water does not burst. Refer to pressure potential in your answer.

Part 5 · Graph it, then apply it

Work out the potential

Put a cell in it

Graph it

How organisms cope



Click the **Graph it** tab at the top of the tool.



10. On the axes below, sketch Ψ s against C for sucrose and for NaCl at 22 °C, from 0 to 2.0 M. Label both lines and label the axes with units.

SP 4 · REPRESENTING AND DESCRIBING DATA

11. State what the slope of each line is equal to, in terms of the symbols in the equation, and explain why the NaCl line is steeper.



For the last question, click the **How organisms cope** tab at the top of the tool.

Work out the potential

Put a cell in it

Graph it

How organisms cope

SP 1 - CONCEPT EXPLANATION

12. A Paramecium lives in fresh water. Describe the osmotic problem this creates and how the organism solves it.

Part 6 · Learning check self-report



Scroll down to the **Learning check** at the bottom of the tool. Type each answer in your own words, check it, and tick the points you earned. Then record your score here and, for every point you did not earn, write what the rubric asked for that your answer left out.

Question	Points possible	Points I earned	Missed opportunities (what the rubric wanted that I left out)
1	3		
2	3		
3	3		
4	2		
Total	11		

What the model simplifies

The cell is drawn as a simple shape whose size changes with the direction of water movement. Real cells change shape in ways that depend on the cytoskeleton and, for plant cells, on the wall.

The tool treats the cell's contents as a single solute at a single concentration. A real cytoplasm contains many solutes at once, and it is their total that sets the solute potential.

Pressure potential is set by a slider rather than emerging from the water that has entered. In a real plant cell the two are coupled: water entering raises the pressure, which then opposes more water entering.

The ionization constant is treated as a whole number. Real solutions deviate slightly from this at high concentration, which is why the equation is a very good approximation rather than an exact law.

Every equation is the CED's own, with $R = 0.0831 \text{ L bar/mol K}$ and T in kelvin taken as $^{\circ}\text{C} + 273$.