Key

AP Biology Water Potential Problems

Reminders:
Units of water potential, pressure potential and solute potential are typically bars, megapascals or kilopascals. When solving the problems below, use the same units as the prompts. If there are no units in the prompt, your units for water potential will be bars because the R constant in your Appendix B formula sheet is 0.0831 liters bars/moles K. (For problems in megapascals, R is 0.00831 liters megapascals/moles K. R in this case is 10 times smaller because 1 MPa=10 Bars)

Give your answers to the nearest hundredth.

1. **A cell is in equilibrium with its surroundings at 30 C. The molarity of the surrounding sucrose solution is 0.5 M.**
   a. Calculate the solute potential for the surrounding solution.

$\Psi_S = -iCRT$ $i = 1$ (sucrose, covalent, ø dissociation) $R = .0831$ L bars/mol. K $T = 30°C + 273 = 303$ K $C = .5M$ $\Psi_S = (-1)(.5M)(.0831)(31$

   b. What is the water potential for the surrounding solution?

$\Psi_{total} = \Psi_S + \Psi_P$ *there is only atmospheric pressure so $\Psi_P = 0$ $\Psi_{total} = -12.6 + 0$ $\Psi_S = -12.6$ bar

   c. What is the water potential for the cytoplasm of the cell?

Ψ total = -12.6

The cell is @ equilibrium so = -12.6

2. You measure the water potential of a cell and find it to be -.024 kPa. If the pressure potential of the same cell is 0.46 kPa, what is the solute potential for that cell?

$\Psi_{total} = \Psi_S + \Psi_P$

$-.024$ kpa $= X + .46$ kpa $\Psi_S =$ [redacted] .484 kpa

3. What is the water potential of a cell with a solute potential of -0.67 kPa and a pressure potential of 0.43 kPa?

$\Psi_{total} = \Psi_S + \Psi_P$ $\Psi_{total} = -.67 + .43$ $= -.24$ kpa

4. A hypertonic environment has a **high/low (circle one)** water potential compared to the cell. Why?

Assume $\Psi_P = 0$ → more dissolved solute = greater water potential = more negative water potential

More solute = more negative

5. If a cell's pressure potential is 3 bars and it's solute potential is -4.5 bars, what is the resulting water potential?

$\Psi_t = \Psi_p + \Psi_s$ $\Psi = 3\text{bars} + -4.5\text{ bars}$

$\Psi_t = -1.5$ bars

6. The cell from question 5 is placed in a beaker ~~of sugar water with solution potential~~ of -4.0 bars. In which direction will the net flow of water be?

Sugar solution: $\Psi = \Psi_p + \Psi_s$ $= 0 + -4.0$ $= -4.0\ \Psi_s$ vs. Cell $= -5$ ← less negative less solute

↑ more negative = more solute

∴ from the cell to the solution

7. The cell from question 5 is placed in a beaker of sugar water with solute potential of -0.15 MPa. We know that 1 MPa = 10 bars. In which direction will the net flow of water be?

Sugar solution $= -0.15$ MPa

$\frac{1\text{MPa}}{10\text{ bar}} = \frac{-.15\text{ Mpa}}{x\text{ bar}} \rightarrow x = -1.5\text{bars}$

Cell $= -1.5$ bars

equal = isotonic

no net movement

8. The value for water potential in root tissue was found to be -3.3 bars. If you take the root tissue and place it in 0.1 M solution of sucrose in an open beaker, what is the water potential of the solution and in which direction will the net flow of water be?

@ 20°C

root tissue $= -3.3$ bars

sucrose solution: $\Psi = -iCRT$

$\Psi = -1(1M)(.0831)(293) = 2.4$ bars

Water will move into the roots

9. ~~NaCl dissociates into 2 particles in water~~. If the solution in question 8 contained 0.1M NaCl instead of 0.1 M sucrose, what would the water potential of the solution be and in which direction will the net flow of water be?

root tissue $= -3.3$ bar

NaCl $= \Psi = -iCRT$

$\Psi = -2(.1M)(.0831)(293) = -4.8$ bars.

10. A plant cell with solute potential of -7.5 bars keeps a constant volume when immersed in an open beaker of a solution that has solute potential of -4 bars. What is the cell's pressure potential?

if volume stays constant then @ equilibrium meaning $\Psi_{total\ cell} = \Psi_{total\ solution}$

Plant cell: $\Psi_s = -7.5$, $\Psi_p = ?$, $\Psi_{total} = ?$

Solution: $\Psi_s = -4$ bar, $\Psi_p = 0$ (open beaker) $\rightarrow \Psi_{total} = -4$ bar

$\Psi_{total} = \Psi_s + \Psi_p$

$-4\text{bar} = -7.5 + x$

$x = 3$ bar

11. At 20 C, a cell with pressure potential of 3 bars is in equilibrium with the surrounding 0.4 M solution of sucrose in an open beaker. What is the molar concentration of sucrose in the cell?

Cell: $\Psi_p = 3$ bar @ equil. $\Psi_s = ?$, $\Psi_{total} = -9.7$

Solution: $C = .4M$, $T = 293K$, $i = 1$

$\Psi_s = -iCRT$

$-(1)(.4)(.0831)(293)$

$\Psi_s = -9.7$ bar