AP Biology Water Potential Problems

Name_____

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 prompt. If there are no units in the prompt, your units for water potential will be bars because the R constant in your Appendix B 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 surrounding at 30°C. The molarity of the surrounding sucrose solution is 0.5M.
   a. Calculate the solute potential of the surrounding solution.

$\psi_s = -iCRT = -(1)(0.5\ M)(0.0831)(308\ K)$

$= -12.59 \approx -12.6$ bars

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

$\psi = -12.6$ bars

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

$\psi = -12.6$ bars

2. You measure the water potential of a cell and find it to be -0.24 kPa. If the pressure potential of the same cell is 0.46 kPa, what is the solute potential of that cell?

$\psi = \psi_p + \psi_s$ $\quad -0.24 = 0.46 + \psi_s$

$\psi = -0.24$ kPa $\quad -0.70 = \psi_s$

-0.70 kPa $= \psi_s$

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?

ψ_s $\quad \psi_p$

$\psi = 0.43 + -0.67$

$\psi = -0.24$ kPa

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

More solute taking up space and getting "in the way" of water diffusing.

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

ψ_p $\quad \psi_s$

$\psi = 3 + -4.5$

$\psi = -1.5$ kPa

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open beaker: $\psi_p = 0$! so $\psi = \psi_s$ water (typo)

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

cell: -1.5 kPa
beaker: -4 kPa
down
water flows out of the cell.

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

$\psi_s = -0.15$ MPa
$\cdot 10$
-1.5 kPa

same as cell: isotonic = no net water 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 a 0.1 M solution of sucrose at 20°C in an open beaker, what is the water potential of the solution and in which direction will the net flow of water be?

Beaker: $\psi_s = -(1)(0.1\text{M})(0.0831)(298\text{K})$
$\psi_s = -2.43$ kPa

-2.43 beaker
-3.3 root
down
water will move into the root tissue.

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

Beaker: $\psi_s = -(2)(0.1\text{M})(0.0831)(293\text{K})$
$\psi_s = -4.87$

-3.3 root
-4.87 beaker
down
water will move out of the root.

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

$\psi = \psi_p + \psi_s$
beaker ψ = beaker ψ_s
$-4 = \psi_p + (-7.5)$
$+7.5 \quad +7.5$
solve for $\psi_p = 3.5$ bars

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

C = 0.52M
$\psi_s = -iCRT$
since @ equilibrium: beaker ψ = ψ_s
$-12.74 = -(1)C(0.0831)(293)$ solve for "C"
$\psi_s = -(1)(0.4)(0.0831)(293)$
beaker $\psi_s = -9.74$

Answer T or F for questions 12 – 15.

12. F The molarity of a flaccid cell is equal to the molarity of the solution.
13. T The molarity of a turgid cell is greater than the molarity of the solution.
14. T The solute potential of a turgid cell is lower than the molarity of the solution.
15. F The molarity of a plasmolyzed cell is greater than the molarity of the solution.

so cell:
$-9.74 = \psi_s + 3$
$-12.74 = \psi_s$