Name: _____

Water Potential

Remember, the formulas you must know are:

$$\Psi = \Psi_S + \Psi_P \qquad \& \qquad \Psi_S = -(iCRT)$$

i = ionization constant (how many particles does one entity of a substance when put in water form)
C = molar concentration in M (mol/L)
R = pressure constant = 0.0831 L·bar/mol·K
T = temperature in K

K = Temp in °C + 273

*(Room temp is about **23 - 25°C**, which is equivalent to 293-298K)*

1MPa = 10 bars

!!! Remember too (though it will **not** be on your AP Biology Exam formula sheet) that...

- **Free water diffuses - osmosis occurs - from an area of higher water potential to an area of lower water potential**
- **NO more osmosis - no more net diffusion of water - occurs when the water potentials of two solutions are equal (when $\Psi_{Solution\ 1} = \Psi_{Solution\ 2}$).**

1. a. It's 20°C. A plant cell is in equilibrium with its surroundings. The molarity of the surrounding sucrose solution is 0.5M. What is the solute potential of the surrounding solution? **For this and all problems below, explain your logic, show which formula you use and when, show how you plug in your numbers, how you cancel units, and how to come up with your final calculations step-by-step.**

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

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

d. The cell from question 1.a. is now placed in a beaker of sugar water with Ψ_S = -4.0 bars. In which direction will the net flow of water be? Just as with al problems, show your work.

e. The cell from question 1.a. is placed in a beaker of sugar water with Ψ_S = -0.15 MPa (megapascals). We know that **1 MPa = 10 bars**. In which direction will the net flow of water be?

2. a. Calculate the water potential of a solution of 0.15M sucrose (assume that RT = 24.3 L*bar/mol), the temperature being around a room temperature of a little under 24°C).

b. If a flaccid cell (Ψ_P=0) having a solute potential of –0.65bar is placed in the above solution, what will its pressure potential be at equilibrium?

c. If the cell above in 2.a. is removed from that solution of 0.15M sucrose and placed in a solution of 0.35M sucrose, will the pressure potential of the cell increase or decrease? And what will be the cells new pressure potential value?

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

4. If a plant cell having a solute potential of -0.35bar is placed in a solution of pure water, what will be its pressure potential at equilibrium?

5. What is the water potential of a plant cell with a solute potential of -.67bar and a pressure potential of 0.43bar?

6. a. Can an animal cell be hypertonic compared to its surrounding solution and be in water equilibrium - not experience osmosis and so not swell further? *Explain your answer by using the concept of water potential and your understanding of how this value is calculated.*

   b. Can a fully turgid plant cell be hypertonic compared to its surrounding solution and be in water equilibrium - not experience osmosis and so not swell further? *Explain your answer by using the concept of water potential and your understanding of how this value is calculated.*

7. a. If a cell's Ψ_P = 3 bars and its Ψ_S = -4.5 bars, what is the resulting Ψ?

b. What about if we transfer the cell from 7.a. into a beaker of sugar water with Ψ_S = -1.5 bar?

8. The value for Ψ 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 Ψ of the solution AND in which direction would the net flow of water be?

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 is the Ψ of the solution AND in which direction would the net flow of water be if kept at the same temperature?

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

11. At 20°C, a cell containing 0.6M glucose is in equilibrium with its surrounding solution containing 0.5M glucose in an open container. What is the cell's Ψ_P?

12. At 20°C, a cell with Ψ_P 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?