AP Water Potential Sample Questions - Answer Key

1. If a plant cell's Ψ_P = 2 bars and its Ψ_S = -3.5 bars, what is the resulting Ψ?

$$\Psi = \Psi_P + \Psi_S = 2 \text{ bars} + (-3.5 \text{ bars}) = -1.5 \text{ bars}$$

2. The plant cell from question #1 is placed in a beaker of sugar water with Ψ_S = -4.0 bars. In which direction will the net flow of water be?

The pressure potential of a solution open to the air is 0. Therefore, the water potential of the sugar water is -4.0 bars [Ψ = 0 bars +(-4.0) bars]. Since free water always flows towards the solution with a lower water potential, the flow of water would be outside of the cell.

3. The original cell from question # 1 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?

$$-0.15 \text{ MPa} = -1.5 \text{ bars}$$

The water potential of the sugar water is -1.5 bars [Ψ = 0 bars + (-1.5 bars)]. Since the water potential of the original cell was also -1.5 bars, there would be no net flow of water. The cell and the sugar water are in equilibrium.

4. The value for Ψ in root tissue was found to be -3.3 bars. If you place the root tissue 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?

$$\Psi_S = -iCRT$$
$$\Psi_S = -(1)(0.1 \text{ mol/L})(0.0831 \text{ L*bars/mol*K})(293 \text{ K}) = -2.43 \text{ bars}$$
$$\Psi = \Psi_P + \Psi_S = 0 \text{ bars} + -2.43 \text{ bars} = -2.43 \text{ bars}$$

The Ψ of the root tissue is -3.3 bars and the Ψ of the sucrose solution is -2.43 bars. Water will flow into the root tissue because free water always moves towards the lower overall water potential.

5. NaCl dissociates into 2 particles in water: Na^+ and Cl^-. If the solution in question 4 contained 0.1 M NaCl instead of 0.1 M sucrose, what is the Ψ of the solution, and in which direction would the net flow of water be?

$$\Psi_S = -iCRT$$
$$\Psi_S = -(2)(0.1 \text{ mol/L})(0.0831 \text{ L*bars/mol*K})(293 \text{ K}) = -4.87 \text{ bars}$$
$$\Psi = \Psi_P + \Psi_S = 0 \text{ bars} + -4.87 \text{ bars} = -4.87 \text{ bars}$$

The Ψ of the root tissue is -3.3 bars and the Ψ of the NaCl solution is -4.87 bars. Water will flow out of the root tissue and into the salt solution because free water always moves towards the lower overall water potential.

6. 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?

The plant cell keeps a constant volume because of the buildup of turgor pressure inside the cell. The Ψ_P at equilibrium would be the difference between the two solute potentials, which is 3.5 bars.

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

Surrounding solution: $\Psi = \Psi_P + \Psi_S$ = 0 bars + (1)(0.5 mol/L)(0.0831 L*bars/mol*K)(293 K) = -12.2 bars

Cell at equilibrium: -12.2 bars = Ψ_P + (1)(0.6 mol/L)(0.0831 L*bars/mol*K)(293 K) = Ψ_P + (-14.6 bars)

Ψ_P = -12.2 bars – (-14.6 bars) = 2.4 bars