EXERCISE 1D: Calculation of Water Potential from Experimental Data

1. The solute potential of this sucrose solution can be calculated using the following formula:

$$\psi_s = -\mathrm{iCRT}$$

where **i = Ionization constant** (for sucrose this is 1.0 because sucrose does not ionize in water)

C = Molar concentration (determined above)

R = Pressure constant (R = 0.0831 liter bars/mole °K)

T = Temperature °K (273 + °C of solution)

The units of measure will cancel as in the following example:

A 1.0 *M* sugar solution at 22°C under standard atmospheric conditions

$$\psi_s = -\mathrm{i} \times \mathrm{C} \times \mathrm{R} \times \mathrm{T}$$

$$\psi_s = -(1)(1.0 \text{ mole/liter})(0.0831 \text{ liter bar/mole °K})(295 \text{ °K})$$
$$\psi_s = -24.51 \text{ bars}$$

2. Knowing the solute potential of the solution (ψ_s) and knowing that the pressure potential of the solution is zero ($\psi_p = 0$) allows you to calculate the water potential of the solution. The water potential will be equal to the solute potential of the solution.

$$\psi = 0 + \psi_s \text{ or } \psi = \psi_s$$

The water potential of the solution at equilibrium will be equal to the water potential of the potato cells. What is the water potential of the potato cells? Show your calculations here:

3. Water potential values are useful because they allow us to predict the direction of the flow of water. Recall from the discussion that water flows from an area of higher water potential to an area of lower water potential.

For the sake of discussion, suppose that a student calculates that the water potential of a solution inside a bag is −6.25 bar ($\psi_s = -6.25$, $\psi_p = 0$) and the water potential of a solution surrounding the bag is −3.25 bar ($\psi_s = -3.25$, $\psi_p = 0$). In which direction will the water flow?

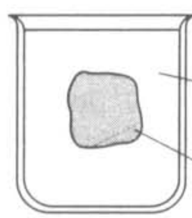
Water will flow into the bag. This occurs because there are more solute molecules inside the bag (therefore a value further away from zero) than outside in the solution.

Questions

1. If a potato core is allowed to dehydrate by sitting in the open air, would the water potential of the potato cells decrease or increase? Why?

2. If a plant cell has a lower water potential than its surrounding environment and if pressure is equal to zero, is the cell hypertonic (in terms of solute concentration) or hypotonic to its environment? Will the cell gain water or lose water? Explain your response.

Figure 1.5



3. In Figure 1.5 the beaker is open to the atmosphere. What is the pressure potential (ψ_p) of the system?

4. In Figure 1.5 where is the greatest water potential? (Circle one.)

   beaker **dialysis bag**

5. Water will diffuse ____________ (circle one) the bag. Why?

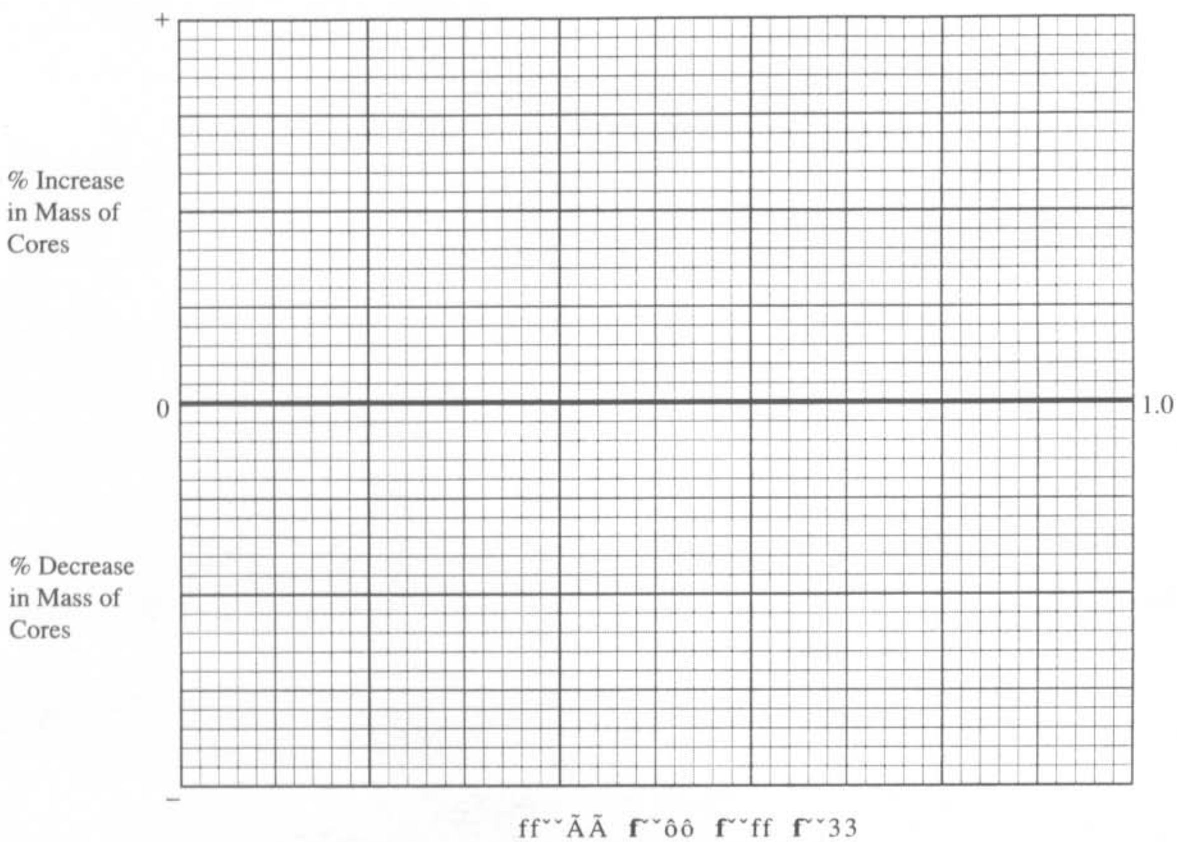
   into **out of**

6. Zucchini cores placed in sucrose solutions at 27°C resulted in the following percent changes after 24 hours:

% Change in Mass	Sucrose Molarity
20%	Distilled Water
10%	0.2 *M*
−3%	0.4 *M*
−17%	0.6 *M*
−25%	0.8 *M*
−30%	1.0 *M*

7. **a.** Graph the results on Graph 1.3.

Graph 1.3 Title: ____



b. What is the molar concentration of solutes within the zucchini cells? ____________________

8. Refer to the procedure for calculating water potential from experimental data (page 13).

   a. Calculate solute potential (ψ_s) of the sucrose solution in which the mass of the zucchini cores does not change. Show your work here:

   b. Calculate the water potential (ψ) of the solutes within the zucchini cores. Show your work here:

9. What effect does adding solute have on the solute potential component (ψ_s) of that solution? Why?

10. Consider what would happen to a red blood cell (RBC) placed in distilled water:

    a. Which would have the higher concentration of water molecules? (Circle one.)

    Distilled H_2O **RBC**

    b. Which would have the higher water potential? (Circle one.)

    Distilled H_2O **RBC**

    c. What would happen to the red blood cell? Why?