Calculating Water Potential

http://www.phschool.com/science/biology_place/labbench/lab1/intro.html

Water potential is calculated using the following formula:

$\Psi = \Psi_P + \Psi_S$

<table>
<thead>
<tr>
<th>Pressure potential ($\Psi_P$):</th>
<th>In a plant cell, pressure exerted by the rigid cell wall that limits further water uptake.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solute potential ($\Psi_S$):</td>
<td>The effect of solute concentration. Pure water at atmospheric pressure has a solute potential of zero. As solute is added, the value for solute potential becomes more negative. This causes water potential to decrease also.</td>
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In sum, as solute is added, the water potential of a solution drops, and water will tend to move into the solution.

In this laboratory we use bars as the unit of measure for water potential; 1 bar = approximately 1 atmosphere.

**Water Potential**

The water potential of pure water in an open container is zero because there is no solute and the pressure in the container is zero. Adding solute lowers the water potential. When a solution is enclosed by a rigid cell wall, the movement of water into the cell will exert pressure on the cell wall. This increase in pressure within the cell will raise the water potential.

Look again at the equation for water potential:

$\Psi = \Psi_P + \Psi_S$

There are two components to water potential: solute concentration and pressure. How do you think this fact affects the movement of water into and out of cells? For example, can two solutions that differ in their solute concentration be at equilibrium in terms of water movement? Can a solution with a molarity of 0.2 be in equilibrium with a solution with a molarity of 0.4?

Two solutions will be at equilibrium when the water potential is the same in both solutions. This does not mean that their solute concentrations must be the same, because in plant cells the pressure exerted by the rigid cell wall is a significant factor in determining the net movement of water.
Lab Investigation 4 (Part 3): **Water Potential of Potato Cores**

This activity is very similar to Part 1, except that you use cores from potatoes instead of dialysis bags. You submerge the cores in solutions of varying sucrose concentrations. When you calculate the percent change in mass, some of the cores will have gained weight while others will have lost weight, depending on the movement of water. You then graph these data and determine which concentration of the sucrose solution is in equilibrium with the cores. Since you know that the pressure potential of the surrounding solution in an open beaker is zero, you can now calculate the water potential.

**Analysis of Results**

So that you might better understand the procedure for calculating water potential, here is a practice problem.

Once you know the solute concentration, you can calculate solute potential using the following formula:

\[
\text{Solute potential } (\mathcal{V}_s) = -iCRT
\]

- **i** = The number of particles the molecule will make in water; for NaCl this would be 2; for sucrose or glucose, this number is 1
- **C** = Molar concentration (from your experimental data)
- **R** = Pressure constant = 0.0831 liter bar/mole K
- **T** = Temperature in degrees Kelvin = 273 + °C of solution

**Sample Problem**

The molar concentration of a sugar solution in an open beaker has been determined to be 0.3M. Calculate the solute potential at 27°C.

**Correct Answer:** -7.48

**Answer:**

\[
\text{Solute potential } = -iCRT \\
= -(1)(0.3 \text{ mole/1})(0.0831 \text{ liter bar/mole K})(300 \text{ K}) \\
= -7.48
\]

The pressure potential of a solution open to the air is zero. Since you know the solute potential of the solution, you can now calculate the water potential. (If you need to, review the equation for calculating water potential.)

What is the water potential for this example? Round your answer to the nearest hundredth.

**Correct Answer:** -7.48

**Answer:**

\[
\text{Water potential } = -7.48 + 0, \text{ so water potential} \\
= -7.48
\]