February 1, 2002

- *Quiz Today!*

- **Office Hours**

  - By appointment only, today

- **Supplemental Instruction**

  - Schedule on Web

- **Problem Set Solutions**

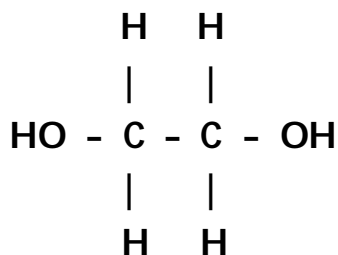 - Chapter 14 now online

1

Solvent Purification

Freezing *process* often involves **solvent freezing first**

➢ Solid, initially, is *pure*
(zone refining, water purification)

➢ Solute concentration in remaining solution *increases* as solvent freezes
(FP is lowered even more)

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Automobile Antifreeze

■ Add *Ethylene Glycol* ($C_2H_6O_2$) to water in radiator:

$$MW = 62.0 \text{ g/mol}$$
$$d = 1.12 \text{ g/mL}$$

```
        H   H
        |   |
 HO  -  C – C  -  OH
        |   |
        H   H
```

3

How Much EG to Add?

➤ **Calculate the FP of a solution made by mixing 50.0 mL of EG with 50.0 g of H_2O.**

1) <u>Calculate *molality* of resulting solution.</u>

50.0 mL EG x $\dfrac{1.12 \text{ g EG}}{\text{mL EG}}$ x $\dfrac{1 \text{ mol EG}}{62.0 \text{ g EG}}$ = *0.90323 mol EG*

So: m = $\dfrac{0.90323 \text{ mol EG}}{0.0500 \text{ kg } H_2O}$ = ***18.06 mol EG/kg H_2O***

How does this compare with solution *molarity*?

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2

On to the solution!

2) <u>Substitute and solve:</u>

$\Delta T_f = m\, K_f$ = (18.06 mol/kg)(1.86 K-kg/mol)

ΔT_f = 33.6 K $\approx$ *34 ºC*

So:

$T_f = T^o_f - \Delta T_f$ = 0 ºC - 34 ºC = **–34 ºC**

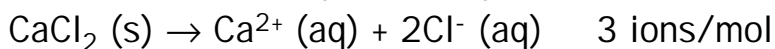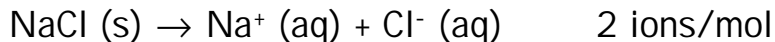| **Reality Check!** Why is the *actual* FP between -35 ºC and -37 ºC? |
| --- |

-29 ºF

5

Melting the Ice

➢ **"Salt" is added to icey roads to melt the ice**
  - FP of H_2O lowered, so ice melts
  - $CaCl_2$ more effective than NaCl . . . . *Why?*
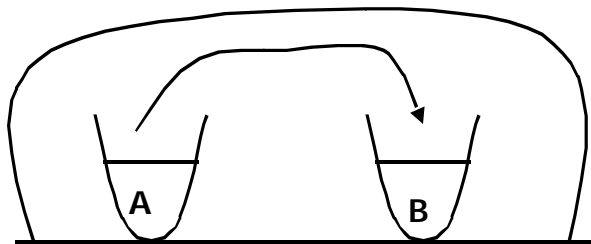
➢ **How many ions released per mol of compound?**

NaCl (s) $\rightarrow$ Na$^+$ (aq) + Cl$^-$ (aq)   2 ions/mol

$CaCl_2$ (s) $\rightarrow$ Ca^{2+} (aq) + 2Cl$^-$ (aq)   3 ions/mol

Need to consider *dissociation* of ionic compounds and the *total number* of species dissolved in solution.

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3

Osmosis

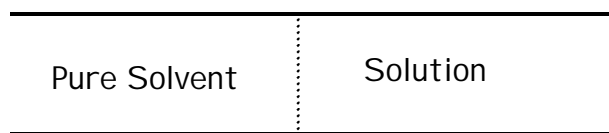Consider the following experiment:

Pure Solvent | Solution

Recall that: $P_A > P_B$

So: net transfer of solvent from A to B

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Osmosis . . . *Really!*

Now, consider the following:

Pure Solvent | Solution

•Solvent "pressure" is greatest for pure solvent, so solvent flows into solution.

Semi-permeable membrane (solvent only can pass through)

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Quantifying Osmosis

➢ "Pressure" of pure solvent = **Osmotic Pressure ($\mathbf{P}$)**

➢ Magnitude will depend on *solution concentration:*

$$\mathbf{P} = M\,RT$$

Absolute Temp (K)

Osmotic Pressure (atm)

Molarity (mol/L)

Gas Constant (0.08206 L-atm/mol-K)

Why can we use *molarity* here instead of **molality**?

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Osmosis: What is it good for?

➢ **Biological Systems**
  • Cell membranes
➢ **Water Desalinization**
  • *Reverse* Osmosis
➢ **MW Determination**
  • No solvent dependence of effect
  • Easier to measure:
  e.g., *30 g of a 10,000 g/mol protein in 1.00 L H_2O*

$\Delta VP = 10^{-7}$ atm

$\Delta T_b = 10^{-4}$ °C $\Delta T_f = 10^{-3}$ °C

$\Pi = 10^{-2}$ atm (~10 torr)

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