Vapor pressure lowering
* cov. molecular solids as solute. (non-vol, non-elect)

January 22nd
↳ VPL continued
BPL & FPL
Conc (ppm) and Mass%.

lab tomorrow
↳ study pre-lab presentation
↳ write intro

Suppose 40.0g sugar, MM=342g/mol, is dissolved in 100g H_2O. What is the vapor pressure of the solution at 24°C?

$$P_{sol'n} = X_{solvent} * P_{solvent}$$

$$X = \frac{n_{solute}}{n_{solute}+n_{solvent}}$$

	m	n
sugar	40 g	0.117
H_2O	100 g	5.56

$$= \frac{5.56}{5.56+0.117} * 22.5\text{ mmHg}$$

$$= 0.979 * 22.5\text{ mmHg}$$

$$= \boxed{22.0\text{ mmHg}}$$

Chap 13 #2 Q7. A 2.00M $CaCl_2$ solution in H_2O has a density of 1.17 g/mL. What is the mole fraction of $CaCl_2$?

↳ mass%, mole fraction, molality } —use density→ Molarity

	m	n	V
$CaCl_2$	222g	2.00mol	
H_2O	948g	52.7mol	
sol'n	1170g		1000mL

↑ m=d·V

Vapor Pressure Lowering

1. * Covalent molecular solids as solute (non-volatile) (non-elect.)
2. * Ionic solute

   ↳ $P_{sol'n} = X_{solvent} * P_{solvent}$

   $= \frac{n_{H_2O}}{n_{H_2O} + n_{solute} * i}$

3. * volatile solute (also volatile) + solvent

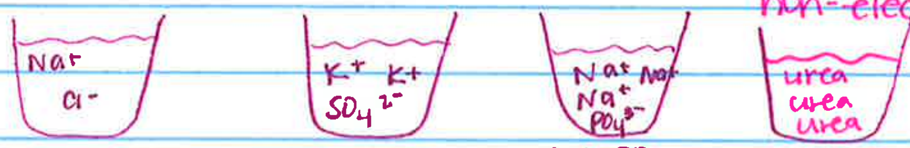
   ↳ $P_{sol'n} = X_{solute} * P_{solute} + X_{solvent} * P_{solvent}$

Vant Hoff factor, i

January 22nd

equals the # of ions made in water

* covalent molec non-electrolyte



NaCl	K_2SO_4	Na_3PO_4	urea
i=2	i=3	i=4	i=1

What is the vapor pressure of a 20.0 mass% ammonium sulfate soln @ 23 °C?

	m	n
$(NH_4)_2SO_4$	20 g	0.152 mol
H_2O	80 g	4.44 mol
soln	100 g	

$$P_{soln} = \frac{4.44}{4.44 + (0.152 * 3)} * 21.0\ mmHg$$

(3 ← i)

* The vapor pressure of CH_3OH at 21 °C is 10 mmHg. What is the vapor pressure of a solution that is 50 mL CH_3OH (d = 0.792 g/mL) and 50 mL H_2O (d = 0.997 g/mL)

		m	n	vol
32 g/mol	CH_3OH	39.6 g	1.24 mol	50 mL
18 g/mol	H_2O	49.85 g	2.77 mol	50 mL

} use density

$$P_{soln} = \frac{1.24}{1.24+2.77} * 90\ mmHg + \frac{2.77}{1.24+2.77} * 18.8\ mmHg = \boxed{40.79\ mmHg}$$

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* Boiling point elevation & freezing point lowering *

	K_b	T_b	K_F	T_F
H_2O	0.51 deg molal	100 °C	1.86 deg/molal	0 °C
$CHCl_3$	3.63	61.15 °C	4.70	−63.5 °C
C_6H_6	2.64	80.1 °C	5.07	+5.53 °C

$$\Delta T_b = K_b \cdot m \cdot i \qquad \Delta T_f = K_f \cdot m \cdot i$$

what is the freezing point of a 0.44 molal $KBr(aq)$ solution? January 22nd

↳ $\Delta T_f = \frac{1.86 \text{ deg}}{\text{molal}} * 0.44 \text{ molal} * 2$

$\Delta T_f = 1.64 \text{ deg} \rightarrow T_f = 0°C - 1.64 \text{ deg} = -1.64°C$

what is the boiling point of 0.35 molal solution of a compound dissolved in benzene?

↳ $\Delta T_b = K_b \cdot m \cdot i$ ← 1

↳ = $\boxed{81.1}$

→ Suppose 8.741g of an unknown, non-electrolyte is dissolved in 50.0g of H_2O. The freezing point is −2.11°C. what is the mm of the unknown?

$MM = \frac{m_{unk}}{n_{unk}}$ ← 8.741g

$\Delta T_f = K_f \cdot m \cdot i$ ← 1 b/c a non-electrolyte!

$T_f = -2.11°C$

$T_f° = 0°C$

$\boxed{\Delta T_f = 2.11°C}$

$2.11°C = \frac{1.86°}{\text{molal}} * m * 1$

$= 1.13$ molal unk / kg H_2O

$n_{unk} = \frac{1.13 \text{ mol unk}}{\text{kg } H_2O} \bigg| 0.050 \text{ kg } H_2O = 0.0567 \text{ mol}$

$= \frac{8.741 \text{ g unk}}{0.0567 \text{ mol unk}}$

$= \boxed{154 \text{ g/mol}}$

$\text{mass \%} = 10^2 * \frac{m_{solute}}{m_{solute} + m_{solvent}}$

↳ concentration (ppm) $= 10^6 * \frac{m_{solute}}{m_{solute} + m_{solvent}}$

ppm ← parts per million

conc (ppb) $= 10^9 * \frac{m_{solute}}{m_{solute} + m_{solvent}}$

ppb ← billion

normally ONLY used for very dilute things

↳ $m_{solute} \ll m_{solvent}$

→ what is the mole fraction of Hg in an aqueous sol'n that is 25 ppm Hg?

	m	n
Hg	25g	
H_2O	≈1,000,000 !!!	
sol'n	1,000,000 g	

Chapter 13 Number 3 (Sections 13.8) (Unit 1) 20 January 2020

1. Drinking water in the US cannot exceed 19 ppb lead (which is always in the form of Pb^{2+}). What is the molarity of lead ion, $[Pb^{2+}]$, in water that contains 19 ppb lead? Hint: Water's density is 1.0 g/cm^3.

	MM	mass, m	moles, n	Vol
Pb^{2+}	207 g/mol			
H_2O	18 g/mol			

2. Benzene, C_6H_6 has a relatively large freezing point depression constant, K_f = 5.07 deg/molal, making it a good solvent for freezing point lowering studies. The normal melting point of benzene is 5.53 °C. What is the molality of a solution that freezes at 1.25 °C?

3. What is the predicted freezing point of water that contains 50.0 g $CaCl_2$ per kg of water? (Given: K_f = 1.86 deg/molal)

	MM	mass, m	moles, n
$CaCl_2$	111 g/mol		
H_2O	18 g/mol		

4. $CHCl_3$ has a normal boiling point of 61.7 °C and a boiling point elevation constant, K_b = 3.63 deg/molal. When 2.00 g aspirin is dissolved in 50.0 g $CHCl_3$, the boiling point increases to 62.5 °C. What is the molar mass of aspirin?

5. Ionic substances rarely have the van't Hoff factor predicted from the formula. What is the van't Hoff factor for a 0.50 *m* KCl(aq) solution if it freezes at a temperature of -1.8 °C?

Questions in final exam format:

6. What volume of 0.716 M KBr solution is needed to provide 13.0 g of KBr?
   A. 6.55 mL
   B. 9.31 mL
   C. 18.5 mL
   D. 153 mL

7. Which of the following solutions will have the **lowest** freezing point?
   A. 0.0100 *m* NaCl
   B. 0.0120 *m* Li_2SO_4
   C. 0.0400 *m* $CH_3CH_2CH_2OH$
   D. 0.0150 *m* $MgCl_2$

8. Calculate the freezing point of a solution of 50.0 g methyl salicylate, $C_7H_6O_2$, dissolved in 800. g of benzene, C_6H_6. K_f for benzene is 5.10°C/*m* and the freezing point is 5.50 °C for benzene.
   A. -2.61°C B. 2.61°C
   C. 2.89°C D. 8.39°C

9. When 0.500 g of vitamin K is dissolved in 10.0 g of camphor (K_f = 40.0 °C/*m*), the freezing point of the solution is 4.43 °C lower than that of pure camphor. Assuming vitamin K is a nonelectrolyte in camphor, calculate its molar mass.
   A. 0.451 g/mol
   B. 55.4 g/mol
   C. 451 g/mol
   D. 3.54×10^4 g/mol

Now try these problems from the book:
Section 13.8. (Boiling point elevation & freezing point depression) Problems 17, 18, 90, 94, 96, 98, 100, 104, 106, 114, 116, 126, 130, 132, 134,
Practice Test (page 530) 13