Chap. 6 **Simple Mole Fraction/Molality Examples**
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$M_{Glu} = 180$ $M_{H_2O} = 18$

Mole Fraction Example (Slide #3)

What is the mole fraction of glucose in a solution prepared by adding 50 g of glucose to 200 g of water?

$n_{Glu} = 50 \times \frac{1}{180} = 0.28 \text{ mol Glu}$

$n_{H_2O} = 200g \times \frac{1 \text{ mol}}{18 g} = 11.11 \text{ mol } H_2O$

$X_{Glu} = \frac{n_{Glu}}{n_{Glu} + n_{H_2O}}$

$= \frac{0.28}{0.28 + 11.11} = 0.025$

Molality Example (Slide #5)

What is the molality of glucose in a solution prepared by adding 50 g of glucose to 200 g of water?

$n_{Glu} = 50 g \times \frac{1}{180} = 0.28 \text{ mol Glu}$

$kg\ H_2O = 200 g \times \frac{1 kg}{1000 g} = 0.20 \text{ kg } H_2O$

$m = \frac{0.28 \text{ mol Glu}}{0.20 \text{ kg } H_2O} = 1.40 \text{ mol Glu/kg solvent}$

$= 1.40 \text{ molal}$

$= 1.40\ m$

(2)

Chap. 6 **Molality/Mole Fraction Conversion (Slide #6)**
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What is X_{Gly} in an aqueous solution in which m_{Gly} = 0.20 molal?

Assume = 1 kg H_2O = 1000 g H_2O

n_{Gly} = 0.20 mol

$n_{H_2O} = 1000 g \times \frac{1 mol}{18 g} = 55.6$ mol.

$X_{Gly} = \frac{0.20}{0.2 + 55.6} = 0.0036$

Chap. 6 **Molarity Example (Slide #8)**
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What mass of aspartic acid is required to prepare
250 mL of 0.065 M aqeous solution.

$M = 133 g$

$C = \frac{n}{V}$

n

$n = C \cdot V = 0.065 \frac{mol}{L} \times 0.25 L$

$= 0.01624$ mol Asp $\times \frac{133 g}{1 mol}$

$= 2.16 g$

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Integrated Concentration Problem (Slide #9)

When 45 g Glucose (M=180) is added to 120 g H_2O,
The density of the resulting solution is 1.25 g/mL

Calculate: (A) the glucose mole fraction
(B) the glucose molality
(C) the glucose Molarity — Part C on next pg.

~~Assume 1L = 1000 mL Solution~~

(A)

$n_{Glu} = 45g/180 = 0.25 M$

$n_{H_2O} = 120g \times \frac{1M}{18g} = 6.67$

$X_{Glu} = \frac{0.25}{0.25 + 6.67} = 0.036$

$n_{Glu} = 0.25$

$m_{H_2O} = 120g \times \frac{1kg}{1000g} = 0.12 kg.$

$m = \frac{n_{Glu}}{kg\,H_2O} = \frac{0.25\,mol}{0.12\,kg} = 2.08 \frac{mol\,Glu}{kg\,H_2O}$

$= 2.08\,m$

Part C

$n_{EtOH} = 0.25\,mol$.

$Mass_{tot} = 45 + 120 = 165\,g$.

$V_{tot} = 165\,g \times \frac{1\,mL}{1.25\,g} = 132\,mL = 0.132\,L$

$C = \frac{0.25\,mol}{0.132\,L} = 1.89\,mol/L$

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Note on later Chapter 6 material:

We will not cover: Slides #38-#45: Osmotic Pressure Definitions and Real Solutions

#48: Partially Dissociated Solutes

We will also not cover #10-#12

The exam will also not cover Slides #10-#11: Chemical Potential

We WILL cover Slides #46-#47: Electrolyte Solutions

Chap. 6 **MP and BP of Antifreeze: Slide #28**
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A solution is prepared by mixing 500 g of antifreeze ethylene glycol, $HOCH_2CH_2OH$) with 500 g of water.

EG

Calculate the freezing point and boiling point of this mixture.

K_f = 1.86 °C/m
K_b = 0.51 °C/m
M(EG) = 62

$n_{EG} = 500g \times \frac{1 mol}{62 g} = 8.06 mol$

$m = \frac{8.06 \text{ mol EG}}{0.50 \text{ kg}} = 16.12 \frac{\text{mol EG}}{\text{kg } H_2O} = 16.12\ m$

F.P

$\Delta T_f = K_f m = 1.86 \frac{°C}{m} \times 16.12\ m = 30°C$

$T_f = -30°C \quad [0°C - (+30°C)]$

bp

$\Delta T_b = K_b m = 0.51 \frac{°C}{m} \times 16.12\ m$

$= 8.2°C$

$T_b = 100 + 8.2 = 108.2°C$

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Molar Mass from BP Elevation: Slide #29

(3)

The boiling point of pure benzene is 80.10 °C.
K_b(benzene) = 2.53 °C/m.

When 5.0 grams of an unknown substance, X, are added to 150 grams of benzene, the boiling point of the solution is 80.75 °C.

Calculate the molar mass of the substance.

Calc. m_x

$$m_x = \frac{\Delta T_x}{K_b} = \frac{(80.75 - 80.1)\,°C}{2.53\,°C/m} = 0.257\,m = 0.257\,\frac{mol\ x}{kg\ solvent}$$

Calc. n_x

kg solvent $150\,g \times \frac{1\,kg}{1000\,g} = 0.15\,kg$.

$$n_x = 0.257\,\frac{mol\ x}{1\,kg}\ 0.15\,kg = 0.0386\ mol\ x$$

$$M_x = \frac{mass_x}{n_x} = \frac{5.0\,g}{n_x} = \frac{5.0\,g}{0.0386\,mol}$$

$= 129.5\ g/mol$.

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Simple Osmotic Pressure Examples

$T = 37°C + 273 = 310\,K$ (4)

Slide #34: The effective concentration of blood plasma is 285 mM. Calculate the osmotic pressure of blood plasma at 37 °C (98.6 °F), in torr.

$$\Pi = [BP]RT = 0.285 \frac{mol}{L}\left(8.31 \frac{kPa \cdot L}{mol \cdot K}\right)(310\,K)$$

$$= 735\,kPa \times \frac{7.5\,torr}{1\,kPa} = 5508\,torr$$

Slide #35: A solution is prepared by dissolving 1 gram of sucrose in 1 L (= 1 kg) of water. Calculate the (a) melting point, (b) boiling point, (c) Osmotic pressure at 25 °C (in torr)

M(suc) = 342 **K_f = 1.86 °C/m** **K_b = 0.51 °C**

$$n_{Suc} = 1\,g \times \frac{1\,mol}{342\,g} = 0.0029\,mol\,Suc$$

$$m_{Suc} = \frac{0.0029\,mol\,Suc}{1\,kg\,H_2O} = 0.0029\,m$$

$$[Suc] = m_{Suc} = 0.0029\,M$$ [H_2O solvent; low conc]

$$\Delta T_f = K_f m_{Suc} = 1.86\,°C/m\,(0.0029\,m) = 0.005\,°C$$

$$T_F = 0 - 0.005 = -0.005$$

$$\Delta T_b = K_b m = 0.51\,°C/m\,(0.0029)$$

$$\Delta T_b = 0.0015\,°C$$

$$T_b = 100.0015\,°C$$

Slide 35 Cont'd. $T = 25°C = 298K$

$$\pi = CRT = [\text{Sw}]RT = 0.0029 \frac{mol}{L}\left(8.31 \frac{kPa \cdot L}{mol \cdot K}\right)(298K)$$

$$= 7.18\ kPa \times \frac{7.5\ torr}{1\ kPa} = 54\ torr$$