# 1125 Review Session

Q center

## Exam 4

1. What mass of $CuBr_2$ is needed to prepare 750.0 mL of 1.25 M solution?

$$\boldsymbol{M = \frac{mol\ solute}{L\ solution}}$$

**Conversion of mL to L:**

$$750mL\left(\frac{1L}{1000mL}\right) = 0.7500\ L$$

**Number of moles $CuBr_2$:**

$$n_{CuBr_2} = 0.7500\ L * 1.25\frac{mol}{L} = 0.9375\ mol$$

**Molar Mass of $CuBr_2$:**

$$MM = MM_{Cu} + 2 * MM_{Br} = 65.546 + 2 * 79.904 = 223.37\ g/mol$$

**Mass of $CuBr_2$:**

$$m_{CuBr_2} = 0.9375\ mol * 223.37\frac{g}{mol}$$

$$\boldsymbol{= 209.4\ g}$$

2. A solution is made by dissolving 170.1 g of glucose ($C_6H_{12}O_6$) in enough water to make a liter of solution. The density of the solution is 1.062 g/mL. Express the concentration in (a) molality, (b) percent by mass, (c) molarity.

$$\boldsymbol{m = \frac{mol\ solute}{kg\ solvent}}\ \boldsymbol{M = \frac{mol\ solute}{L\ solution}}$$

**Molar Mass of $NH_4C\ell$:**

$$MM = MM_N + 4 * MM_H + MM_{Cl} = 14.007 + 4 * 1.008 + 35.453 = 53.491\ g/mol$$

**Assuming 100 g of solution:**

$$m_{NH_4Cl} = 8.5\ g$$

$$m_{solvent} = 100 - 8.5 = 91.5\ g = 0.0915\ kg$$

**Volume of solution:**

$$V_{solution} = 100\ g * \frac{1\ mL}{1.024\ g} = 97.7\ mL = 0.0977\ L$$

**Moles of $NH_4Cℓ$:**

$$n_{NH_4Cl} = 8.5g * \frac{1mol}{53.491\ g} = 0.1589\ mol$$

**Molarity:** $M = \frac{0.1589\ mol}{0.0977\ L} = \mathbf{1.63\ M}$

**Molality:** $m = \frac{0.1589\ mol}{0.0915\ kg} = \mathbf{1.74\ M}$

3. An aqueous solution is prepared by diluting 3.30 mL acetone $CH_3COCH_3$, (d = 0.789 g/mL) with water to a final volume of 75.0 mL. The density of the solution is 0.993 g/mL. What are the molarity and molality of acetone in this solution?

$$\boldsymbol{m = \frac{mol\ solute}{kg\ solvent}}\ \boldsymbol{M = \frac{mol\ solute}{L\ solution}}$$

**Molar Mass of $CH_3COCH_3$:**

$$MM = 3 * MM_C + 6 * MM_H + MM_O = 3 * 12.011 + 6 * 1.008 + 15.999 = 58.08\ g/mol$$

**Mass and mol of Acetone:**

$$m_{CH_3OCH_3} = 3.30\ mL * 0.789\frac{g}{mL} = 2.6037\ g$$

$$n_{CH_3OCH_3} = 2.6037\ g * \frac{1\ mol}{58.08\ g} = 0.0448\ mol$$

**Volume and mass of solution:**

$$V_{solution} = 75.0\ mL = 0.0750\ L$$

$$m_{solution} = 75.0\ mL * \frac{0.993\ g}{1\ mL} = 74.475\ g$$

**Mass of solvent:**

$$m_{solvent} = 74.475 - 2.6037 = 71.87\ g = 0.07187\ kg$$

**Molarity:** $M = \frac{0.0448\ mol}{0.0750\ L} = \mathbf{0.598\ M}$

**Molality:** $m = \frac{0.0448\ mol}{0.07187\ kg} = \mathbf{0.623\ m}$

4. How many grams of oxygen can be dissolved in 1.00 L of water at 20°C if the oxygen pressure is 2.00 atm? The Henry's law constant for oxygen at 20°C is 1.38 x $10^{-3}$ M/atm.

**Henry's Law:**

$$\boldsymbol{C = kP_g}$$

**Concentration of oxygen in water:**

$$C = 1.38 \cdot 10^{-3}\frac{M}{atm} * 2.00\ atm = 2.76 \cdot 10^{-3}M$$

**Moles of oxygen in solution:**

$$n_{O_2} = 2.76 \cdot 10^{-3} \frac{mol}{L} * 1\ L = 2.76 \cdot 10^{-3}\ mol$$

**Mass of oxygen:**

$$m_{O_2} = 2.76 \cdot 10^{-3}\ mol * 32.00 \frac{g}{mol} = \mathbf{0.088\ g}$$

5. Calculate the vapor pressure of water over a solution made by dissolving 225 g of glucose in 575 g of water at 35°C (At 35 °C, $P°water$= 42.2 mmHg.)

**Vapor pressure of a solution:**

$$\boldsymbol{P_{solution} = x_{solvent} P_{solvent}}$$

**Moles of glucose in solution:**

$$MM = 6 * MM_C + 12 * MM_H + 6 * MM_O = 6 * 12.011 + 12 * 1.008 + 6 * 15.999 = 180.15\ g/mol$$

$$n_{glucose} = 225\ g * \frac{1\ mol}{180.15\ g} = 1.25\ mol$$

**Moles of water in solution:**

$$n_{O_2} = 575\ g * \frac{1\ mol}{18.016\ g} = 31.92\ mol$$

**Mol fraction of Water:**

$$x_{H_2O} = \frac{31.92\ mol}{(1.25 + 31.92)\ mol} = 0.962$$

**Vapor pressure of the solution:**

$$\boldsymbol{P_{solution}} = x_{solvent} P_{solvent} = 0.962 * 42.2\ mmHg = \mathbf{40.6\ mmHg}$$

6. An aqueous solution of 10.00 g of catalase, an enzyme found in the liver, has a volume of 1.00 L at 27°C and an osmotic pressure of 0.74 mmHg. What is the molar mass of the catalase?

$$\boldsymbol{\Pi = MRT\ M = \frac{mol\ solute}{L\ solution}\ MM = \frac{m}{n}}$$

**Molarity:**

$$\Pi = 0.74\ mmHg * \frac{1\ atm}{760\ mmHg} = 9.74 \cdot 10^{-4}\ atm$$

$$9.74 \cdot 10^{-4}\ atm = M \left(0.08206 \frac{atm\ L}{mol\ K}\right) (300.15\ K)$$

$$M = 3.95 \cdot 10^{-5}\ M$$

**Moles of catalase in solution:**

$$3.95 \cdot 10^{-5}\ M = \frac{n_{catalase}}{1.00\ L}$$

$$n_{catalase} = 3.95 \cdot 10^{-5}\ mol$$

**Molar mass:**

$$MM = \frac{10.0\ g}{3.95 \cdot 10^{-5}\ mol} = \mathbf{252959.9\ g/mol}$$

7. Consider chloroform ($CHC\ell_3$) boils at 61.7°C.

a. A solution prepared by dissolving 0.146 mol of a nonelectrolyte in 197 g of chloroform boils at 64.4°C. What is the boiling point constant ($k_b$) for chloroform.

$$\mathbf{\Delta T_b = k_b m = T_{b,solution} - T_{b,\,solvent}}$$

**Elevation in boiling point:**

$$\Delta T_b = 64.4\,°C - 61.7°C = 2.7°C$$

**Molality:**

$$m = \frac{0.146\,mol}{0.197\,kg} = 0.741m$$

**Boiling point constant ($k_b$):**

$$2.7°C = \boldsymbol{k_b}(0.741m)$$
$$\boldsymbol{k_b = 3.64\,°C/m}$$

b. In another experiment, a solution of an unknown electrolyte is prepared in chloroform. Its concentration is 0.462 m. The solution boils at 66.7°C. What is i (the Van't Hoff factor) for the electrolyte?

$$\mathbf{\Delta T_b = ik_b m = T_{b,solution} - T_{b,\,solvent}}$$

**Elevation in boiling point:**

$$\Delta T_b = 66.7\,°C - 61.7\,°C = 5\,°C$$

**Van't Hoff factor:**

$$5°C = \boldsymbol{i}\left(3.64\frac{°C}{m}\right)(0.462m)$$
$$\boldsymbol{i = 2.97\,mol}$$

8. An aqueous solution of LiX is prepared by dissolving 3.58 g of the electrolyte in 283 mL of $H_2O$ (d=1.00 g/mL). The solution freezes at -1.81 °C. What is the identity of the unknown element X? (Assume complete dissociation of LiX to $Li^+$ and $X^-$). The freezing point depression constant of water is 1.86 °C/m.

$$\mathbf{\Delta T_b = ik_b m}$$

**Molality:**

$$1.81°C = 2\left(1.86\frac{°C}{m}\right)\mathrm{m}$$
$$\mathrm{m} = 0.487\ \mathrm{m}$$

**Moles of electrolyte:**

$$283\ \mathrm{mL\ H_2O} * \frac{1\ \mathrm{g}}{1\ \mathrm{mL}} * \frac{1\ \mathrm{kg}}{1000\ \mathrm{g}} = 0.283\ \mathrm{kg}$$
$$0.487\ \mathrm{m} = \frac{n}{0.283\,kg}$$
$$n = 0.138\,mol$$

**Molar mass of the electrolyte:**

$$MM = \frac{3.58\,g}{0.138\,mol} = 25.999\frac{g}{mol} = MM_{Li} + MM_X$$
$$MM_X = 25.999 - 6.941 = \mathbf{19.05}\frac{\boldsymbol{g}}{\boldsymbol{mol}}$$

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