

CHEM 206 Tutorial 3 – Pre-Quiz Task

#1. Compare the following three aqueous solutions by completing the table below. For only the nitric acid solution, calculate the melting point and vapour pressure values at 25°C. Assume the solution's density is the same as pure water and the vapour pressure of pure water at 25°C is 23.8 mm Hg.

- 0.075 M zinc (II) nitrate, $\text{Zn}(\text{NO}_3)_2$ $\text{Zn}(\text{NO}_3)_2 \rightarrow \text{Zn}^{2+}(\text{aq}) + 2\text{NO}_3^{-}(\text{aq})$ $\text{C}_3\text{H}_8\text{O}_3$ $i=1$ [solute] = 0.120 M
- 0.120 M glycerin, $\text{C}_3\text{H}_8\text{O}_3$ $i=1+2=3$ [solute] = $3 \cdot 0.075\text{M} = 0.225\text{M}$ $\text{HNO}_3 \rightarrow \text{H}^{+}(\text{aq}) + \text{NO}_3^{-}(\text{aq})$
- 0.050 M nitric acid, HNO_3 $i=1+1=2$ [solute] = $2 \cdot 0.05\text{M} = 0.100\text{M}$

PROPERTY	Highest melting point	Highest vapour pressure
CHOICE OF SOLUTION	HNO_3	HNO_3
RELEVANT FORMULA	$\Delta T_P = i \cdot m \cdot K_F$ \rightarrow molality	$P_{\text{solution}} = X_{\text{solute}} \cdot P^{\circ}_{\text{solute}}$ \rightarrow mole fraction
BRIEF EXPLANATION (including fundamental molecular-level causes of the phenomena)	lowest concentration \rightarrow highest mp molality \uparrow ; more ΔT_P ; mp \downarrow	$X_{\text{solute}} \uparrow \rightarrow \text{VP} \uparrow$ highest VP \rightarrow highest X_{solute} \rightarrow lowest concentration of solute $n_{\text{H}_2\text{O}} = \frac{m_{\text{H}_2\text{O}}}{M_{\text{H}_2\text{O}}} = \frac{996.849\text{g}}{18.015\text{g/mol}} = 55.331\text{mol}$ $n_{\text{total}} = n_{\text{H}_2\text{O}} + i \cdot n_{\text{solute}}$ $= 55.331\text{mol} + 2 \cdot 0.050\text{mol} = 55.431\text{mol}$ $X_{\text{H}_2\text{O}} = \frac{55.331}{55.431} = 0.9982$ $P_{\text{HNO}_3 \text{ solution}} = X_{\text{H}_2\text{O}} \cdot P^{\circ}_{\text{H}_2\text{O}} = 0.9982 \cdot 23.8\text{mmHg} = 23.76\text{mmHg}$

#2. If a scuba diver is under water breathing compressed air (remember, air is 78% N_2 by mole) at a pressure of 2 atm, nitrogen gas will dissolve in the diver's blood to twice its usual concentration. If the diver returns to the surface too quickly, the N_2 may form tiny bubbles in the blood as it undissolves and re-equilibrates with the normal atmospheric nitrogen pressure. If the release of nitrogen gas from the blood is a first order process with a half-life of 9 minutes, how long will it take for 40% of the dissolved N_2 to leave the diver's blood?

$$1\text{L H}_2\text{O } P=1\text{ kg/L}$$

$$\text{total mass: } m_{\text{solution}} = P \cdot V = 1000\text{g}$$

$$m_{\text{HNO}_3} = n \cdot M = (0.050\text{mol/L} \cdot 1\text{L}) \cdot 63.018\text{g} = 3.1509\text{g}$$

$$m_{\text{H}_2\text{O}} = m_{\text{solution}} - m_{\text{HNO}_3} = 1000\text{g} - 3.1509\text{g} = 996.849\text{g}$$

$$\text{molality: } i \cdot 2 \cdot \frac{0.050\text{mol/L}}{0.996849\text{kg}} = 0.1003\text{mol/kg}$$

$$\Delta T_P = i \cdot m \cdot K_F = 2 \cdot 0.05005\text{mol/kg} \cdot 1.86^\circ\text{C} \cdot \text{kg/mol} = 0.186058^\circ\text{C} = 0.187^\circ\text{C}$$

$$\text{mp} = 0^\circ\text{C} - 0.187^\circ\text{C} = -0.187^\circ\text{C}$$

$$+ \frac{1}{2} i \cdot [A]_{t=1/2} = \frac{1}{2} [A]_0$$

$$\ln\left(\frac{1}{2}[A]_0\right) = -k \cdot t_{1/2} + \ln[A]_0$$

$$k + \frac{1}{2} \ln\left(\frac{0.5}{0.5}\right) = \ln 2 \quad \therefore \frac{1}{2} \ln 2 = \frac{k \cdot t_{1/2}}{2}$$

$$k = \frac{\ln 2}{t_{1/2}} = \frac{\ln 2}{9\text{min}} = 0.0770\text{min}^{-1}$$

$$40\% \text{ release } [\text{N}_2]_t = 0.60[\text{N}_2]_0$$

$$\ln(0.60[\text{N}_2]_0) = -k \cdot t + \ln[\text{N}_2]_0$$

$$-k \cdot t = \ln(0.60[\text{N}_2]_0) - \ln[\text{N}_2]_0 = \ln\left(\frac{0.60[\text{N}_2]_0}{[\text{N}_2]_0}\right) = \ln(0.6)$$

$$t = \frac{\ln(0.6)}{-k} = \frac{\ln(0.6)}{-0.0770} = 6.639\text{min}$$

$$\text{ISF} = 7\text{min}$$

Ctstephenmurry Ch14 1 Answers

Wolfgang Guggemos

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