CHE152
Chapter 13 - Physical Properties of Solutions Additional Problems
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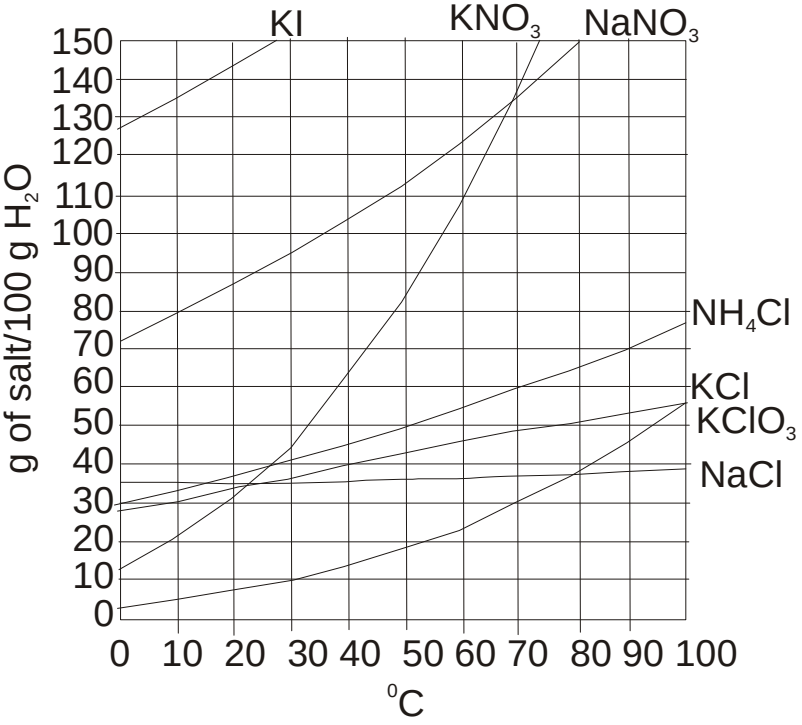
13.1 35.00 mL of an alcohol are added to sufficient water to produce 250.00 mL of solution. If the density of the alcohol is 0.8050 g/cm^3 and the density of the solution is 0.9875 g/cm^3, calculate the mass percent of the alcohol in the soution.

13.2 65.001 g of NaCl are added to sufficient water to produce 825.00 mL of solution. The mass solution is 914.100 g and the solution density is 1.108 g/cm^3. Calculate the (a) molarity and (b) molality of the solution.

13.3 150.00 g of NH_4Cl are dissolved in 250.00 g of water at 90.0 ^{0}C. If the solution is cooled to 8.0 ^{0}C, what mass of NH_4Cl will prtecipitate out of solution?



13.4 Concentrated HCl that comes from the laboratory supply house is 37.2% HCl by mass. If the density of this concentrated solution is 1.19 g/mL, what is the (a) molarity and (b) the molality of the this solution? Which calculation is approximate?

13.5 Concentrated HNO_3 that comes from the laboratory supply house is 70.0% HNO_3 by mass. If the density of this concentrated solution is 1.42 g/mL, what is the (a) molarity and (b) the molality of the this solution? Which calculation is approximate?

13.6 The vapor pressure of acetone, C_3H_6O, and hexane, C_6H_{14}, at 25.0 ^{0}C is 229.52 mmHg and 151.28 mmHg, respectively. Calculate the partial pressures of acetone and hexane at 25.0 ^{0}C over a solution of acetone and hexane, in which the mole fraction of acetone is 0.568.

13.7 The vapor pressure of benzene, C_6H_6, and diethylether, $C_4H_{10}O$, at 35.0 ^{0}C is 153.52 mmHg and 724.47 mmHg, respectively. Calculate the partial pressures of benzene and diethylether at 35.0 ^{0}C over a solution of benzene and diethylether, in which the mole fraction of benzene is 0.725.

$$13.1\ \frac{35.00\text{ mL alcohol}}{1}\ \text{x}\ \frac{0.8050\text{ g alcohol}}{1\text{ mL alcohol}} = 28.17_5\text{ g alcohol}$$

$$\frac{250.00\text{ mL soln}}{1}\ \text{x}\ \frac{0.9875\text{ g soln}}{1\text{ mL soln}} = 246.8_{75}\text{ g soln}$$

$$\frac{28.17_5\text{ g alcohol}}{246.8_{75}\text{ g soln}}\ \text{x}\ 100 = 11.41\%\text{ alcohol (m/m)}$$

$$13.2\ \frac{65.001\text{ g NaCl}}{1}\ \text{x}\ \frac{1\text{ mol NaCl}}{58.452\text{ g NaCl}} = 1.1120\text{ mol NaCl}$$

$$825.00\text{ mL} = 0.82500\text{ L}$$

$$\text{M} = \frac{1.1120\text{ mol NaCl}}{0.82500\text{ L}} = \frac{1.3479\text{ mol NaCl}}{\text{L}}$$

$$\text{g } H_2O = 914.100\text{ g soln} - 65.001\text{ g NaCl} = 849.099\text{ g} = 0.849099\text{ kg}$$

$$\text{m} = \frac{1.1120\text{ mol NaCl}}{0.849099\text{ kg}} = \frac{1.3096\text{ mol NaCl}}{\text{kg}}$$

$$13.3\ \text{at } 8.0\ ^0\text{C the solubilty of } NH_4Cl\text{ is}: \frac{34\text{ g } NH_4Cl}{100\text{ g } H_2O}$$

$$\frac{34\text{ g } NH_4Cl}{100\text{ g } H_2O}\ \text{x}\ \frac{250.0\text{ g } H_2O}{1} = 85\text{ g } NH_4Cl\text{ (remain in solution)}$$

$$150.00\text{ g } NH_4Cl - 85\text{ g } NH_4Cl = 65\text{ g } NH_4Cl\text{ (come out of solution)}$$

13.4 Assume 100.0 g of conc. HCl.

$$\frac{\mathbf{100.0\ g\ conc\ HCl}}{\mathbf{1}} \mathbf{x} \frac{\mathbf{37.2\ g\ HCl}}{\mathbf{100.0\ g\ conc\ HCl}} \mathbf{x} \frac{\mathbf{1\ mol\ HCl}}{\mathbf{36.461\ g\ HCl}} = \mathbf{1.02\ mol\ HCl}$$

$$\frac{\mathbf{100.0\ g\ conc\ HCl}}{\mathbf{1}} \mathbf{x} \frac{\mathbf{1\ mL}}{\mathbf{1.19\ g\ conc\ HCl}} \mathbf{x} \frac{\mathbf{10^{-3}\ L}}{\mathbf{mL}} = \mathbf{0.0840\ L}$$

$$\frac{\mathbf{1.02\ mol\ HCl}}{\mathbf{0.0840\ L}} = \frac{\mathbf{12.1\ mol\ HCl}}{\mathbf{L}}$$

100.0 g conc HCl – 37.2 g HCl = 62.8 g H_2O = 0.0628 kg H_2O

$$\frac{\mathbf{1.02\ mol\ HCl}}{\mathbf{0.0}628\ \mathbf{L}} = \frac{16.2\ \text{mol HCl}}{\text{kg}}$$

Both are exact.

13.5 Assume 100.0 g of concentrated HNO_3 solution.

$$\frac{\mathbf{100.0\ g\ conc\ HNO_3}}{\mathbf{1}} \mathbf{x} \frac{\mathbf{70.0\ g\ HNO_3}}{\mathbf{100.0\ g\ conc\ HNO_3}} \mathbf{x} \frac{\mathbf{1\ mol\ HNO_3}}{\mathbf{63.013\ g\ HNO_3}} = \mathbf{1.11\ mol\ HNO_3}$$

$$\frac{\mathbf{100.0\ g\ conc\ HNO_3}}{\mathbf{1}} \mathbf{x} \frac{\mathbf{1\ mL}}{\mathbf{1.42\ g\ conc\ HNO_3}} \mathbf{x} \frac{\mathbf{10^{-3}\ L}}{\mathbf{mL}} = \mathbf{0.0704\ L}$$

$$\frac{\mathbf{1.11\ mol\ HNO_3}}{\mathbf{0.0704\ L}} = \frac{\mathbf{15.8\ mol\ HNO_3}}{\mathbf{L}}$$

$$\mathbf{100.0\ g\ conc\ HNO_3} - \mathbf{70.0\ g\ HNO_3} = 30.0\ \text{g}\ H_2O = 0.0300\ \text{kg}\ H_2O$$

$$\frac{\mathbf{1.11\ mol\ HNO_3}}{0.0300\ \text{kg}\ H_2O} = \frac{37.0\ \text{mol}\ HNO_3}{\text{kg}}$$

Both are exact.

13.6 $P_i = \chi_i \text{ x } P_i^0$

$P_{aceone} = 0.568 \text{ x } 229.52\ \text{mmHg} = 1.30 \text{ x } 10^2\ \text{mmHg}$

$P_{hexane} = \underbrace{(1.000 - 0.568)}_{0.432} \text{ x } 151.28\ \text{mmHg} = 65.4\ \text{mmHg}$

13.7 $P_i = \chi_i \text{ x } P_i^0$

$P_{benzene} = 0.725 \text{ x } 153.52\ \text{mmHg} = 111\ \text{mmHg}$

$P_{hexane} = \underbrace{(1.000 - 0.725)}_{0.275} \text{ x } 724.47\ \text{mmHg} = 199\ \text{mmHg}$