Practice Problems on **Recrystallization**

KEY

1. The solubility of *p*-nitroaniline in water is as follows:

2.22	g/100 mL hot water
0.08	g/100 mL cold water

If you wanted to recrystallize 1.75 g of *p*-nitroaniline,

(a) what is the minimum amount of water needed?

$$(1.75 \text{ g solid})\left(\frac{100 \text{ mL water}}{2.22 \text{ g solid}}\right) = \boxed{78.8 \text{ mL}} \text{ of water}$$

(b) how many grams of *p*-nitroaniline, out of the original 1.75 g, could be recovered from 80.0 mL of water?

$$(80.0 \text{ mL } H_2O)\left(\frac{0.08 \text{ g solid}}{100 \text{ mL } H_2O}\right) = 0.064 \text{ g left in solution}$$

$$1.75 - 0.064 = \boxed{1.69 \text{ g}} \text{ recovered}$$

2. The solubility of quercetin in alcohol is as follows:

5.5	g/100 mL hot alcohol
0.40	g/100 mL cold alcohol

If you wanted to recrystallize 2.67 g of quercetin

(a) what is the minimum amount of alcohol needed?

$$(2.67 \text{ g solid})\left(\frac{100 \text{ mL alcohol}}{5.5 \text{ g solid}}\right) = \bar{4}8.545 \text{ mL} = \boxed{49 \text{ mL}} \text{ of alcohol}$$

(b) how many grams of quercetin, out of the original 2.67 g, could be recovered from 50.0 mL of alcohol?

$$(50.0 \text{ mL alcohol})\left(\frac{0.40 \text{ g solid}}{100 \text{ mL alcohol}}\right) = 0.20 \text{ g left in solution}$$

$$2.67 - 0.20 = \boxed{2.47 \text{ g}} \text{ recovered}$$

CHEM 3312
SOLUTION CONCENTRATION
Answers to exercises

1. How many milliliters of 12.0 M aqueous HCl solution (concentrated hydrochloric acid) would be required to prepare 150 mL of 0.600 M HCl solution?

$$(\text{150 mL dilute sol'n})\left(\frac{\text{0.600 mmole HCl}}{\text{1 mL dilute sol'n}}\right) = \text{90.0 mmole HCl}$$

$$(\text{90.0 mmole HCl})\left(\frac{\text{1 mL conc. sol'n}}{\text{12.0 mmole HCl}}\right) = \textbf{7.50 mL conc. sol'n}$$

2. If 10.0 mL of 0.520 M glucose solution is diluted to 40.0 mL, what is the final concentration of glucose?

$$(\text{10.0 mL conc. sol'n})\left(\frac{\text{0.520 mmole glucose}}{\text{1 mL conc. sol'n}}\right) = \text{5.20 mmole glucose}$$

$$\frac{\text{5.20 mmole glucose}}{\text{40.0 mL dil. sol'n}} = \text{0.130 mmole glucose / mL dil. sol'n}$$

$$= \textbf{0.130 M}$$

3. How would you prepare 250 mL of a 1.64 M solution of Na_2CO_3 (106.0 g/mole)?

$$(\text{250 mL sol'n})\left(\frac{\text{1 L sol'n}}{\text{1000 mL sol'n}}\right)\left(\frac{\text{1.64 moles } Na_2CO_3}{\text{1 L sol'n}}\right)\left(\frac{\text{106.0 g } Na_2CO_3}{\text{1 mole } Na_2CO_3}\right) = 43.\bar{4}6 \text{ g } Na_2CO_3$$

Dissolve 43.5 g of Na_2CO_3 in enough water to make 250 mL of solution.

4. Calculate both the molarity and the molality for an 8.000 % *w/w* aqueous solution of NaCl (58.44 g/mole) for which the density is 1.056 g/mL.

$$\left(\frac{\text{8.000 g NaCl}}{\text{100 g sol'n}}\right)\left(\frac{\text{1.056 g sol'n}}{\text{1 mL sol'n}}\right)\left(\frac{\text{1000 mL sol'n}}{\text{1 L sol'n}}\right)\left(\frac{\text{1 mole NaCl}}{\text{58.44 g NaCl}}\right)$$

$$= 1.44\bar{5}6 \text{ mole NaCl / L sol'n} = \textbf{1.446 M}$$

$$\left(\frac{\text{8.000 g NaCl}}{\text{92.000 g solvent}}\right)\left(\frac{\text{1000 g solvent}}{\text{1 kg solvent}}\right)\left(\frac{\text{1 mole NaCl}}{\text{58.44 g NaCl}}\right) = 1.48\bar{7}96 \text{ mole NaCl / kg solvent}$$

$$= \textbf{1.488 m}$$

$$\begin{array}{r} 100.0000000\ldots \\ -\quad 8.000 \\ \hline 92.000 \end{array}$$

Practice Problems on EXTRACTION

1. For compound **Y**, the distribution coefficient (methylene chloride/water) is 8.00. Calculate the amount of **Y** that could be extracted from a solution containing 3.00 g of **Y** in 100 mL of water by

   (a) a single extraction with 100 mL of methylene chloride.

   x = amount of Y extracted.

   $$\frac{x/100}{(3 - x)/100} = 8 \qquad \frac{x}{3 - x} = 8$$

   $$x = (8)(3 - x) \qquad x = 24 - 8x \qquad 9x = 24 \qquad x = \mathbf{2.67}\text{ g}$$

   (b) two successive extractions, each with 50 mL of methylene chloride.

   $$\frac{x_1/50}{(3 - x_1)/100} = 8 \qquad \frac{2x_1}{3 - x_1} = 8$$

   $$2x_1 = (8)(3 - x_1) \qquad 2x_1 = 24 - 8x_1$$

   $$10x_1 = 24 \qquad x_1 = \mathit{2.40}\text{ g}$$

   $$3.00 - 2.40 = 0.60\text{ g}$$

   $$\frac{x_2/50}{(0.6 - x_2)/100} = 8 \qquad \frac{2x_2}{0.6 - x_2} = 8$$

   $$2x_2 = (8)(0.6 - x_2) \qquad 2x_2 = 4.8 - 8x_2$$

   $$10x_2 = 4.8 \qquad x_2 = \mathit{0.480}\text{ g}$$

   $$\text{Total} = \mathit{2.40} + \mathit{0.480} = \mathbf{2.88\text{ g}}$$

2. For compound **X**, the distribution coefficient (methylene chloride/water) is 1.00. Calculate the amount of **X** that could be extracted from a solution containing 1.00 g of **X** in 100 mL of water by

   (a) a single extraction with 100 mL of methylene chloride.

   x = amount of X extracted.

   $$\frac{x/100}{(1 - x)/100} = 1 \qquad \frac{x}{1 - x} = 1$$

   $$x = (1)(1 - x) \qquad x = 1 - x \qquad 2x = 1 \qquad x = \mathbf{0.500}\text{ g}$$

   (b) two successive extractions, each with 50 mL of methylene chloride.

   $$\frac{x_1/50}{(1 - x_1)/100} = 1 \qquad \frac{2x_1}{1 - x_1} = 1$$

   $$2x_1 = (1)(1 - x1) \qquad 2x_1 = 1 - x_1$$

   $$3x_1 = 1 \qquad x_1 = \mathit{0.333}\text{ g } (1/3)$$

   $$1.00 - 0.333 = 0.67\text{ g } (2/3)$$

   $$\frac{x_2/50}{(2/3 - x_2)/100} = 1 \qquad \frac{2x_2}{2/3 - x_2} = 1$$

   $$2x_2 = (1)(2/3 - x_2) \qquad 2x_2 = 2/3 - x_2$$

   $$3x_2 = 2/3 \qquad x_2 = 2/9 = \mathit{0.222}\text{ g}$$

   $$\text{Total} = 1/3 + 2/9 = 3/9 + 2/9 = 5/9 = \mathbf{0.556}\text{ g}$$