Chemistry H

Exercise 12.3c(H)

Solution Concentration Matrix - Answers

Name: _____

Date: _____ Per: _____

DIRECTIONS: Fill in the table below with information relating to solution concentrations.

m	*Definition*	*Ratio*	*Multiplier?*	*Unit / Symbol*	*Write as a Ratio*
Percent by Mass	*You look it up.*	*grams solute / total grams sol'n*	*100*	*%*	3.52% *3.52 g solute / 100 g sol'n*
Percent by Volume	*You look it up.*	*mL solute / total mL sol'n*	*100*	*%*	78.2% *78.2 mL solute / 100 mL sol'n*
Molarity	*You look it up.*	*mol solute / L sol'n*	*N/A*	*M*	3.40 M *3.40 mol solute / 1 L sol'n*
Molality	*You look it up.*	*mol solute / kg sol'n*	*N/A*	*m*	3.20 m *3.20 mol solute / 1 kg sol'n*
Mole Fraction	*You look it up.*	*mol solute / total mol sol'n*	*N/A*	*X*	0.333 *0.333 mol solute / 1 mol sol'n*
Parts per Million	*You look it up.*	*units solute / $1x10^6$ units sol'n*	*1 000 000*	*PPM*	23 PPM *23 units solute / $1x10^6$ units sol'n*
Parts per Billion	*You look it up.*	*units solute / $1x10^9$ units sol'n*	*1 000 000 000*	*PPB*	10 PPB *10 units solute / $1x10^9$ units sol'n*
Mass/Volume	*You look it up.*	*mass solute / volume sol'n*	*N/A*	*mass unit / volume unit*	35 g/L *35 g solute / 1 L sol'n*

DIRECTIONS: Answer the following in the space provided.

1. What do all the solution concentrations have in common? *They are ratios of solute to either total solution or solvent.*
2. How is molality different from the other solution concentrations? *It compares solute to solvent instead of total solution.*
3. Which solution concentrations have a multiplier used in their formula? *The "parts per" concentrations – parts per million, parts per billion, and percentages (which are basically parts per hundred).*
4. How are molarity, molality and mole fraction similar? *The solute is represented in moles.*
5. Which solution concentration expression is related to density? How are they related? *Mass/volume is the same ratio used to define density, so they appear to be the same. Density, however, is the ratio describing the entirety of a single sample of matter. Mass/volume as a unit of concentration only describes the density of the solute within the solution – it does not include the mass of solvent.*

Exercise 12.3c

Solution Concentration Matrix

Name: _____

Date: _____ Per: _____

DIRECTIONS: Assume you are dissolving 12.6 g of carbon tetrachloride, CCl_4, in half a liter of benzene (C_6H_6).

	CCl_4	C_6H_6
Density	1.59 g/mL	0.876 g/mL

6. Calculate the volume of carbon tetrachloride used.

Density of CCl_4 = 1.59g/mL

$$\frac{12.6\text{ g } CCl_4 \quad \left| \quad \frac{1\text{ mL } CCl_4}{1.59\text{ g } CCl_4}\right.}{} = 7.924\text{ mL } CCl_4 \Rightarrow \boxed{7.92\text{ mL}}$$

7. Calculate the mass of benzene used.

Density of C_6H_6 = 0.876g/mL

$$\frac{500\text{ mL } C_6H_6 \quad \left| \quad \frac{0.876\text{ g } C_6H_6}{1\text{ mL } C_6H_6}\right.}{} = \boxed{438\text{ g } C_6H_6}$$

8. Calculate the solution concentration in each of the following systems:

a. Percent by mass

$$\frac{12.6\text{ g } CCl_4}{(12.6\text{ g } CCl_4 + 438\text{ g } C_6H_6)} \times 100 = 2.796\% \Rightarrow \boxed{2.80\%}$$

b. Percent by volume

$$\frac{7.924\text{ mL } CCl_4}{(7.924\text{ mL } CCl_4 + 500\text{ mL } C_6H_6)} \times 100 = 1.560\% \Rightarrow \boxed{1.56\%}$$

c. Molarity

$$\text{Molarity} = \frac{\text{mol solute}}{\text{liters solution}} = \frac{0.08191\text{ mol } CCl_4}{0.5079\text{ L solution}} = 0.1612\ M \Rightarrow \boxed{0.161\ M}$$

$$\text{mol solute} = \frac{12.6\text{ g } CCl_4 \quad \left| \quad \frac{1\text{ mol } CCl_4}{153.823\text{ g } CCl_4}\right.}{} = 0.08191\text{ mol } CCl_4$$

L solution = volume of solute (7.924mL) + volume solvent (500mL) = 507.924 mL ⇒ 507.9 mL ⇒ 0.5079 L

d. Molality

$$\text{Molality}(m) = \frac{\text{mol solute}}{\text{kg solvent}} = \frac{0.08191\text{ mol } CCl_4}{0.438\text{ kg } C_6H_6} = 0.1870\ m \Rightarrow \boxed{0.187\ m}$$

e. Mole fraction

$$\text{Mole fraction (X)} = \frac{\text{Mol solute}}{\text{Total moles solution}} = \frac{0.08191\text{ mol } CCl_4}{(0.08191\text{ mol } CCl_4 + 5.607\text{ mol } C_6H_6)} = 0.01440 \Rightarrow \boxed{0.0144}$$

$$\text{mol solute} = \frac{438\text{ g } C_6H_6 \quad \left| \quad \frac{1\text{ mol } C_6H_6}{78.114\text{ g } C_6H_6}\right.}{} = 5.607\text{ mol } C_6H_6$$

f. Parts per million (mass)

$$\frac{12.6\text{ g } CCl_4}{(12.6\text{ g } CCl_4 + 438\text{ g } C_6H_6)} \times 1\,000\,000 = 27962\text{ PPM} \Rightarrow \boxed{2.80 \times 10^4\text{ PPM}}$$

g. Parts per billion (mass)

$$\frac{12.6\text{ g } CCl_4}{(12.6\text{ g } CCl_4 + 438\text{ g } C_6H_6)} \times 1\,000\,000\,000 = 27962716\text{ PPM} \Rightarrow \boxed{2.80 \times 10^7\text{ PPB}}$$

Answers: 6) 7.92 mL 7) 438 g 8a) 2.80% b) 1.56% c) 0.161 *M* d) 0.187 *m* e) 0.0144 f) 2.80×10^4 *ppm* g) 2.80×10^7 *ppb*