12.91, p 520

56 grams of a sample contain 0.51 mole fraction propane and the remainder butane. What are the masses of propane and butane in the sample?

Know: $X_{C_3H_8} = 0.51$

$X_{C_4H_{10}} = 1 - 0.51 = 0.49$

Want: mass C_3H_8

mass C_4H_{10}

How do we get from mole fraction to the masses in the sample?

$X_{C_3H_8} = 0.51 = \frac{\text{moles } C_3H_8}{\text{total moles}}$

let's assume ... FOR NOW ... that we have a mole of solution!

$\text{mol } C_3H_8 = 0.51 \times 1 = 0.51 \text{ mol } C_3H_8$

$\text{mol } C_4H_{10} = 0.49 \times 1 = 0.49 \text{ mol } C_4H_{10}$

Now, let's convert these to masses! We need formula weights.

C_3H_8: 44.094 g/mol | C_4H_{10}: 58.12 g/mol

$g\ C_3H_8: 0.51 \text{ mol } C_3H_8 \times \frac{44.094 \text{ g}}{\text{mol}} = 22.48794 \text{ g } C_3H_8$

$g\ C_4H_{10}: 0.49 \text{ mol } C_3H_8 \times \frac{58.12 \text{ g}}{\text{mol}} = 28.4788 \text{ g } C_4H_{10}$

50.96674 g total

Use the ratio of mass butane/total mass and mass propane/total mass to find the actual butane and propane content of the sample!

$$g\ C_3H_8:\ 0.51\ mol\ C_3H_8 \times \frac{44.094\ g}{mol} = 22.48794\ g\ C_3H_8$$

$$g\ C_4H_{10}:\ 0.49\ mol\ C_3H_8 \times \frac{58.12\ g}{mol} = 28.4788\ g\ C_4H_{10}$$

$$50.96674\ g\ total$$

56 g of sample, so ...

$$56\ g \times \frac{22.48794\ g\ C_3H_8}{50.96674\ g\ total} = 24.7\ g\ C_3H_8$$

$$56\ g \times \frac{28.4788\ g\ C_4H_{10}}{50.96674\ g\ total} = 31.2\ g\ C_4H_{10}$$

So the composition of the sample is 25 g propane, 31 g butane.

12.103, p 521

Commercial sulfuric acid (98% by mass) is 18 M. What is the density of the solution, and what is the molality?

want: density = $\frac{\text{mass solution}}{\text{volume solution}}$

know: $18\,M = \frac{\text{mol } H_2SO_4}{\text{L solution}}$

$98\% = \frac{\text{g } H_2SO_4}{100\text{g solution}}$

Let's assume we have 1 L of solution.

$\frac{18 \text{ mol } H_2SO_4}{L} \times 1L = 18 \text{ mol } H_2SO_4$

We need to find mass solution. To do that, we'll first calculate the mass of sulfuric acid.

H_2SO_4: 98.086 g/mol

$18\text{mol } H_2SO_4 \times \frac{98.086\text{g}}{\text{mol}} = 1765.548 \text{ g } H_2SO_4$

Find mass solution

$1765.548\text{g} = 0.98 \times \text{mass solution}$

98% of the solution is sulfuric acid!

$1801.5796\text{g} = \text{mass solution}$

Find density

$\text{density} = \frac{\text{mass solution}}{\text{volume solution}} = \frac{1801.5796\text{g}}{1000\text{mL}} = \boxed{1.8 \text{ g/mL}}$

$$\text{molality} = \frac{\text{mol } H_2SO_4}{\text{kg } H_2O}$$

If we keep our assumption of 1L of solution, we know the moles sulfuric acid is 18 mol. We also know the mass of sulfuric acid AND the total mass of the solution!

Find mass water by subtraction:

$$1801.5796\text{ g solution} - 1765.548\text{ g } H_2SO_4 = 36.03154\text{ g } H_2O$$

or, $0.03603154\text{ kg } H_2O$

$$\text{molality} = \frac{\text{mol } H_2SO_4}{\text{kg } H_2O} = \frac{18\text{ mol } H_2SO_4}{0.03603154\text{ kg } H_2O} = \boxed{5\bar{0}0\text{ m } H_2SO_4}$$

KINETICS

- the study of the RATE of chemical reactions. Or, the study of the factors affecting how fast chemical reactions proceed.

DEFINING RATE

- RATE is defined as the change in the molar (M) concentration of a reactant or product over time. Usually, rate is defined in terms of one of the REACTANTS

$$A + B \longrightarrow C$$

...Let's look at a simple combination

$$\text{Rate} = \frac{-\Delta [A]}{\Delta t}$$

$[A]$ = "molar concentration of substance "A".

Square brackets ( ) are used to denote MOLAR concentration

Δt: change in time

Negative sign because we define the rate as a POSITIVE number, and (A) will decrease over time!

$$\text{Rate} = \frac{\Delta [C]}{\Delta t}$$

You could ALSO define the rate in terms of the disappearance of B or the appearance of C over time! Our choice of A was arbitrary,

THE RATE LAW

- We express the rate of reaction using an equation called the RATE LAW.

$$A + B \rightarrow C$$

$$Rate = -\frac{\Delta[A]}{\Delta t} = k \times [A]^p \times [B]^q$$

This is the RATE CONSTANT. It depends on TEMPERATURE, but does not depend on the CONCENTRATION of any reactant or product.

"p" and "q" are called REACTION ORDERS. They indicate the effect a particular reactant or catalyst has on the rate of a reaction. Reaction orders may be positive, zero (in which case the substance has NO effect on rate) and negative (in which case the substance actually slows the reaction down).

- Rate laws depend on CONCENTRATION of reactants. Since the concentrations of reactants CHANGE throughout the course of the reaction, so does the rate!

- RATE CONSTANTS and REACTION ORDERS are determined experimentally. If you do experiment 13 (the iodine clock reaction), you will see how this can be done in the lab via the INITIAL RATES METHOD.