Chapter 10 & 11 − Review Set

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1. If the mass percent of KOH is 22% and density is 1.52 $\left[\frac{\text{g}}{\text{mL}}\right]$, what is the molality?

$$\begin{aligned} 1000[\text{mL}] &\rightarrow 1520[\text{g}_{total}] \\ .22 \cdot 1520 &= 334.4[\text{g}_{\text{KOH}}] \\ 1520 - 334.4 &= 1185.6[\text{g}_{\text{H}_2\text{O}}] \\ \frac{334.4}{39+16+1} &= 5.97[\text{mol}] \\ \frac{5.97}{1.186} &= 5.03[\text{M}] \end{aligned} \tag{1}$$

2. The molality of $C_{12}H_{22}O$ in water is 1.62 $\left[\frac{\text{mol}}{\text{kg}}\right]$. What is the mass percent of the solute?

$$\begin{aligned} 1.62[\text{mol}_{\text{C}_{12}\text{H}_{22}\text{O}}] &\rightarrow 1[\text{kg}] \\ 1.62 \cdot 182 &= 294.84[\text{g}] \\ 1000 + 294.84 &= 294.84[\text{g}_{\text{H}_2\text{O}}] \\ \frac{294.84}{1294.84} &= 23\% \end{aligned} \tag{2}$$

3. Calculate the mass of HCl in 5.0[mL] of concentrated hydrochloric acid (density = 1.19 $\left[\frac{\text{g}}{\text{mL}}\right]$) containing 37.23% HCl by mass.

$$\begin{aligned} 5 \cdot 1.19 &= 5.95 \\ 5.95 \cdot .3723 &= 2.2[\text{g}] \end{aligned} \tag{3}$$

4. A dilute sulfuric acid solution that is 3.39[M] H_2SO_4 has a density of 1.18 $\left[\frac{\text{g}}{\text{mL}}\right]$. How many moles of H_2SO_4 are there in 375[mL] of this solution?

$$\begin{aligned} 1.18 \cdot 375 &= 442.5[\text{g}] \\ .4425 \cdot 3.39 &= 1.5[\text{mol}] \end{aligned} \tag{4}$$

5. Calculate the mass percent of H_2SO_4 in a 6.80[M] solution.

6. The mole fraction of C_2H_5OH in a water solution is 0.0532. Calculate the molality of C_2H_5OH.

$$\begin{aligned} \frac{.0532}{x - .0532} &= .0532 \\ x &= .9468\,[\text{mol}] \\ 18 \cdot .9468 &= 17.0424[\text{g}] \\ \frac{.0532}{.017} &= 3.12[\text{M}] \end{aligned} \tag{6}$$

7. How long will it take a first order substance with $k = 0.45\left[\frac{1}{\text{s}}\right]$ to be reduced to 33% of the original concentration?

$$\begin{aligned} t &= \frac{\ln(3)}{.45} \\ &= 2.44[\text{s}] \end{aligned} \tag{7}$$

8. How long will it take a first order substance with $k = 0.88\left[\frac{1}{\text{s}}\right]$ to be reduced to 1/8 of original?

$$\begin{aligned} t &= \frac{\ln(8)}{.88} \\ &= 2.36[\text{s}] \end{aligned} \tag{8}$$

9. The decomposition of CO_2 is second order with a rate of $0.008\left[\frac{\text{mol}}{\text{L s}}\right]$ when the concentration is 0.12[M]. Calculate the rate when the concentration of CO_2 is 0.25[M].

$$\begin{aligned} .008 &= k[.12]^2 \\ k &= .555\left[\frac{\text{L}}{\text{mol s}}\right] \\ rate &= .555 \cdot [.25]^2 \\ &= .0347\left[\frac{\text{M}}{\text{s}}\right] \end{aligned} \tag{9}$$

10. Given the following data for the reaction of BF with H_2, calculate k

[BF]	[H_2]	Rate
0.1	0.1	0.0341
0.2	0.233	0.159
0.2	0.0750	0.0512

$$\begin{aligned}
\frac{.0512}{.159} &= \left(\frac{.075}{.233}\right)^m \\
m &= 1 \\
\frac{.0341}{.0512} &= \left(\frac{.1}{.075}\right)\left(\frac{.1}{.2}\right)^n \\
n &= 1 \\
.0512 &= k[.075][.2] \\
k &= 3.41\left[\frac{1}{\mathrm{M\,s}}\right]
\end{aligned} \tag{10}$$

11. Which step must be the rate-determining step in the following mechanism if the rate law is $Rate = k[H_2][NO]^2$?

$$\begin{aligned}
2\,NO &\longrightarrow N_2O_2 \\
N_2O_2 + H_2 &\longrightarrow N_2O + H_2O \\
N_2O + H_2 &\longrightarrow N_2 + H_2O
\end{aligned}$$

Step Two