Chapter 3 Review Sheet

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1. Answer the following for 25[g] of sulfuric acid (H_2SO_4):

   (a) The number of grams of oxygen (1)

$$\begin{aligned} \frac{64}{98} &= .653 \\ .653 \cdot 25[\text{g}] &= 16.325[\text{g}_\text{O}] \end{aligned} \tag{1}$$

   (b) The number of molecules of sulfuric acid (2)

$$\begin{aligned} \frac{25}{98} &= .255[\text{mol}_{\text{H}_2\text{SO}_4}] \\ \text{H}_2\text{SO}_{4molecules} &= .255 \cdot 6.022 \cdot 10^{23} \\ &= 1.54 \cdot 10^{23}[\text{H}_2\text{SO}_4] \end{aligned} \tag{2}$$

   (c) The number of atoms of hydrogen (3)

$$\begin{aligned} &\text{2 H atoms in } \text{H}_2\text{SO}_4 \\ \text{H}_{atoms} &= 2 \cdot 1.54 \cdot 10^{23} \\ &= 3.08 \cdot 10^{23}[\text{H}_{atoms}] \end{aligned} \tag{3}$$

2. Calculate the mass percent of hydrogen in $(NH_4)_2SO_4$ (4)

$$\frac{8}{132} \cdot 100\% = 6\% \tag{4}$$

3. A sample of a compound that contains Cl and O reacts with excess hydrogen to give 0.233[g] of HCl and 0.403[g] of water. Determine the empirical formula (5)

$$\begin{aligned} \text{mol}_{\text{Cl}} &= \frac{.233}{36} \\ &= .0064[\text{mol}_{\text{Cl}}] \\ \text{mol}_{\text{O}} &= \frac{.403}{18} \\ &= .022[\text{mol}_{\text{O}}] \\ \text{Cl}_{\frac{.022}{.0064}}\,\text{O}_{\frac{.0064}{.0064}} &= \text{Cl}_2\text{O}_7 \end{aligned} \tag{5}$$

4. When 0.273[g] of magnesium is heated in nitrogen gas a compound forms that weights 0.378[g]. Calculate the empirical formula (6).

$$\begin{aligned} \text{Mg} + \text{N}_2 &\longrightarrow \text{MgN}_2 \\ m_{\text{N}_2} &= .378 - .273 \\ &= .105[\text{g}_{\text{N}_2}] \\ \text{mol}_{\text{N}_2} &= \frac{.105}{28} \\ &= .00375[\text{mol}_{\text{N}_2}] \\ \text{mol}_{\text{Mg}} &= \frac{.273}{24} \\ &= .0114[\text{mol}_{\text{Mg}}] \\ \text{Mg}_{\frac{.0114}{.00375}}\,\text{N}_{2\,\frac{.00375}{.00375}} &\rightarrow \text{Mg}_3\text{N}_2 \end{aligned} \tag{6}$$

5. Find the formula of the hydrated compound $\text{MgCl}_2 n(\text{H}_2\text{O})$ with the following data when it is heated (7): Mass of empty dish = 22.347[g]; Initial mass of sample and dish = 25.825[g]; Mass of sample and dish after heating = 23.976[g].

$$
\begin{aligned}
m_{\mathrm{MgCl_2}} &= 23.976 - 22.347 \\
&= 1.629[\mathrm{g_{MgCl_2}}] \\
\mathrm{mol_{MgCl_2}} &= \frac{1.629}{94} \\
&= .0173[\mathrm{mol_{MgCl_2}}] \\
m_{\mathrm{MgCl_2}n(\mathrm{H_2O})} &= 25.825 - 22.347 \\
&= 3.478[\mathrm{g_{MgCl_2}}n(\mathrm{H_2O})] \\
m_{n\,(\mathrm{H_2O})} &= 3.478 - 1.629 \\
&= 1.849[\mathrm{g_{H_2O}}] \\
\mathrm{mol_{H_2O}} &= \frac{1.849}{18} \\
&= .102[\mathrm{mol_{H_2O}}] \\
\left(\frac{.0173}{.0173}\right)\mathrm{MgCl_2}\left(\frac{.102}{.0173}\right)\mathrm{H_2O} &\rightarrow \mathrm{MgCl_2}\cdot 6\,\mathrm{H_2O}
\end{aligned}
\tag{7}
$$

6. $NaNO_2$ and carbon dioxide are prepared by passing nitrogen monoxide and oxygen into a solution of sodium carbonate. How many grams of $NaNO_2$ are produced if you start with 50 grams of each reactant? (8)

$$
\begin{aligned}
4\,\mathrm{NO} + \mathrm{O_2} + 2\,\mathrm{Na_2CO_3} &\longrightarrow 4\,\mathrm{NaNO_2} + 2\,\mathrm{CO_2} \\
\mathrm{mol_{NO}} &= \frac{50}{30}\cdot .25 \\
&= .417[\mathrm{mol_{NO}}] \\
\mathrm{mol_{Na_2CO_3}} &= \frac{50}{106}\cdot .5 \\
&= .236[\mathrm{mol_{Na_2CO_3}}] \\
\mathrm{mol_{O_2}} &= \frac{50}{32} \\
&= 1.5625[\mathrm{mol_{O_2}}] \\
m_{\mathrm{NaNO_2}} &= 70\cdot 4\cdot .236 \\
&= 66[\mathrm{g_{NaNO_2}}]
\end{aligned}
\tag{8}
$$

7. Calculate the theoretical yield of ZnS, in grams, that can be made from 0.488[g] of Zn and 0.503[g] of sulfur (9).

$$
\begin{aligned}
8\,\mathrm{Zn} + \mathrm{S_8} &\longrightarrow 8\,\mathrm{ZnS} \\
\mathrm{mol_{Zn}} &= \frac{.488}{65} \cdot \frac{1}{8} \\
&= .00094[\mathrm{mol_{Zn}}] \\
\mathrm{mol_{S_8}} &= \frac{.503}{256} \\
&= .002[\mathrm{mol_{S_8}}] \\
m_{\mathrm{ZnS}} &= 97 \cdot 8 \cdot .00094 \\
&= .729[\mathrm{g_{ZnS}}]
\end{aligned} \tag{9}
$$

8. After 2.02[g] of Al has reacted with 0.4[L] of HCl ($\rho = 1.12[\mathrm{g\,mL^{-1}}] \rightarrow 1.12[\mathrm{kg\,L^{-1}}]$), what is the mass of the remaining HCl? (10)

$$
\begin{aligned}
2\,\mathrm{Al} + 6\,\mathrm{HCl} &\longrightarrow 2\,\mathrm{AlCl_3} + 3\,\mathrm{H_2} \\
m_{\mathrm{HCl}} &= .4 \cdot 1.12 \cdot 1000 \\
&= 448[\mathrm{g_{HCl}}] \\
\mathrm{mol_{Al}} &= .5 \cdot \frac{2.02}{27} \\
&= .0374[\mathrm{mol_{Al}}] \\
\mathrm{mol_{HCl}} &= 6 \cdot .0374 \\
&= .2244[\mathrm{mol_{HCl}}] \\
m_{\mathrm{HCl}} &= .2244 \cdot 36 \\
&= 8[\mathrm{g_{HCl}}]\ \text{Used} \\
\Delta m_{\mathrm{HCl}} &= 448 - 8 \\
&= 440[\mathrm{g_{HCl}}]
\end{aligned} \tag{10}
$$