

# Chapter 3 Review Sheet

Michael Brodskiy

Instructor: Mr. Morgan

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1. Answer the following for 25[g] of sulfuric acid ( $\text{H}_2\text{SO}_4$ ):

(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)

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

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

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

2. Calculate the mass percent of hydrogen in  $(\text{NH}_4)_2\text{SO}_4$  (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).

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

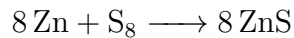
5. Find the formula of the hydrated compound  $\text{MgCl}_2n(\text{H}_2\text{O})$  with the following data when it is heated (7): Mass of empty dish = 22.347[g]; Initial mass of sample and dish = 25.825[g]; Mass of sample and dish after heating = 23.976[g].

$$\begin{aligned}
m_{\text{MgCl}_2} &= 23.976 - 22.347 \\
&= 1.629[\text{g}_{\text{MgCl}_2}] \\
\text{mol}_{\text{MgCl}_2} &= \frac{1.629}{94} \\
&= .0173[\text{mol}_{\text{MgCl}_2}] \\
m_{\text{MgCl}_2 n(\text{H}_2\text{O})} &= 25.825 - 22.347 \\
&= 3.478[\text{g}_{\text{MgCl}_2 n(\text{H}_2\text{O})}] \\
m_{n(\text{H}_2\text{O})} &= 3.478 - 1.629 \\
&= 1.849[\text{g}_{\text{H}_2\text{O}}] \\
\text{mol}_{\text{H}_2\text{O}} &= \frac{1.849}{18} \\
&= .102[\text{mol}_{\text{H}_2\text{O}}] \\
\left(\frac{.0173}{.0173}\right) \text{MgCl}_2 \left(\frac{.102}{.0173}\right) \text{H}_2\text{O} &\rightarrow \text{MgCl}_2 \cdot 6 \text{H}_2\text{O}
\end{aligned} \tag{7}$$

6.  $\text{NaNO}_2$  and carbon dioxide are prepared by passing nitrogen monoxide and oxygen into a solution of sodium carbonate. How many grams of  $\text{NaNO}_2$  are produced if you start with 50 grams of each reactant? (8)

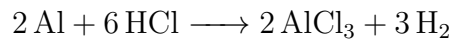
$$\begin{aligned}
4 \text{NO} + \text{O}_2 + 2 \text{Na}_2\text{CO}_3 &\longrightarrow 4 \text{NaNO}_2 + 2 \text{CO}_2 \\
\text{mol}_{\text{NO}} &= \frac{50}{30} \cdot .25 \\
&= .417[\text{mol}_{\text{NO}}] \\
\text{mol}_{\text{Na}_2\text{CO}_3} &= \frac{50}{106} \cdot .5 \\
&= .236[\text{mol}_{\text{Na}_2\text{CO}_3}] \\
\text{mol}_{\text{O}_2} &= \frac{50}{32} \\
&= 1.5625[\text{mol}_{\text{O}_2}] \\
m_{\text{NaNO}_2} &= 70 \cdot 4 \cdot .236 \\
&= 66[\text{g}_{\text{NaNO}_2}]
\end{aligned} \tag{8}$$

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



$$\begin{aligned} \text{mol}_{\text{Zn}} &= \frac{.488}{65} \cdot \frac{1}{8} \\ &= .00094[\text{mol}_{\text{Zn}}] \\ \text{mol}_{\text{S}_8} &= \frac{.503}{256} \\ &= .002[\text{mol}_{\text{S}_8}] \\ m_{\text{ZnS}} &= 97 \cdot 8 \cdot .00094 \\ &= .729[\text{g}_{\text{ZnS}}] \end{aligned} \tag{9}$$

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



$$\begin{aligned} m_{\text{HCl}} &= .4 \cdot 1.12 \cdot 1000 \\ &= 448[\text{g}_{\text{HCl}}] \\ \text{mol}_{\text{Al}} &= .5 \cdot \frac{2.02}{27} \\ &= .0374[\text{mol}_{\text{Al}}] \\ \text{mol}_{\text{HCl}} &= 6 \cdot .0374 \\ &= .2244[\text{mol}_{\text{HCl}}] \\ m_{\text{HCl}} &= .2244 \cdot 36 \\ &= 8[\text{g}_{\text{HCl}}] \text{ Used} \\ \Delta m_{\text{HCl}} &= 448 - 8 \\ &= 440[\text{g}_{\text{HCl}}] \end{aligned} \tag{10}$$