

## Answers to Chapter 3 Study Questions

1. a)  $3(12.0) + 8(1.01) + 3(16.0) = 92.1 \text{ g/mole}$     b)  $92.1 \text{ g}$     c)  $6.02 \times 10^{23} \text{ molecules}$   
 d)  $0.217 \text{ moles} \times \frac{92.1 \text{ g}}{1 \text{ mole}} = 20.0 \text{ g}$
2. a) 4 atoms (one N + 3 H)  
 b)  $1 \text{ mole NH}_3 \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mole NH}_3} \times \frac{4 \text{ atoms}}{1 \text{ molecule}} = 2.41 \times 10^{24} \text{ atoms}$   
 c)  $3.40 \text{ g NH}_3 \times \frac{1 \text{ mole NH}_3}{17.0 \text{ g NH}_3} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mole NH}_3} \times \frac{4 \text{ atoms}}{1 \text{ molecule}} = 4.82 \times 10^{23} \text{ atoms}$
3. Molar mass of  $\text{NaNO}_2 = 23.0 + 14.0 + 2(16.0) = 69.0 \text{ g/mole}$   
 $\% \text{ Na} = 23.0/69.0 = 33.3\% \text{ Na}$ ;  $\% \text{ N} = 14.0/69.0 = 20.3\% \text{ N}$ ;  $\% \text{ O} = 2(16.0)/69.0 = 46.4\% \text{ O}$   
**33.3% Na, 20.3% N and 46.4% O.**
4. a) In 100 g of this compound, there are 40.7 g C, 5.1 g H, and 54.2 g O  
 $40.7 \text{ g C} \times \frac{1 \text{ mole C}}{12.0 \text{ g C}} = 3.39 \text{ moles C}$      $3.39/3.39 = 1 \times 2 = 2$   
 $5.1 \text{ g H} \times \frac{1 \text{ mole H}}{1.0 \text{ g H}} = 5.1 \text{ moles H}$      $5.1/3.39 = 1.5 \times 2 = 3$   
 $54.2 \text{ g O} \times \frac{1 \text{ mole O}}{16.0 \text{ g O}} = 3.39 \text{ moles O}$      $3.39/3.39 = 1 \times 2 = 2$   
 empirical formula =  **$\text{C}_2\text{H}_3\text{O}_2$**
- b) Molar mass of  $\text{C}_2\text{H}_3\text{O}_2 = 2(12.0) + 3(1.0) + 2(16.0) = 59.0 \text{ g/mole}$   
 $118/59.0 = 2 \rightarrow$  molecular formula =  **$\text{C}_4\text{H}_6\text{O}_4$**
5. a) In 25.0 g of compound, there are 7.20 g Mg, 3.55 g C and  $25.0 - (7.20 + 3.55) = 14.25 \text{ g O}$ .  
 $7.20 \text{ g Mg} \times \frac{1 \text{ mole Mg}}{24.3 \text{ g Mg}} = 0.296 \text{ moles Mg}$      $0.296/0.296 = 1$   
 $3.55 \text{ g C} \times \frac{1 \text{ mole C}}{12.0 \text{ g C}} = 0.296 \text{ moles C}$      $0.296/0.296 = 1$   
 $14.25 \text{ g O} \times \frac{1 \text{ mole O}}{16.0 \text{ g O}} = 0.891 \text{ moles O}$      $0.891/0.296 = 3$   
 formula =  **$\text{MgCO}_3$**
- b)  $\% \text{ Mg} = 7.20/25.0 = 28.8\% \text{ Mg}$ ;  $\% \text{ C} = 3.55/25.0 = 14.2\% \text{ C}$ ;  $\% \text{ O} = 14.25/25.0 = 57.0\% \text{ O}$ . (You should get the same result using molar mass and atomic masses.)
- c)  $13.9 \text{ g compound} \times \frac{28.8 \text{ g Mg}}{100 \text{ g compound}} = 4.00 \text{ g Mg}$

$$5. \text{ d) } 0.290 \text{ mol C} \times \frac{12.0 \text{ g C}}{1 \text{ mole C}} \times \frac{100 \text{ g compound}}{14.2 \text{ g C}} = 24.5 \text{ g compound}$$

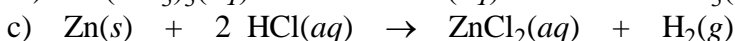
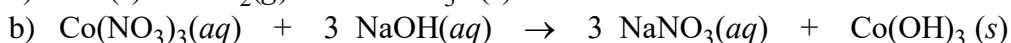
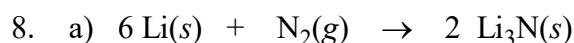
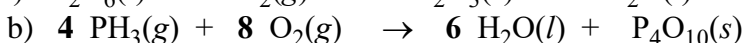
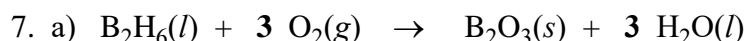
$$6. \text{ mass of Zn} = 33.64 \text{ g} - 32.00 \text{ g} = 1.64 \text{ g Zn}$$

$$\text{mass of O} = 34.04 \text{ g} - 33.64 \text{ g} = 0.40 \text{ g O.}$$

$$\# \text{ moles Zn: } 1.64 \text{ g Zn} \times \frac{1 \text{ mole Zn}}{65.4 \text{ g Zn}} = 0.0251 \text{ moles Zn} \quad 0.251/0.25 = 1$$

$$\# \text{ moles O: } 0.40 \text{ g O} \times \frac{1 \text{ mole O}}{16.0 \text{ g O}} = 0.025 \text{ moles O} \quad 0.25/0.25 = 1$$

formula = ZnO



d) (a) is a combination (synthesis) reaction. (b) is a double replacement reaction.

$$9. \text{ a) } 8.20 \text{ moles SO}_2 \times \frac{2 \text{ mol H}_2\text{S}}{2 \text{ mol SO}_2} = 8.20 \text{ moles H}_2\text{S}$$

$$\text{b) } 1.00 \text{ mole H}_2\text{S} \times \frac{3 \text{ mol O}_2}{2 \text{ mol H}_2\text{S}} \times \frac{32.0 \text{ g O}_2}{1 \text{ mol O}_2} = 48.0 \text{ g O}_2$$

$$\text{c) } 6.82 \text{ g H}_2\text{S} \times \frac{1 \text{ mol H}_2\text{S}}{34.1 \text{ g H}_2\text{S}} \times \frac{2 \text{ mol H}_2\text{O}}{2 \text{ mol H}_2\text{S}} \times \frac{18.0 \text{ g H}_2\text{O}}{1 \text{ mol H}_2\text{O}} = 3.60 \text{ g H}_2\text{O}$$

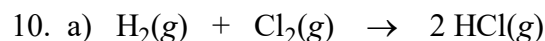
$$\text{d) } 7.98 \text{ g H}_2\text{S} \times \frac{1 \text{ mol H}_2\text{S}}{34.1 \text{ g H}_2\text{S}} \times \frac{2 \text{ mol SO}_2}{2 \text{ mol H}_2\text{S}} \times \frac{64.1 \text{ g SO}_2}{1 \text{ mol SO}_2} = 15.0 \text{ g SO}_2$$

$$\% \text{ yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100\% = \frac{12.0 \text{ g SO}_2}{15.0 \text{ g SO}_2} \times 100\% = 80.0\%$$

$$\text{e) } 2.66 \text{ g H}_2\text{S} \times \frac{1 \text{ mol H}_2\text{S}}{34.1 \text{ g H}_2\text{S}} \times \frac{2 \text{ mol SO}_2}{2 \text{ mol H}_2\text{S}} \times \frac{64.1 \text{ g SO}_2}{1 \text{ mol SO}_2} = 5.00 \text{ g SO}_2$$

$$3.00 \text{ g O}_2 \times \frac{1 \text{ mol O}_2}{32.0 \text{ g O}_2} \times \frac{2 \text{ mol SO}_2}{3 \text{ mol O}_2} \times \frac{64.1 \text{ g SO}_2}{1 \text{ mol SO}_2} = 4.01 \text{ g SO}_2$$

O<sub>2</sub> is limiting; 4.01 g SO<sub>2</sub> is produced



b) H<sub>2</sub> is limiting (H<sub>2</sub> and Cl<sub>2</sub> react in a ratio 1:1 ratio and there is less H<sub>2</sub>.)

$$\text{c) } 7.50 \text{ mol H}_2 \times \frac{2 \text{ mol HCl}}{1 \text{ mol H}_2} = 15.0 \text{ mol HCl}$$

$$\text{d) } 9.00 - 7.50 = 1.50 \text{ mol Cl}_2 \text{ left}$$