3.3a) Because there are twice as many red oxygen molecules than blue nitrogen molecules, the empirical formula for the reactant must be NO_2.

3.3b) It is not possible to draw a diagram of the original compound. Empirical formulas only tell you the relative ratios of atoms in the compound. As such, the formula could be NO_2, N_2O_4, N_3O_6.....

3.5)

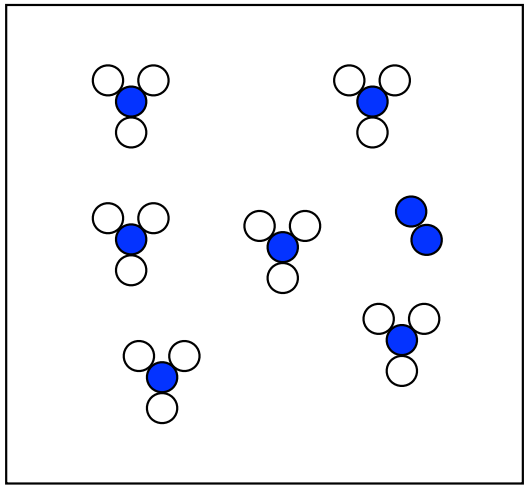
a) $C_2O_2NH_5$

b) 75.0 g mol^{-1}

c) $$\frac{100.0\text{g } C_2O_2NH_5}{} \left| \frac{1 \text{ mol } C_2O_2NH_5}{75.0 \text{ g } C_2O_2NH_5} \right. = 1.33 \text{ mol } C_2O_2NH_5$$

d) $$\% \text{ Comp} = \frac{(\#\text{ of atoms})(\text{AM})}{\text{Formula Mass}} = \frac{(1 \text{ N})(14.0 \text{ g mol}^{-1})}{75.0 \text{ g mol}^{-1}} = 18.7\%$$

3.7)



$3H_2 + N_2 \Rightarrow 2\ NH_3$

Because the product is NH_3, I know that 1 N atom bonds with 3 H atoms. From this, I circled groups of 1 N_2 and 3 H_2. This resulted in 3 "sets," each creating 2 NH_3. In addition, there was 1 remaining N_2, meaning H_2 was the limiting reactant.

3.16

a) $SO_3 + H_2O \Rightarrow H_2SO_4$

b) $B_2S_3 + 6H_2O \Rightarrow 2H_3BO_3 + 3H_2S$

c) $4PH_3 + 8O_2 \Rightarrow P_4O_{10} + 6H_2O$

d) $2Hg(NO_3)_2 \Rightarrow 2HgO + 4NO_2 + O_2$

e) $Cu + 2H_2SO_4 \Rightarrow CuSO_4 + SO_2 + 2H_2O$

3.21

a) $2C_3H_6 + 9O_2 \Rightarrow 6CO_2 + 6H_2O$ - combustion

b) $NH_4NO_3 \Rightarrow N_2O + 2H_2O$ - decomposition

c) $C_5H_6O + 6O_2 \Rightarrow 5CO_2 + 3H_2O$ - combustion

d) $N_2 + 3H_2 \Rightarrow 2NH_3$ - synthesis

e) $K_2O + H_2O \Rightarrow 2KOH$ - synthesis

3.27

a) $$\%\ \text{Comp} = \frac{(\#\ \text{of atoms})(\text{AM})}{\text{Formula Mass}} = \frac{(7\ \text{C})(12.0\ \text{g mol}^{-1})}{106.0\ \text{g mol}^{-1}} = 79.2\%$$

b) $$\%\ \text{Comp} = \frac{(\#\ \text{of atoms})(\text{AM})}{\text{Formula Mass}} = \frac{(8\ \text{C})(12.0\ \text{g mol}^{-1})}{152.0\ \text{g mol}^{-1}} = 63.2\%$$

c) $$\%\ \text{Comp} = \frac{(\#\ \text{of atoms})(\text{AM})}{\text{Formula Mass}} = \frac{(7\ \text{C})(12.0\ \text{g mol}^{-1})}{130.0\ \text{g mol}^{-1}} = 64.6\%$$

3.39

a) 162.3 g mol^{-1}

b)

$$\frac{5.00\text{mg } C_6H_{10}OS_2 \mid 1\text{ g} \mid 1\text{ mol } C_6H_{10}OS_2}{1000\text{mg} \mid 162.3\text{g } C_6H_{10}OS_2} = 3.08 \times 10^{-5}\text{ mol } C_6H_{10}OS_2$$

c)

$$\frac{3.08 \times 10^{-5}\text{ mol } C_6H_{10}OS_2 \mid 6.02 \times 10^{23}\ C_6H_{10}OS_2}{1\text{ mol } C_6H_{10}OS_2}$$

$$1.86 \times 10^{19}\ C_6H_{10}OS_2$$

d)

$$\frac{1.86 \times 10^{19}\ C_6H_{10}OS_2 \mid 2\text{ S}}{1\ C_6H_{10}OS_2} = 3.71 \times 10^{19}\text{ S}$$

3.47a)

$$\frac{10.4\text{g C}}{} \left| \frac{1\text{ mol C}}{12.0\text{g C}} \right. = 0.867\text{ mol C} \div 0.866 = 1$$

$$\frac{27.8\text{g S}}{} \left| \frac{1\text{ mol S}}{32.1\text{g S}} \right. = 0.866\text{ mol S} \div 0.866 = 1 \qquad CSCl_2$$

$$\frac{61.7\text{g Cl}}{} \left| \frac{1\text{ mol Cl}}{35.5\text{g Cl}} \right. = 1.74\text{ mol Cl} \div 0.866 = 2$$

3.51a) $\dfrac{MM}{EM} = \dfrac{84\text{ gmol}^{-1}}{14\text{ gmol}^{-1}} = 6 \qquad C_6H_{12}$

b) $\dfrac{MM}{EM} = \dfrac{51.5\text{ gmol}^{-1}}{51.5\text{ gmol}^{-1}} = 1 \qquad NH_2Cl$

3.59

Mass of water lost = $Mass_{hydrate}$ - $Mass_{dehydrated}$

Mass of water lost = 2.558g - 0.948g = 1.610g H_2O

$$\frac{0.948\text{g } Na_2CO_3 \mid 1 \text{ mol } Na_2CO_3}{\mid 106.0\text{g } Na_2CO_3} = \frac{8.94 \times 10^{-3} \text{ mol } Na_2CO_3}{8.94 \times 10^{-3}} = 1$$

$$\frac{1.610\text{g } H_2O \mid 1 \text{ mol } H_2O}{\mid 18.0 \text{ g } H_2O} = \frac{8.94 \times 10^{-2} \text{ mol } H_2O}{8.94 \times 10^{-3}} = 10$$

$$Na_2CO_3 \cdot 10H_2O$$

3.63a) $Al(OH)_3 + 3HCl \Rightarrow AlCl_3 + 3H_2O$

3.63b)

$$\frac{0.500\text{g } Al(OH)_3 \mid 1 \text{ mol } Al(OH)_3 \mid 3 \text{ mol HCl} \mid 36.5\text{g HCl}}{\mid 78.0 \text{ } Al(OH)_3 \mid 1 \text{ mol } Al(OH)_3 \mid 1 \text{ mol HCl}}$$

0.702g HCl

3.63c)

$$0.500\text{g } Al(OH)_3 \left| \frac{1 \text{ mol } Al(OH)_3}{78.0 \text{ } Al(OH)_3} \right| \frac{1 \text{ mol } AlCl_3}{1 \text{ mol } Al(OH)_3} \left| \frac{133.5\text{g } AlCl_3}{1 \text{ mol } AlCl_3} \right.$$

$$0.856\text{g } AlCl_3$$

3.63c)

$$0.500\text{g } Al(OH)_3 \left| \frac{1 \text{ mol } Al(OH)_3}{78.0 \text{ } Al(OH)_3} \right| \frac{3 \text{ mol } H_2O}{1 \text{ mol } Al(OH)_3} \left| \frac{18.0\text{g } H_2O}{1 \text{ mol } H_2O} \right.$$

$$0.346\text{g } H_2O$$

3.63d)

$Mass_{rct} = Mass_{Al(OH)3} + Mass_{HCl}$

$Mass_{rct} = 0.500\text{g} + 0.702\text{g} = 1.202\text{g}$

$Mass_{prd} = Mass_{AlCl3} + Mass_{H2O}$

$Mass_{rct} = 0.856\text{g} + 0.346\text{g} = 1.202\text{g}$

3.81 $Na_2CO_3 + 2AgNO_3 \Rightarrow 2NaNO_3 + Ag_2CO_3$

$$\frac{3.50\text{g } Na_2CO_3}{} \left| \frac{1 \text{ mol } Na_2CO_3}{106.0\text{g } Na_2CO_3} \right. = \frac{0.0330 \text{ mol}}{1} = 0.0330$$

$$\frac{5.00\text{g } AgNO_3}{} \left| \frac{1 \text{ mol } AgNO_3}{169.9 \text{ g } AgNO_3} \right. = \frac{0.0294 \text{ mol}}{2} = 0.0147$$

$AgNO_3$ is limiting reactant. As such, **none** will remain

$$\frac{5.00\text{g } AgNO_3}{} \left| \frac{1 \text{ mol } AgNO_3}{169.9 \text{ g } AgNO_3} \right. \left| \frac{1 \text{ mol } Na_2CO_3}{2 \text{ mol } AgNO_3} \right. \left| \frac{106.0\text{g } Na_2CO_3}{1 \text{ mol } Na_2CO_3} \right.$$

=1.56g **Na_2CO_3** consumed. If we began with 3.50 grams, **1.94 g remain**

$$\frac{5.00\text{g } AgNO_3}{} \left| \frac{1 \text{ mol } AgNO_3}{169.9 \text{ g } AgNO_3} \right. \left| \frac{2 \text{ mol } NaNO_3}{2 \text{ mol } AgNO_3} \right. \left| \frac{85.0\text{g } NaNO_3}{1 \text{ mol } NaNO_3} \right.$$

2.50g $NaNO_3$

$$\frac{5.00\text{g } AgNO_3}{} \left| \frac{1 \text{ mol } AgNO_3}{169.9 \text{ g } AgNO_3} \right. \left| \frac{1 \text{ mol } Ag_2CO_3}{2 \text{ mol } AgNO_3} \right. \left| \frac{276.0\text{g } Ag_2CO_3}{1 \text{ mol } Ag_2CO_3} \right.$$

4.06g Ag_2CO_3