Name KEY
Date

# Chemistry 11

## *Chapter 4 Review – Stoichiometry*

1. Given the balanced equation:

$$2\ Si_4H_{10\ (s)} + 13\ O_{2\ (g)} \rightarrow 8\ SiO_{2\ (s)} + 10\ H_2O_{(g)}$$

$4(28.09) + 10(1.01) = 122.46$

a) What volume of oxygen (STP) is required to react with 204.0 g of $Si_4H_{10}$?

$$204.0\text{ g } Si_4H_{10} \times \frac{1\text{ mol } Si_4H_{10}}{122.46\text{ g } Si_4H_{10}} \times \frac{13\text{ mol } O_2}{2\text{ mol } Si_4H_{10}} \times \frac{22.4\text{ L } O_2}{1\text{ mol } O_2} = \boxed{242.5\text{ L } O_2}$$

b) What mass of $SiO_2$ is formed when 345.0 g of $H_20$ are formed?

$$345.0\text{ g } H_2O \times \frac{1\text{ mol } H_2O}{18.02\text{ g } H_2O} \times \frac{8\text{ mol } SiO_2}{10\text{ mol } H_2O} \times \frac{60.09\text{ g } SiO_2}{1\text{ mol } SiO_2} = \boxed{920.4\text{ g } SiO_2}$$

c) How many molecules of $H_2O$ are formed when 17.92 L of $O_2$ are used at STP?

$$17.92\text{ L } O_2 \times \frac{1\text{ mol } O_2}{22.4\text{ L } O_2} \times \frac{10\text{ mol } H_2O}{13\text{ mol } O_2} \times \frac{6.02\times10^{23}\text{ molecules } H_2O}{1\text{ mol } H_2O}$$

$$= \boxed{3.71\times10^{23}\text{ molecules } H_2O}$$

d) How many moles of $Si_4H_{10}$ are needed to just react with $1.204 \times 10^{26}$ molecules of oxygen?

$$1.204\times10^{26}\text{ molec. } O_2 \times \frac{1\text{ mol } O_2}{6.02\times10^{23}\text{ molec. } O_2} \times \frac{2\text{ mol } Si_4H_{10}}{13\text{ mol } O_2} = \boxed{30.8\text{ mol } Si_4H_{10}}$$

2. Given the balanced equation:

L.R excess

$$Al_2C_6 + 6\,H_2O \rightarrow 2\,Al(OH)_3 + 3CH_{4\,(g)}$$

a) If 34.5 grams of $Al_2C_6$ is mixed with 72.0 grams of water, which reactant is in excess? Show by calculations.

$$34.5g\ Al_2C_6 \times \frac{1\,mol\ Al_2C_6}{126.02\,g\ Al_2C_6} \times \frac{2\,mol\ Al(OH)_3}{1\,mol\ Al_2C_6} \times \frac{78.01\,g\ Al(OH)_3}{1\,mol\ Al(OH)_3} = 42.71\,g\ Al(OH)_3$$

$$72.0g\ H_2O \times \frac{1\,mol\ H_2O}{18.02\,g\ H_2O} \times \frac{2\,mol\ Al(OH)_3}{6\,mol\ H_2O} \times \frac{78.01\,g\ Al(OH)_3}{1\,mol\ Al(OH)_3} = 103.9\,g\ Al(OH)_3$$

$\boxed{H_2O \text{ is excess}}$

b) If 34.5 grams of $Al_2C_6$ is mixed with 72.0 grams of water, what mass of $Al(OH)_3$ is formed?

$\boxed{42.71\,g\ Al(OH)_3}$

c) If 34.5 grams of $Al_2C_6$ is mixed with 72.0 grams of water, what volume of $CH_4$ is formed at STP?

$$34.5g\ Al_2C_6 \times \frac{1\,mol\ Al_2C_6}{126.02\,g\ Al_2C_6} \times \frac{3\,mol\ CH_4}{1\,mol\ Al_2C_6} \times \frac{22.4\,L\ CH_4}{1\,mol\ CH_4} = 18.4\,L\ CH_4$$

3. Given the equation: $4\,NH_3 + 5\,O_2 \rightarrow 4\,NO + 6\,H_2O$

When 51.0 grams of $NH_3$ is burned in an excess of oxygen, 52.65 g of water are produced.

actual Yield

a) Calculate the theoretical yield of $H_2O$.

$$51.0g\ NH_3 \times \frac{1\,mol\ NH_3}{17.04\,g\ NH_3} \times \frac{6\,mol\ H_2O}{4\,mol\ NH_3} \times \frac{18.02\,g\ H_2O}{1\,mol\ H_2O} = \boxed{80.9\,g\ H_2O}$$

b) Calculate the % yield of $H_2O$.

$$\%\ Yield = \frac{AY}{TY} \times 100 = \frac{52.65g}{80.9g} \times 100\% = \boxed{65.1\%\ Yield}$$

4. Given the equation: $N_2 + 3\,H_2 \rightarrow 2\,NH_3$ When 4.0 grams of hydrogen is combined with an excess of nitrogen, a 92% yield of $NH_3$ is obtained.

a) Calculate the theoretical yield of $NH_3$

$$4.0g\ H_2 \times \frac{1\,mol\ H_2}{2.02\,g\ H_2} \times \frac{2\,mol\ NH_3}{3\,mol\ H_2} \times \frac{17.04\,g\ NH_3}{1\,mol\ NH_3} = 22.\ g\ NH_3$$

b) Calculate the actual yield of $NH_3$

$$AY = \frac{\%\ Y}{100} \times TY = \frac{92}{100} \times 22.49 = 20.\ g\ NH_3$$

5. Given the balanced equation:

$$3\ HCl_{(aq)} + Fe(OH)_{3\ (aq)} \rightarrow 3\ H_2O_{(l)} + FeCl_{3\ (aq)}$$


a) It takes 19.56 mL of 0.50 M HCl to titrate a 25.0 mL sample of a solution of $Fe(OH)_3$. Calculate the $[Fe(OH)_3]$

moles HCl = 0.50 M × 0.01956 L = 0.00978 mol HCl

moles $Fe(OH)_3$ = 0.00978 mol HCl × $\frac{1 \text{ mol } Fe(OH)_3}{3 \text{ mol HCl}}$ = 0.00326 mol $Fe(OH)_3$

$[Fe(OH)_3] = \frac{0.00326 \text{ mol } Fe(OH)_3}{0.0250 \text{ L } Fe(OH)_3} = \boxed{0.13 \text{ M}}$

b) What mass of $Fe(OH)_3$ is needed to completely react with 10.0 mL of 0.50M HCl solution?

moles HCl = 0.50 M × 0.0100 L = 0.00500 mol HCl

0.00500 mol HCl × $\frac{1 \text{ mol } Fe(OH)_3}{3 \text{ mol HCl}}$ × $\frac{106.88 \text{ g } Fe(OH)_3}{1 \text{ mol } Fe(OH)_3}$

$\boxed{= 0.1.8 \text{ g } Fe(OH)_3}$

c) What volume of 0.50M HCl is required to titrate a 21.36 gram sample of iron (III) hydroxide?

21.36 g $Fe(OH)_3$ × $\frac{1 \text{ mol } Fe(OH)_3}{106.88 \text{ g } Fe(OH)_3}$ × $\frac{3 \text{ mol HCl}}{1 \text{ mol } Fe(OH)_3}$ = 0.600 mol HCl


$L = \frac{mol}{M} = \frac{0.600 \text{ mol}}{0.50 \text{ M}} = \boxed{1.2 \text{ L}}$