Stoichiometry worksheet

1. Consider the following equation:

$$3\ Ag + 4\ HNO_3 \rightarrow 3\ AgNO_3 + NO + 2\ H_2O$$

What mass of nitric acid, HNO_3, is necessary to obtain n 6 moles of water?

G

$$6\text{mol } H_2O \times \frac{4\text{mol } HNO_3}{2\text{mol } H_2O} \times \frac{63.02\text{g } HNO_3}{1\text{mol } HNO_3} = 800\text{g } HNO_3$$

2. Using the equation below, answer the following questions.

$$2\ H_2 + O_2 \rightarrow 2\ H_2O$$

a- If 4.0 moles of H_2 gas are reacted, how many grams of water would be produced?

G

$$4.0\text{mol } H_2 \times \frac{2\text{mol } H_2O}{2\text{mol } H_2} \times \frac{18.02\text{g } H_2O}{1\text{mol } H_2O} = 72\text{g } H_2O$$

b- If 2.45×10^2 molecules of oxygen gas are available, how many moles of H_2 would react with it?

G

$$2.45\times10^2\text{molec } O_2 \times \frac{1\text{mol } O_2}{(6.02\times10^{23})\text{molec } O_2} \times \frac{2\text{mol } H_2}{1\text{mol } O_2} = 8.14\times10^{-22}\text{ mol } H_2$$

3. What would the final volume be of water when a 5.5 M solution is needed to react with 12 g of HCl? The equation that represents the reaction follows.

$$NaHCO_3 + HCl \rightarrow NaCl + H_2O + CO_2$$

$$12\text{g } HCl \times \frac{1\text{mol } HCl}{36.46\text{g } HCl} \times \frac{1\text{mol } H_2O}{1\text{mol } HCl} = \frac{0.329127811\text{mol}}{x} = \frac{5.5\text{ mol}}{L}$$

$$= 0.060\text{L}$$

4. a- Balance the equation below:

$2Al + 3F_2 \rightarrow 2AlF_3$

b- How many moles of aluminum react with 4.5 moles of fluorine?

$4.5\,mol\,F_2 \times \frac{2\,mol\,Al}{3\,mol\,F_2} = 3.0\,mol\,Al$

c- If 42 g of aluminum fluoride, AlF_3 are produced, what mass of aluminum is reacted with aluminum fluoride?

$42\,g\,AlF_3 \times \frac{1\,mol\,AlF_3}{83.98\,g\,AlF_3} \times \frac{2\,mol\,Al}{2\,mol\,AlF_3} \times \frac{26.98\,g\,Al}{1\,mol\,Al} = 13\,g\,Al$

d- How many moles of fluorine will take part in the above reaction to produce 33.6 g of aluminum fluoride?

$33.6\,g\,AlF_3 \times \frac{1\,mol\,AlF_3}{83.98\,g\,AlF_3} \times \frac{3\,mol\,F_2}{2\,mol\,AlF_3} = 0.600\,mol\,F_2$

5. Kim uses 50 mL of $Pb(NO_3)_2$ at a concentration of 4.5 mol/L, what is the mass produced of sodium iodide (NaI)? Using the following equation:

$\frac{4.5\,mol}{L} = \frac{x}{.050} = .225\,mol$

$2\,NaI + Pb(NO_3)_2 \rightarrow PbI_2 + 2\,Na(NO_3)$

$.225\,mol\,Pb(NO_3)_2 \times \frac{2\,mol\,NaI}{1\,mol\,Pb(NO_3)_2} \times \frac{149.89\,g\,NaI}{1\,mol\,NaI} = 70\,g\,NaI$

6. a- Write a balanced equation for the **combustion** of methane gas (CH_4) to form carbon dioxide (CO_2) and water vapour (H_2O).

$2O_2 + CH_4 \rightarrow CO_2 + 2H_2O$

b- If 124.5 g of CO_2 is produced, how many moles of CH_4 must have been reacted?

$124.5\,g\,CO_2 \times \frac{1\,mol\,CO_2}{44.01\,g\,CO_2} \times \frac{1\,mol\,CH_4}{1\,mol\,CO_2} = 2.829\,mol\,CH_4$

7. a- Write a balanced equation for the reaction of nitrogen gas (N_2) and hydrogen gas (H_2) to produce ammonia gas (NH_3).

$$N_2 + 3\,H_2 \rightarrow 2\,NH_3$$

b-If 212.5 g of ammonia gas is produced, how many molecules of hydrogen gas must have reacted with the nitrogen?

$$212.5\,g\,NH_3 \times \frac{1\,mol\,NH_3}{17.04\,g\,NH_3} \times \frac{3\,mol\,H_2}{2\,mol\,NH_3} \times \frac{6.02\times10^{23}\,molec\,H_2}{1\,mol\,H_2} = 1.126\times10^{25}\,molec\,H_2$$

8. 120 mL of CH_3COONa is used to produce H_2O . If 9.81g of H_2O is made, what is the concentration of CH_3COONa used? The following equation represents the reaction:

$$NaHCO_3\,(s) + CH_3COOH\,(aq) \rightarrow CH_3COONa\,(aq) + CO_2\,(g) + H_2O\,(l)$$

$$9.81\,g\,H_2O \times \frac{1\,mol\,H_2O}{18.02\,g\,H_2O} \times \frac{1\,mol\,CH_3COONa}{1\,mol\,H_2O} = 0.544395117\,mol$$

$$\frac{0.544395117\,mol}{0.12\,L} = 4.5\,M$$

9. Solid copper can be prepared from copper oxide by reacting with ammonia, according to the following unbalanced equation:

$$3\,CuO + 2\,NH_3 \rightarrow N_2 + 3\,Cu + 3\,H_2O$$

How many moles of ammonia(NH_3) are needed to obtain 9.0 moles of copper (Cu)?

$$9.0\,mol\,Cu \times \frac{2\,mol\,NH_3}{3\,mol\,Cu} = 6.0\,mol\,NH_3$$

10. Iron (Fe) and carbon monoxide (CO) are produced when iron oxide (Fe_2O_3) reacts with carbon (C). Write a balanced equation for this reaction.

$$Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$$

You would like to produce 50 mol if iron, what mass of iron oxide is required?

$$50\,mol\,Fe \times \frac{1\,mol\,Fe_2O_3}{2\,mol\,Fe} \times \frac{159.7\,g\,Fe_2O_3}{1\,mol\,Fe_2O_3} = 4000\,g\,Fe_2O_3$$

11. 300 mL of NaI whose concentration is 3 mol/L are reacted with $Pb(NO_3)_2$ in order to obtain the precipitate PbI_2 . Calculate the moles of PbI_2 obtained.

$\frac{3\,mol}{1\,L} = \frac{x}{0.3\,L} = 0.9\,mol$ $\quad 2\,NaI + Pb(NO_3)_2 \rightarrow PbI_2 + 2\,Na(NO_3)$

$$0.9\,mol\,NaI \times \frac{1\,mol\,PbI_2}{2\,mol\,NaI} = 0.5\,mol\,PbI_2$$

12. When a solution of aluminum hydroxide, $Al(OH)_3$, reacts with a solution of sulfuric acid, H_2SO_4, the result is a salt, aluminum sulphate, $Al_2(SO_4)_3$ and water, H_2O.

The reaction is seen by the following unbalanced equation:

$$2\,Al(OH)_3 + 3\,H_2SO_4 \rightarrow Al_2(SO_4)_3 + 6\,H_2O$$

What mass of aluminum hydroxide is required to produce 100.0 g of aluminum sulphate?

$$100.0\,g\,Al_2(SO_4)_3 \times \frac{1\,mol\,Al_2(SO_4)_3}{342.17\,g\,Al_2(SO_4)_3} \times \frac{2\,mol\,Al(OH)_3}{1\,mol\,Al_2(SO_4)_3} \times \frac{78.01\,g\,Al(OH)_3}{1\,mol\,Al(OH)_3} = 45.60\,g\,Al(OH)_3$$

13. Use the equation below to solve questions a and b.

$$2\ HCl + Mg(OH)_2 \rightarrow MgCl_2 + 2\ H_2O$$

a- If 650 g of water was produced, how many molecules of magnesium hydroxide $Mg(OH)_2$ must have reacted?

$$650g \times \frac{1\ mol\ H_2O}{18.02g\ H_2O} \times \frac{1\ mol\ Mg(OH)_2}{2\ mol\ H_2O} \times \frac{6.02\times10^{23}\ molec\ Mg(OH)_2}{1\ mol\ Mg(OH)_2} = 1.1\times10^{25}\ molec\ Mg(OH)_2$$

b- If 5.3×10^9 molecules of water are available, how many moles of HCl react with it?

$$5.3\times10^9\ molec\ H_2O \times \frac{1\ mol\ H_2O}{(6.02\times10^{23})\ molec\ H_2O} \times \frac{2\ mol\ HCl}{2\ mol\ H_2O} = 8.8\times10^{-15}\ mol\ HCl$$

14. 75mL of $BaCl_2$ is used to produce $BaCrO_4$. If 12g of $BaCrO_4$ is made, what is the concentration of the $BaCl_2$ used? The following equation represents the reaction:

$$K_2CrO_{4\,(aq)} + BaCl_{2(aq)} \rightarrow BaCrO_{4(s)} + 2KCl_{(aq)}$$

$$12g\ BaCrO_4 \times \frac{1\ mol\ BaCrO_4}{253.33g\ BaCrO_4} \times \frac{1\ mol\ BaCl_2}{1\ mol\ BaCrO_4} = \frac{0.047369044\ mol}{.075\ L} = .63\ mol/L$$

15. How many L of a 7.0M solution of HCl are needed to react with 9.85g of CO_2? The equation that represents the reaction follows.

$$NaHCO_3 + HCl \rightarrow NaCl + H_2O + CO_2$$

$$9.85g\ CO_2 \times \frac{1\ mol\ CO_2}{44.01g\ CO_2} \times \frac{1\ mol\ HCl}{1\ mol\ CO_2} = \frac{0.22381277\ mol}{x} = \frac{7.0\ mol}{L}$$

$$= 0.32\ L$$

16. Use the equation below to answer questions a and b.

$$Cu + 2\,AgNO_3 \rightarrow Cu(NO_3)_2 + 2\,Ag$$

a- If 4.33×10^7 molecules of Ag are available, how many moles of silver ~~nitrate~~ $AgNO_3$ would react with it?

$$4.33\times10^{7}\ \text{molec Ag} \times \frac{1\ \text{mol Ag}}{(6.02\times10^{23})\ \text{molec Ag}} \times \frac{2\ \text{mol AgNO}_3}{2\ \text{mol Ag}} = 7.19\times10^{-17}\ \text{mol AgNO}_3$$

b- If 450.0 g of copper nitrate $Cu(NO_3)_2$ was produced, how many Ag atoms must have reacted with the copper nitrate?

$$450.0\ \text{g Cu(NO}_3)_2 \times \frac{1\ \text{mol Cu(NO}_3)_2}{187.5\ \text{g Cu(NO}_3)_2} \times \frac{2\ \text{mol Ag}}{1\ \text{mol Cu(NO}_3)_2} \times \frac{6.02\times10^{23}\ \text{atoms Ag}}{1\ \text{mol Ag}}$$

$$= 2.890\times10^{24}\ \text{Ag atoms}$$

17. Kim neutralizes 250 mL of HCL at a concentration of 4.5mol/L using $Ca(OH)_2$ according to the following equation: $2HCl + Ca(OH)_2 \rightarrow CaCl_2 + 2\,H_2O$

What is the mass of the $CaCl_2$ that will be left in the beaker?

$n = C \times V$

$$\frac{4.5\ \text{mol}}{\text{L}} \cdot .25\text{L} = 1.125\ \text{mol}$$

$$1.125\ \text{mol HCl} \times \frac{1\ \text{mol CaCl}_2}{2\ \text{mol HCl}} \times \frac{110.975\ \text{g CaCl}_2}{1\ \text{mol CaCl}_2} = 62\ \text{g CaCl}_2$$