Stoichiometry Class Worksheet

1. According to the equation below, adding copper (Cu) to silver nitrate ($AgNO_3$) allows a chemical reaction to occur that produces silver (Ag) and copper nitrate ($Cu(NO_3)_2$).

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

A- You need 2.0 g of silver (Ag) for an experiment. What mass of the silver nitrate will you require to obtain the 2.0 g of silver that you need?

Given m m Ratio

$$2.0\,g\,Ag \times \frac{1\,mol}{107.87\,g\,Ag} \times \frac{2\,mol\,AgNO_3}{2\,mol\,Ag} \times \frac{169.88\,g\,AgNO_3}{1\,mol\,AgNO_3} = 3.1\,g\,AgNO_3$$

B- You need 2.0 g of silver (Ag) for an experiment. How many moles of the Cu will you require to obtain the 2.0 g of silver that you need?

Given m m Ratio

$$2.0\,g\,Ag \times \frac{1\,mol\,Ag}{107.87\,g\,Ag} \times \frac{1\,mol\,Cu}{2\,mol\,Ag} = .0093\,mol\,Cu$$

2. To neutralize hydrochloric acid (HCl), magnesium hydroxide ($Mg(OH)_2$), a base is added. The neutralization reaction is represented by the following equation:

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

A- You have 4.0 moles of HCl, what mass of $Mg(OH)_2$ is required to neutralize the 4.0 moles of HCl?

Given Ratio MM

$$4.0\,mol\,HCl \times \frac{1\,mol\,Mg(OH)_2}{2\,mol\,HCl} \times \frac{58.33\,g\,Mg(OH)_2}{1\,mol\,Mg(OH)_2} = 120\,g\,Mg(OH)_2$$

B- You have 4.0 moles of HCl, how many moles of $Mg(OH)_2$ is required to neutralize the 4 moles of HCl?

Given m m

$$4.0\,mol\,HCl \times \frac{1\,mol\,Mg(OH)_2}{2\,mol\,HCl} = 2.0\,mol\,Mg(OH)_2$$

3. The following equation describes how iron oxide, Fe_2O_3, is produced.

$$4\ Fe + 3\ O_2 \rightarrow 2\ Fe_2O_3$$

A- How much Fe_2O_3 is formed by the complete oxidation of 448 g of iron?

Given (m m) (ratio) (m m)

$$448\text{ g Fe} \times \frac{1\text{ mol Fe}}{55.85\text{ g Fe}} \times \frac{2\text{ mol } Fe_2O_3}{4\text{ mol Fe}} \times \frac{159.7\text{ g } Fe_2O_3}{1\text{ mol } Fe_2O_3} = 641\text{ g } Fe_2O_3$$

B- How many moles of Fe_2O_3 are produced when 7.5 moles of iron react completely? (m m)

Given

$$7.5\text{ mol Fe} \times \frac{2\text{ mol } Fe_2O_3}{4\text{ mol Fe}} = 3.8\text{ mol } Fe_2O_3$$

4. How many moles of ammonia (NH_3) are needed to obtain 7.00 moles of copper (Cu)?

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

Given (m m)

$$7.00\text{ mol Cu} \times \frac{2\text{ mol } NH_3}{3\text{ mol Cu}} = 4.67\text{ mol } NH_3$$

5. You would like to produce 40.0 g of iron (Fe), what mass of iron oxide (Fe_2O_3) is needed?

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

Given (m m) (ratio) (m m)

$$40.0\text{ g Fe} \times \frac{1\text{ mol Fe}}{55.85\text{ g Fe}} \times \frac{1\text{ mol } Fe_2O_3}{2\text{ mol Fe}} \times \frac{159.7\text{ g } Fe_2O_3}{1\text{ mol } Fe_2O_3} = 57.2\text{ g } Fe_2O_3$$

6. 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 sulfuric acid is required to produce 10.0 g of water?

Given (m m) (ratio) (m m)

$$10.0\text{ g } H_2O \times \frac{1\text{ mol } H_2O}{18.0\text{ g } H_2O} \times \frac{3\text{ mol } H_2SO_4}{6\text{ mol } H_2O} \times \frac{98.0\text{ g } H_2SO_4}{1\text{ mol } H_2SO_4} = 27.2\text{ g } H_2SO_4$$

7. According to the equation below, adding copper (Cu) to silver nitrate ($AgNO_3$) allows a chemical reaction to occur that produces silver (Ag) and copper nitrate ($Cu(NO_3)_2$).

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

A- If 3.33×10^7 molecules of Cu are available, how many moles of silver nitrate $AgNO_3$ would react with it?

Given 3.33×10^7 molec Cu $\times \frac{1\text{ mol Cu}}{(6.02\times10^{23})\text{ molecules of Cu}}$ (M-Mol) $\times \frac{2\text{ mol } AgNO_3}{1\text{ mol Cu}}$ (R) $= 1.11\times10^{-16}$ moles of $AgNO_3$

B- If 400.0 g of copper nitrate $Cu(NO_3)_2$ was produced, how many Cu atoms must have reacted with the copper nitrate?

G: $400.0\text{ g } Cu(NO_3)_2 \times \frac{1\text{ mol } Cu(NO_3)_2}{187.5\text{ g } Cu(NO_3)_2}$ (MM) $\times \frac{1\text{ mol Cu}}{1\text{ mol } Cu(NO_3)_2}$ (R) $\times \frac{(6.02\times10^{23})\text{ molec Cu}}{1\text{ mol Cu}} = 1.284\times10^{24}$ Cu atoms

C- If 7.5×10^4 molecules of Ag are available, how many moles of silver nitrate $AgNO_3$ would react with it?

G: $7.5\times10^4\text{ molec Ag} \times \frac{1\text{ mol Ag}}{(6.02\times10^{23})\text{ molec Ag}} \times \frac{2\text{ mol } Ag(NO_3)_2}{2\text{ mol Ag}} = 1.2\times10^{-19}$ moles $AgNO_3$

8. Use the equation below to solve questions A, B and C.

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

A- If 700.0 g of water was produced, how many molecules of magnesium chloride ($MgCl_2$) must have reacted with the oxygen?

Given $700.0\text{ g } H_2O \times \frac{1\text{ mol } H_2O}{18.02\text{ g } H_2O}$ (MM) $\times \frac{1\text{ mol } MgCl_2}{2\text{ mol } H_2O}$ (R) $\times \frac{(6.02\times10^{23})\text{ mol } MgCl_2}{1\text{ mol } MgCl_2} = 1.169\times10^{25}$ molecules

B- If 3.3×10^9 molecules of HCl are available, how many moles of water react with it?

Given $3.3\times10^9\text{ molec HCl} \times \frac{1\text{ mol HCl}}{(6.02\times10^{23})\text{ molec HCl}} \times \frac{2\text{ mol } H_2O}{2\text{ mol HCl}} = 5.5\times10^{-15}$ mol H_2O

C- If 100.0 g of water was produced, how many molecules of hydrochloric acid (HCl) was needed?

Given $100.0\,g\,H_2O \times \frac{1\,mol\,H_2O}{18.02\,g\,H_2O} \times \frac{2\,mol\,HCl}{2\,mol\,H_2O} \times \frac{6.04\times10^{23}\,molec\,HCl}{1\,mol\,HCl} = 3.341\times10^{24}\,molec\,HCl$

9. 200.0 mL of NaI whose concentration is 2.0 M are reacted with $Pb(NO_3)_2$ in order to obtain the precipitate PbI_2. Calculate the mass of PbI_2 obtained.

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

$\frac{2.0\,mol}{L} = \frac{x}{.2L} = .4\,mol$

$.4\,mol\,NaI \times \frac{1\,mol\,PbI_2}{2\,mol\,NaI} \times \frac{461\,g\,PbI_2}{1\,mol\,PbI_2} = 92\,g\,PbI_2$

10. 75mL of $BaCl_2$ is used to produce $BaCrO_4$. If 4.81g of $BaCrO_4$ is made, what is the concentration of the $BaCl_2$ used? The following equation represents the reaction: (.075L) (= mol/L)

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

$4.81\,g\,BaCrO_4 \times \frac{1\,mol\,BaCrO_4}{253.33\,g\,BaCrO_4} \times \frac{1\,mol\,BaCl_2}{1\,mol\,BaCrO_4} = \frac{.0189870920\,mol}{.075L} = .25\,mol/L$

11. How many mL (volume) of a 6.0M solution of HCl are needed to react with 4.85g of $NaHCO_3$? The equation that represents the reaction follows.

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

Given $4.85\,g\,NaHCO_3 \times \frac{1\,mol\,NaHCO_3}{84.01\,g\,NaHCO_3} \times \frac{1\,mol\,HCl}{1\,mol\,NaHCO_3} = .0577222\,mol$

$\frac{6.0\,mol}{L} = \frac{.055\ldots}{x} = 9.6mL$

12. Sandy neutralizes 200mL of HCL at a concentration of 1.5mol/L using $Ca(OH)_2$ according to the following equation:

$$2HCl + Ca(OH)_2 \rightarrow CaCl_2 + 2\,H_2O$$

$\frac{1.5\,mol}{L} = \frac{x}{.2L} = .3\,mol$

After the neutralization, she allows the water from the beaker to evaporate. What is the mass of the $CaCl_2$ that will be left in the beaker?

Given $.3\,mol\,HCl \times \frac{1\,mol\,CaCl_2}{2\,mol\,HCl} \times \frac{110.97\,g\,CaCl_2}{1\,mol\,CaCl_2} = 20\,g\,CaCl_2$