Stoichiometry Class notes

4 types of questions

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- Gram to gram question (steps 1-4)
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?

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

b- Gram to moles question (steps 1-3)
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?

$$2.0\,g\,Ag \times \frac{1\,mol\,Ag}{107.87\,g\,Ag} \times \frac{1\,mol\,Cu}{2\,mol\,Ag} = 0.0093\,mol\,Cu$$

c- Moles to gram question (steps 1, 3 and 4)
You have 1.5 moles of $Cu(NO_3)_2$, what mass of $AgNO_3$ was needed for the reaction to occur?

$$1.5\,mol\,Cu(NO_3)_2 \times \frac{2\,mol\,AgNO_3}{1\,mol\,Cu(NO_3)_2} \times \frac{169.88\,g\,AgNO_3}{1\,mol\,AgNO_3} = 510\,g\,AgNO_3$$

d- Moles to moles question (steps 1 and 3)
You have 3.0 moles of $Cu(NO_3)_2$, how many moles of $AgNO_3$ was needed for the reaction to occur?

$$3.0\,mol\,Cu(NO_3)_2 \times \frac{2\,mol\,AgNO_3}{1\,mol\,Cu(NO_3)_2} = 6\,mol\,AgNO_3$$

Atoms and molecules questions – 4 types

2. 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- Atom (or molecules) to grams (Steps 1-4)
If 3.33×10^7 atoms of Cu are available, how many grams of silver nitrate $AgNO_3$ would react with it?

$$3.33\times10^{7}\,\text{Cu atoms} \times \frac{1\,\text{mol Cu}}{(6.02\times10^{23})\,\text{Cu atoms}} \times \frac{2\,\text{mol AgNO}_3}{1\,\text{mol Cu}} \times \frac{169.88\,\text{g AgNO}_3}{1\,\text{mol AgNO}_3} = 1.88\times10^{-14}\,\text{g AgNO}_3$$

B- Grams to atoms (or molecule) (Steps 1-4)
If 400.0 g of copper nitrate $Cu(NO_3)_2$ was produced, how many Cu atoms must have reacted with the copper nitrate?

$$400.0\,\text{g Cu(NO}_3)_2 \times \frac{1\,\text{mol Cu(NO}_3)_2}{187.5\,\text{g Cu(NO}_3)_2} \times \frac{1\,\text{mol Cu}}{1\,\text{mol Cu(NO}_3)_2} \times \frac{6.02\times10^{23}\,\text{Cu atoms}}{1\,\text{mol Cu}} = 1.284\times10^{24}\,\text{Cu atoms}$$

C- Atoms (or molecules) to moles (Steps 1-3)
If 7.5×10^4 Ag atoms are available, how many moles of silver nitrate $AgNO_3$ would react with it?

$$7.5\times10^{4}\,\text{Ag atoms} \times \frac{1\,\text{mol Ag}}{(6.02\times10^{23})\,\text{Ag atoms}} \times \frac{2\,\text{mol AgNO}_3}{2\,\text{mol Ag}} = 1.2\times10^{-19}\,\text{mol AgNO}_3$$

D- Moles to molecules (or atoms) (steps 1, 3 and 4)
If 3.0 moles of Cu were used in the reaction, how many molecules of $Cu(NO_3)_2$ would be produced?

$$3.0\,\text{mol Cu} \times \frac{1\,\text{mol Cu(NO}_3)_2}{1\,\text{mol Cu}} \times \frac{6.02\times10^{23}\,\text{molec Cu(NO}_3)_2}{1\,\text{mol Cu(NO}_3)_2} = 1.8\times10^{24}\,\text{molecules Cu(NO}_3)_2$$

Mole and stoichiometry combination questions

3. 'Given' not in problem, must find given to solve question

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.

$n = CV$ (or Ratio)

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

$\frac{2.0\,mol}{L} \times .2000L = .4\,mol$ (Given)

$$.4\,mol\,NaI \times \frac{1\,mol\,PbI_2}{2\,mol\,NaI} \times \frac{461.00g\,PbI_2}{1\,mol\,PbI_2} = 92g\,PbI_2$$

4. Looking for molar concentration mol/L

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:

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

$$4.81g\,BaCrO_4 \times \frac{1\,mol\,BaCrO_4}{253.33g\,BaCrO_4} \times \frac{1\,mol\,BaCl_2}{1\,mol\,BaCrO_4} = \frac{0.0189...\,mol}{.075L}$$

$= .25\,mol/L$

5. Looking for volume L

What 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.

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

$$4.85g\,NaHCO_3 \times \frac{1\,mol\,NaHCO_3}{84.01g\,NaHCO_3} \times \frac{1\,mol\,HCl}{1\,mol\,NaHCO_3} = \frac{0.057732\,mol\,HCl}{x} = \frac{6\,mol}{L}$$

$.0096L$

Practice Questions

1. 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?

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

b- You have 4.0 moles of HCl, how many moles of H_2O is required to neutralize the 4 moles of HCl?

$$4.0\,\text{mol HCl} \times \frac{2\,\text{mol } H_2O}{2\,\text{mol HCl}} = 4.0\,\text{mol } H_2O$$

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

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

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

$$448\,\text{g Fe} \times \frac{1\,\text{mol Fe}}{55.85\,\text{g Fe}} \times \frac{2\,\text{mol } Fe_2O_3}{4\,\text{mol Fe}} \times \frac{159.70\,\text{g } Fe_2O_3}{1\,\text{mol } Fe_2O_3} = 641\,\text{g } Fe_2O_3$$

3. Using the formula $3\,CuO + 2\,NH_3 \rightarrow N_2 + 3\,Cu + 3\,H_2O$

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

$$7.00\,\text{g Cu} \times \frac{1\,\text{mol Cu}}{63.55\,\text{g Cu}} \times \frac{2\,\text{mol } NH_3}{3\,\text{mol Cu}} = 0.0734\,\text{mol } NH_3$$

4. Use the equation below to solve questions A and B

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

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

$$700.0\,\text{g } H_2O \times \frac{1\,\text{mol } H_2O}{18.02\,\text{g } H_2O} \times \frac{1\,\text{mol } MgCl_2}{2\,\text{mol } H_2O} \times \frac{6.02\times10^{23}\,\text{molec } MgCl_2}{1\,\text{mol } MgCl_2} = 1.169\times10^{25}\,\text{molec } MgCl_2$$

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

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