Name:______________________ Chem 11 Block _____ March 10, 2017

Percentage Purity and Percentage Yield

Percentage Purity:

Virtually impossible to obtain a chemical in a pure form. Purity of a chemical is determined by:

$$Percentage\ purity\ (by\ mass) = \frac{mass\ of\ pure\ chemical}{mass\ of\ impure\ sample} \times 100\%$$

Common questions:

1. $\underline{2}Al(s) + \_\_Fe_2O_3(s) \rightarrow \_\_Al_2O_3(s) + \underline{2}Fe(s)$ $O^{2-}: 2- \times 3 = 6-$
   a. Balance the equation
   b. Determine the charge on iron based on Fe_2O_3 & no overall charge ∴ $Fe = 6+$ $\frac{6}{2} = \boxed{3+}$
   c. If 2.44g of 95% pure aluminum is reacted, how many grams of aluminum oxide can be produced?

imp(g) and %p

$\%p = \frac{p(g)}{imp(g)} \times 100\%$

$2.31g\ of\ Al \times \frac{1\ mol\ Al}{26.98g\ of\ Al} \times \frac{1\ mol\ Al_2O_3}{2\ mol\ Al} \times \frac{101.96g}{mol\ Al_2O_3}$

$p(g) = \frac{\%p}{100\%} \times imp(g) = \frac{95\%}{100\%} \times 2.44g = 2.31g$ of Al (pure) $\boxed{= 4.36g\ of\ Al_2O_3}$

2. Automotive air bags inflate when solid sodium azide (NaN_3) decomposes explosively into its constituent elements. What volume of nitrogen gas is formed if 120g of 85% pure sodium azide decomposes? Assume STP conditions.

$\underline{2}NaN_3 \rightarrow \underline{2}Na + \underline{3}N_2$ *note: N is a diatomic

$p(g) = \frac{\%p}{100\%} \times imp(g) = \frac{85\%}{100\%} \times 120g$ of impure NaN_3 $= 102g$ of NaN_3 (pure)

$102g\ of\ NaN_3 \times \frac{1\ mol\ NaN_3}{65.02g} \times \frac{3\ mol\ N_2}{2\ mol\ NaN_3} \times \frac{22.4L}{1\ mol}$ $\boxed{= 53L}$

3. When dilute hydrochloric acid is added to 5.73g of contaminated calcium carbonate, 2.49g of CO_2 is produced. What was the percentage purity of the calcium carbonate?

$\underline{2}HCl + \_\_CaCO_3 \rightarrow \_\_CO_2 + \_\_H_2O + \_\_CaCl_2$

$2.49g\ of\ CO_2 \times \frac{1\ mol\ CO_2}{44.01g} \times \frac{1\ mol\ CaCO_3}{1\ mol\ CO_2} \times \frac{100.09g}{mol\ CaCO_3} = 5.66g$ of pure $CaCO_3$

$\%p = \frac{5.66g}{5.73g} \times 100\%$ $\boxed{= 98.8\%}$

4. $\_\_Mg(OH)_2 + \_\_H_3PO_4 \rightarrow \_\_Mg_3(PO_4)_2 + \_\_H_2O$
   a. Balance the equation
   b. Calculate the percent purity of a sample of $Mg(OH)_2$ if titration of 2.568g of the sample required 38.45mL of 0.6995M H_3PO_4

n (moles)
C V (volume)
(concentration=molarity)

$M = \frac{moles}{L}$

moles = C × V

$= 0.6995M \times \left(38.45mL \times \frac{1L}{1000mL}\right)$

$= 0.02689$ moles of H_3PO_4 $\times \frac{3\ mol\ Mg(OH)_2}{2\ mol\ H_3PO_4} \times \frac{58.33g}{mol\ Mg(OH)_2} = 2.353g$ of pure $Mg(OH)_2$

$\%p = \frac{2.353g}{2.568g} \times 100\% = \boxed{91.63\%}$

Miss Chatrath

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Percentage Yield:

Some reactions complete themselves only partially (not all of the limiting reactant has been converted into product). To compare how much has actually been obtained to what was expected we use:

$$Percentage\ yield = \frac{amount\ of\ product\ obtained}{amount\ of\ product\ expected} \times 100\%$$

Amount of product expected is commonly referred to as the *theoretical yield*

Common Questions

1. GeF3H is synthesized in the reaction: $GeH_4 + 3GeF_4 \rightarrow 4GeF_3H$. If the reaction yield is 91.5%, how many moles of GeH_4 are needed to produce 12.00 mol of GeF_3H?

$\%y = \frac{pdt.ob}{pdt.ex} \times 100\%$

$13.11\ mol\ GeF_3H \times \frac{1\ mol\ GeH_4}{4\ mol\ GeF_3H} = \boxed{3.278\ mol\ of\ GeH_4}$

$pdt\ ex = pdt\ ob \times \frac{100\%}{\%y} = 12.00\ mol \times \frac{100\%}{91.5\%} = 13.11\ mol$ of GeF_3H expected

2. What mass of silver could be formed if a large zinc wire is placed in a beaker containing 145.0mL of 0.095 mol/L silver nitrate and allowed to react overnight? Assume the reaction has a 97% yield $1\ Zn + 2\ AgNO_3 \rightarrow 2\ Ag + 1\ Zn(NO_3)_2$

$mol = \frac{0.095\ mol}{L} \times \left(145.0\ mL \times \frac{1L}{1000\ mL}\right)$

$= 0.013775...\ mol\ of\ AgNO_3 \times \frac{2\ mol\ Ag}{2\ mol\ AgNO_3} \times \frac{107.87g}{mol\ Ag} = 1.486g$ of Ag obtained

$\%y = \frac{pdt\ ob}{pdt\ ex} \times 100 \rightarrow pdt\ ex = pdt\ ob\ \frac{100\%}{\%y}$

$= 1.486g\ \frac{100\%}{97\%}$

$= 1.532g$ of Ag

$= \boxed{1.5g\ of\ Ag}$ expected

3. Copper (II) oxide reacts with hydrogen gas to form water and copper metal. From this reaction, 3.6g of copper metal was obtained with a yield of 32.5%. What mass of copper(II) oxide was reacted with the excess hydrogen gas? Begin with a balanced equation.

$\_CuO + \_H_2 \rightarrow \_H_2O + \_Cu$

$pdt.ex = pdt.ob \times \frac{100\%}{32.5\%}$ (3.6) $= 11g\ of\ Cu \times \frac{1\ mol\ Cu}{63.55g} \times \frac{1\ mol\ CuO}{1\ mol\ Cu} \times \frac{79.55g}{1\ mol\ CuO} = \boxed{14g\ of\ CuO}$

4. 32g of O_2 react with 11g of C_3H_8:
   a. Balanced equation?
   b. Limiting reagent?
   c. Theoretical yield of water?

$1\ C_3H_8 + 5\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$

c). start with limiting reagent: 32g O_2

$32g$ of $O_2 \times \frac{1\ mol}{32.00g} = 1.0\ mol$ of O_2 (given) $\times \frac{1\ mol\ C_3H_8}{5\ mol\ O_2} = 0.20\ mol$ of C_3H_8 required

$32g\ O_2 \times \frac{mol\ O_2}{32.00g} \times \frac{4\ mol\ H_2O}{5\ mol\ O_2} \times \frac{18.02g}{1\ mol\ H_2O}$

$11g$ of $C_3H_8 \times \frac{1\ mol}{42.09g} = 0.26\ mol$ of C_3H_8 (given) $\times \frac{5\ mol\ O_2}{1\ mol\ C_3H_8} = 1.3\ mol$ of O_2 required

c) $\boxed{=14g\ of\ H_2O}$

b.) O_2 (oxygen is our limiting reagent). C_3H_8 is in XS as the amount required < given