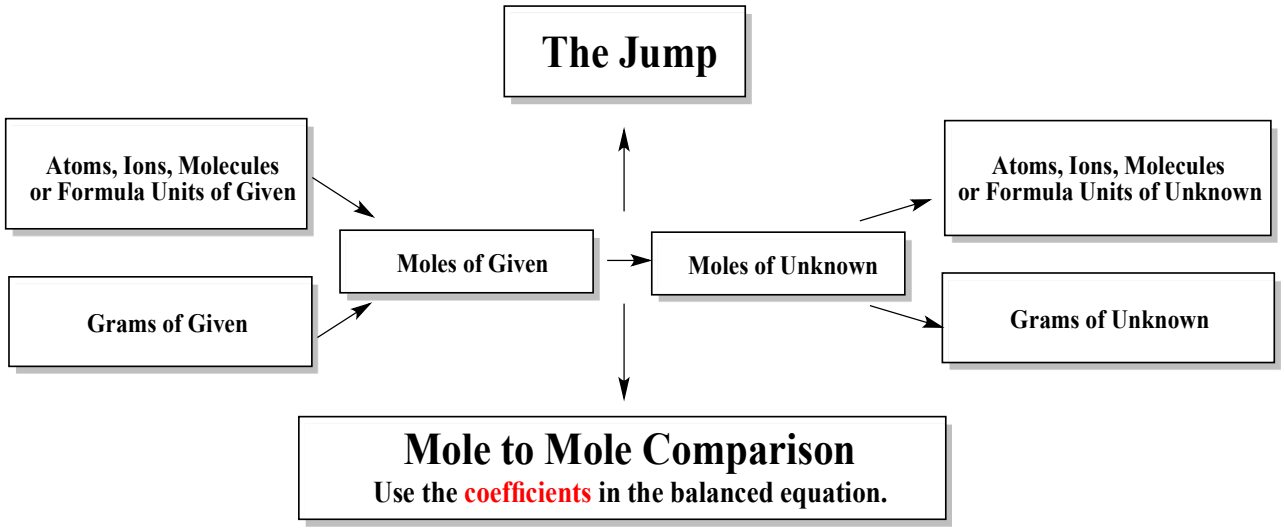
CONCEPT: TITRATIONS

Gravimetric Analysis is a chemical analysis that involves determining the weight of an isolated product and *stoichiometry* is the calculations of compounds from a balanced chemical reaction.

We use this *Stoichiometric Chart* when we are given a balanced chemical equation with the known quantity of a compound or element and asked to find the unknown quantity of another compound or element.



EXAMPLE: Iron (III) can be oxidized by an acidic $K_2Cr_2O_7$ solution according to the net ionic equation below. How many microliters of a 0.250 M $FeCl_2$ are needed to completely react with 9.12 g of a compound containing 41.5% weight $K_2Cr_2O_7$?

$$Cr_2O_7^{2-} + 6\ Fe^{2+} + 14\ H^+ \longrightarrow 2\ Cr^{3+} + 6\ Fe^{3+} + 7\ H_2O$$

CONCEPT: TITRATION CALCULATIONS 1

EXAMPLE 1: Magnesium reacts with HCl according to the reaction below. How many grams of 5.310% by weight of aqueous magnesium are required to provide a 25% excess to react with 75.0 mL of 0.0550 M HCl.

$$Mg\ (s) + 2\ HCl\ (aq) \longrightarrow MgCl_2\ (aq) + H_2\ (g)$$

EXAMPLE 2: The amount of iron within an ore sample was determined by an oxidation-reduction titration using potassium permanganate, $KMnO_4$, as the titrant. A 0.5600 g sample of the ore was placed into acid and the newly freed Fe^{3+} was then reduced to Fe^{2+}. The titration of this solution required 39.82 mL of 0.0315 M $KMnO_4$ to reach the end-point. Determine the mass percent of Fe_2O_3 in the sample.

$$MnO_4^- + 5\ Fe^{2+} + 8\ H^+ \rightleftharpoons Mn^{2+} + 5\ Fe^{3+} + 4\ H_2O$$

CONCEPT: TITRATION CALCULATIONS 2

EXAMPLE 1: A 0.4317 g sample of $CaCO_3$ (MW: 100.09 g/mol) is added to flask that also contained 12.50 mL of 1.530 M HBr.

$$CaCO_3\,(aq) + 2\,HBr\,(aq) \longrightarrow CaBr_2\,(aq) + H_2O\,(l) + CO_2\,(g)$$

Additional water is then added to create a 250.0 mL of Solution A. Next 20.00 mL aliquot of solution A is taken and titrated with 0.0980 M NaOH. How many milliliters of NaOH were used?

$$NaOH\,(aq) + HBr\,(aq) \longrightarrow H_2O\,(l) + NaBr\,(aq)$$

EXAMPLE 2: The amount of iron can be determined by using dichromate to oxidize Fe^{2+} to Fe^{3+}. The equation for this process is shown below:

$$Cr_2O_7^{2-}\,(aq) + 6\,Fe^{2+}\,(aq) + 14\,H^{+}\,(aq) \longrightarrow 6\,Fe^{3+}\,(aq) + 2\,Cr^{3+}\,(aq) + 7\,H_2O\,(l)$$

Determine the percent by mass of iron in 0.3500 g ore sample if the complete titration of Fe^{2+} required 20.7 mL of 0.0185 M $Cr_2O_7^{2-}$.

CONCEPT: TITRATION CALCULATIONS 3

EXAMPLE: What is the molar mass of a 0.750 g sample of a diprotic binary acid if it requires 50.0 mL of 0.440 M $Ca(OH)_2$ to completely neutralize it?

PRACTICE: A 1.000 g sample of Na_2CO_3 (MW: 105.99 g/mol) is dissolved in enough water to make 200.0 mL of solution. A 25.00 mL aliquot required 32.18 mL of HCl to completely neutralize it. What is the molar concentration of HCl?

$$Na_2CO_3\,(aq) + 2\,HCl\,(aq) \longrightarrow 2\,KCl\,(aq) + H_2O(l) + CO_2\,(g)$$