Gravimetric analysis

Gravimetric analysis describes a set of methods used in analytical chemistry for the quantitative determination of an analyte (the ion being analyzed) based on its mass. The principle of this type of analysis is that once an ion's mass has been determined as a unique compound, that known measurement can then be used to determine the same analyte's mass in a mixture, as long as the relative quantities of the other constituents are known.

The four main types of this method of analysis are

1-precipitation

2- volatilization

3-electro-analytical

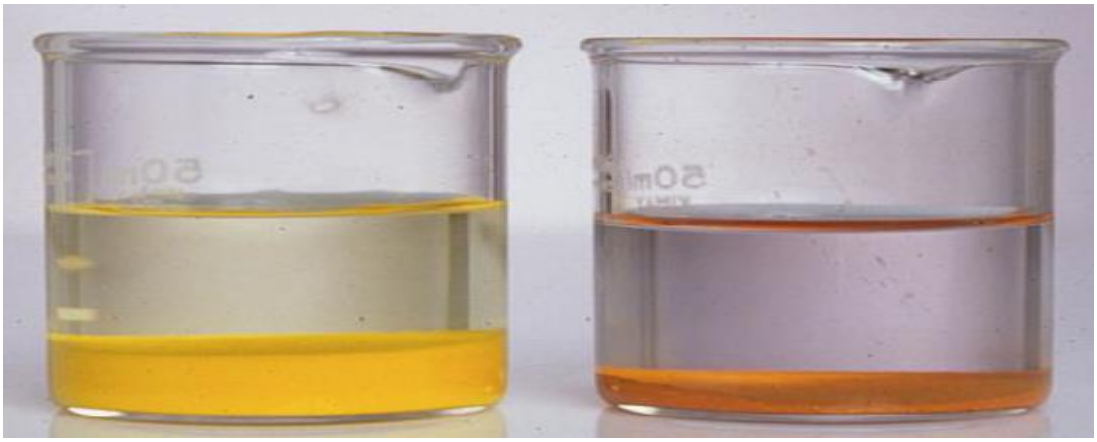
4- miscellaneous physical method.

The methods involve changing the phase of the analyte to separate it in its pure form from the original mixture and are quantitative measurements.

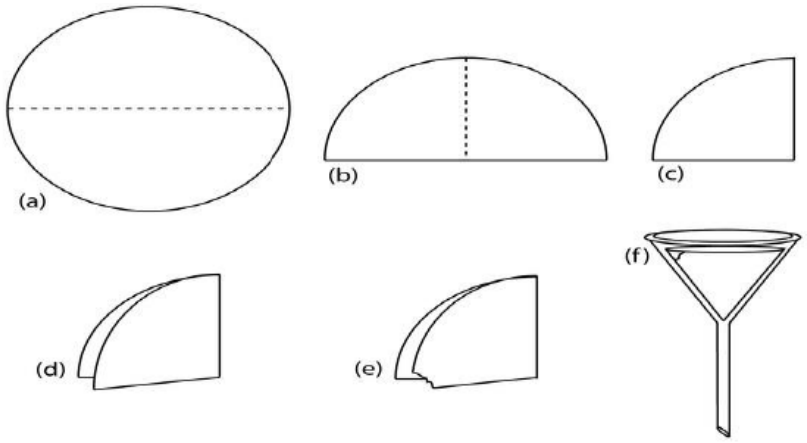
Step of gravimetric analysis

1. The sample is dissolved (water ,acid and base), if it is not already in solution.

2. The solution may be treated to adjust the pH (so that the proper precipitate is formed, or to suppress the formation of other precipitates).



3. The precipitating reagent is added at a concentration that favors the formation of a "good" precipitate . This may require low concentration, extensive heating, or careful control of the pH. Digestion can help reduce the amount of coprecipitation.
4. After the precipitate has formed and been allowed to "digest", the solution is carefully filtered. The filter is used to collect the precipitate; smaller particles are more difficult to filter.



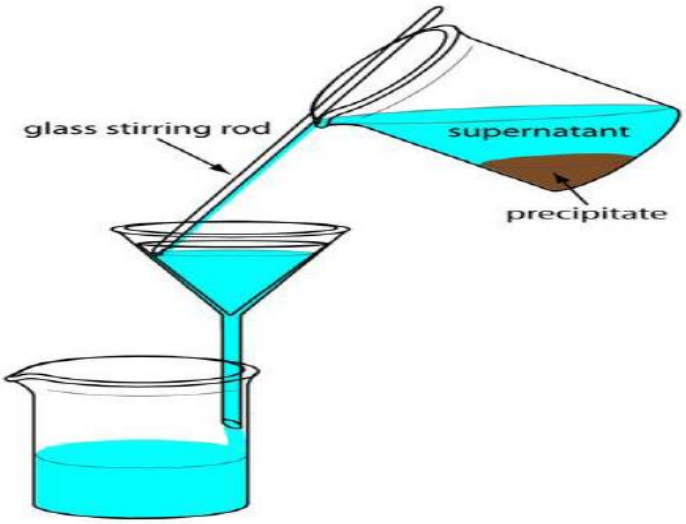


Figure 2 Proper procedure for transferring the supernatant to the filter paper cone.

5. After filtration, the precipitate – including the filter paper or crucible – is heated, or charred. This accomplishes the following:
6. After the precipitate is allowed to cool (preferably in a desiccator to keep it from absorbing moisture), it is weighed (in the crucible). To calculate the final mass of the analyte, the starting mass of the empty crucible is subtracted from the final mass of the crucible containing the sample. Since the composition of the precipitate is known, it is simple to calculate the mass of analyte in the original sample.

$$\% \text{ analyte} = \frac{weight\ of\ analyte}{weight\ of\ sample} \text{ X100}$$

Gravimetric Factor(G.F)

$$\mathbf{G.F} = \frac{\textbf{equivelent weight of unknown substance}}{\textbf{equivelent weight of known substance}} \mathbf{X} \frac{a}{b}$$

Where a/b : is the stoichiometric ratio between the element and the precipitate

For example ,if is required to determine the percentage of chloride in sample ,then chloride ion is converted by precipitating reagent to AgCl

cl^- = Agcl

cl_2 = 2Agcl

a b

$$\frac{gCl2}{gAgCl} = \frac{M.wt\ CL2}{M.wt\ AgCl} X \frac{1\ mole\ Cl2}{2\ mole\ AgCl}$$

Similarity cl_2 = $pbcl_2$:

$$\frac{gCl2}{gpbCl2} = \frac{M.wt\ CL2}{M.wtpbCl2} X \frac{1\ mole\ Cl2}{1\ mole\ pbCl2}$$

$$\%\ substance\ A = \frac{G.F * wt.of\ substance\ B}{wt.of\ sample} X100$$

The following some some common examples of the gravimetric factor

Sought sub.	weighted ppt.	G.F.
SO_4^{-2}	$BaSO_4$	$\frac{Mwt.\ SO_4}{Mwt.\ BaSO_4}$
Fe	Fe_2O_3	$\frac{2Mwt.\ Fe}{Mwt.\ Fe_2O_3}$
CO_3^{-2}	$CaCO_3$	$\frac{Mwt.\ CO_3}{Mwt.\ CaCO_3}$
P	$Mg_2P_2O_7$	$\frac{2Mwt.\ P}{Mwt.\ Mg_2P_2O_7}$

Example2: The phosphate in a 0.68 gm mineral sample was precipitated as $MgNH_4PO_4$. This yield 0.435 gm of $Mg_2P_2O_7$ by ignition, Calculate the percentage of P in the sample?

Solution:

$$\%P = \frac{wt.\ of\ P}{wt.\ of\ sample} * 100$$

$$wt.\ of\ P = wt.\ of\ Mg_2P_2O_7 * G.F. \quad \left(\frac{2\ Mwt.\ P}{Mg_2P_2O_7}\right)$$

$$= 0.435 * \frac{2 * 30.9}{222.4}$$

$$= 0.1209\ gm$$

$$\%P = \frac{0.1209\ gm}{0.68\ gm} * 100 = 17.8\%$$

Example 1: 1.5 gm sample contain Cl^-. If we added $AgNO_3$ to solution produced precipitate from silver chloride weighted 0.9214 gm. compute percentage of chloride in the sample?

Solution:

$$G.F = \frac{Mwt.\ Cl^-}{Mwt.\ AgCl}$$

wt. of Cl^- = wt. of AgCl * G.F

$$= 0.9214 * \frac{35.5}{143.4} = 0.2282 \text{ gm } Cl^-$$

$$\% Cl = \frac{0.2282 \text{ gm}}{1.5 \text{ gm}} * 100 = 15.2\%$$