Gravimetry

Dr. Mai Ramadan

Gravimetry

Definition:

It is a method based on measurement of weight of an analyte or a compound containing the analyte. (Analysis by weighing)

Types:

Precipitation method

Volatilization method

Gravimetry

Precipitation method:

The species to be determined is precipitated by a reagent that yields a sparingly soluble product (or a product of known composition, or a product that can be converted to one of known composition).

Precipitation method

Examples:

Determination of barium is performed by precipitation using sulfate as precipitating agent. The precipitate is $BaSO_4$ which remains after ignition up to 800 °C as $BaSO_4$

$$Ba^{+2} + SO_4^{-2} \longrightarrow BaSO_4.XH_2O \xrightarrow[-\,X\,H_2O]{800\ °C} BaSO_4$$

Precipitation method

Examples:

Ca^{+2} in water is determined by precipitating with oxalate. The formed Ca oxalate undergoes decomposition during ignition. The weighed substance at the end of process is then CaO.

$$Ca^{+2} + C_2O_4^{-2} \longrightarrow \underset{\substack{\downarrow \\ \text{precipitating} \\ \text{form}}}{CaC_2O_4.XH_2O} \xrightarrow[-\,X\,H_2O]{900\,^\circ C} \underset{\substack{\downarrow \\ \text{weighing} \\ \text{form}}}{CaO} + CO_2 + CO$$

Precipitation method

Examples:

To precipitate phosphate Mg^{+2}/ NH_3 buffer is added

$$PO_4^{-3} + Mg^{+2} + NH_4^{+} \longrightarrow MgNH_4PO_4.XH_2O\downarrow \xrightarrow[\substack{-X\,H_2O \\ -NH_3}]{900\,^{\circ}C} Mg_2P_2O_7\downarrow$$

precipitating form

weighing form

Precipitation method

Precipitating form

Weighing form

Gravimetry

Volatilization method:

The analyte (or its decomposition products) are volatilized at a suitable temperature. The volatilized species are collected and weighed directly or weighed by difference.

Example:

$$NaHCO_3 + H_2SO_4 \longrightarrow CO_2\,(g) + H_2O + NaHSO_4$$

$Wt\ CO_2 = X_t - X_o$

Xt: wt of media after absorption

Xo: original weight of media

Steps of precipitation method

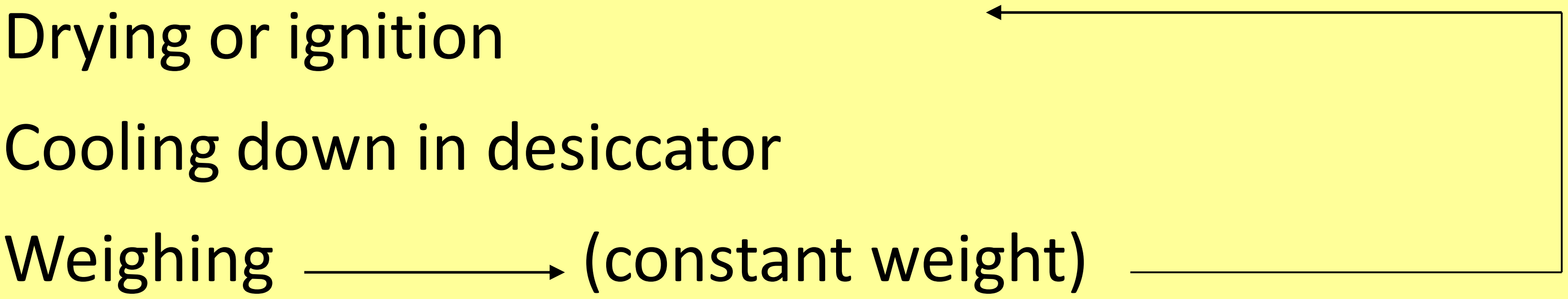
Sample preparation

Addition of precipitating solution

Digestion

Filtration

Washing



Drying or ignition

Cooling down in desiccator

Weighing → (constant weight)

Calculation

Steps of precipitation method

Sample preparation

The sample should be weighed, grounded and then dissolved. pH adjustment could be needed.

Addition of precipitating agent

This stage is critical for the precipitate, since it influences its physical properties.

Precipitating agent should be added hot, diluted, slowly and under stirring.

Steps of precipitation method

Digestion: the precipitate is allowed to stand in the presence of the mother liquor at elevated temp. or by room temp. and large particles grow at the expense of small ones.

Digestion improves the purity and filtrability of both colloidal and crystalline ppt.

This process includes the dissolution and recrystallization of small particles which results in bridging between particles to form a larger, easily filtrable one.

Steps of precipitation method

Filtration:

separation of the precipitate from the mother liquor.

Filtration should be accelarated using Buchner funnel.

The media employed for filtration are:

***Filter paper*:**

It has a very small ash content, retain the smallest particles of precipitate (Porosity) and permit rapid filtration.

Steps of precipitation method

Sintered-glass filtering crucible:

It is made of resistance glass and have a porous disc

(*various porosity indicated from 0-5, see Tab.*)

It should not be heated above 200°C.

Don,t use for strongly alkaline

Porosity	0	1	2	3	4	5
Pore diameter (µm)	200-250	100-120	40-50	20-30	5-10	1-2

Porcelain filtering crucible: porous filter base, can be heated to higher temprature.

Steps of precipitation method

Washing:

to remove impurities adsorbed on the surface

after filtration using destilled water for several times.

Drying and ignition

Drying:

removes the solvent(s) of the mother liquid from which the

precipitate was formed. For Temp. up to 250 °C a

thermostatically controlled electric oven is used.

Steps of precipitation method

Ignition:

converts the precipitate to a known composition called the *weighing form.* For higher Temp. a muffle furnace is used.

Drying/ignition behavior

Consider calcium oxalate

Around 145 °C, calcium oxalate exists as $CaC_2O_4.H_2O$.

Around 225 °C, calcium oxalate exists as CaC_2O_4 .

Around 500 °C, calcium oxalate exists is converted to $CaCO_3$.

Above 900 °C, calcium carbonate is converted to CaO.

Steps of precipitation method

Ignition:

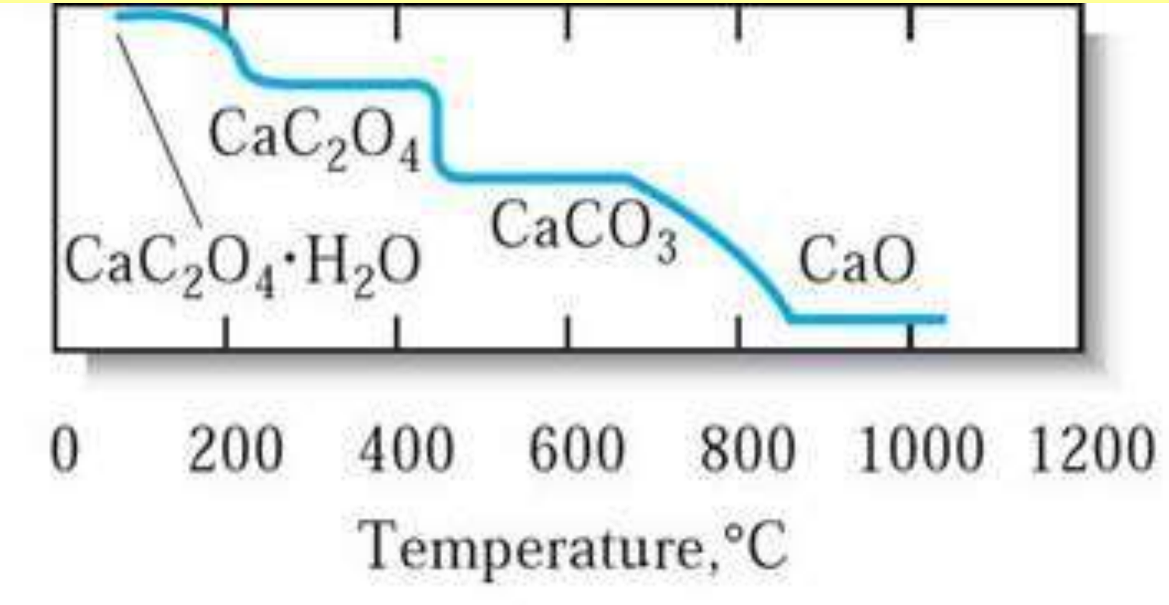


Figure 4-7 Effect of temperature on precipitate mass.

Steps of precipitation method

Cooling in desiccator:

The ppt should be put in desiccator after drying or ignition.

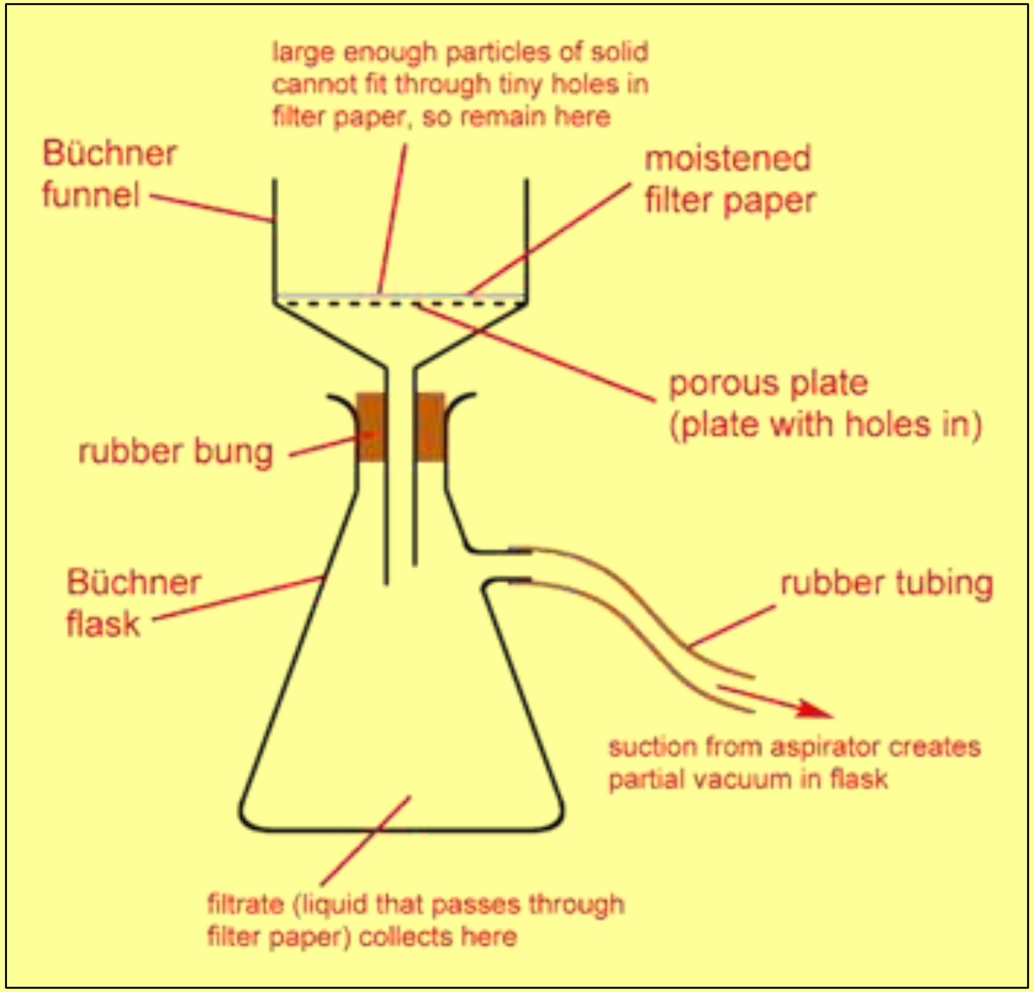
Weighing*:*

Using a digital calibrated balance. Drying process is repeated until the weight is not more changed.

Calculation:

It will be discussed later.

Steps of precipitation method



Glass filtering crucible

Desiccator

Formation of precipitate

Two steps are involved in this process:

1. ***Nucleation***: Formation of the smallest precipitate particles in a supersaturated solution, which are capable of spontaneous growth.

2. Particle Growth: Deposition of ions/molecules on the surface of the solid, nucleated particles.

To obtain particles with the best characters (large pure crystals) then form your precipitate slowly using warm, dilute solution with stirring then allow it to digest without stirring.

Gravimetry

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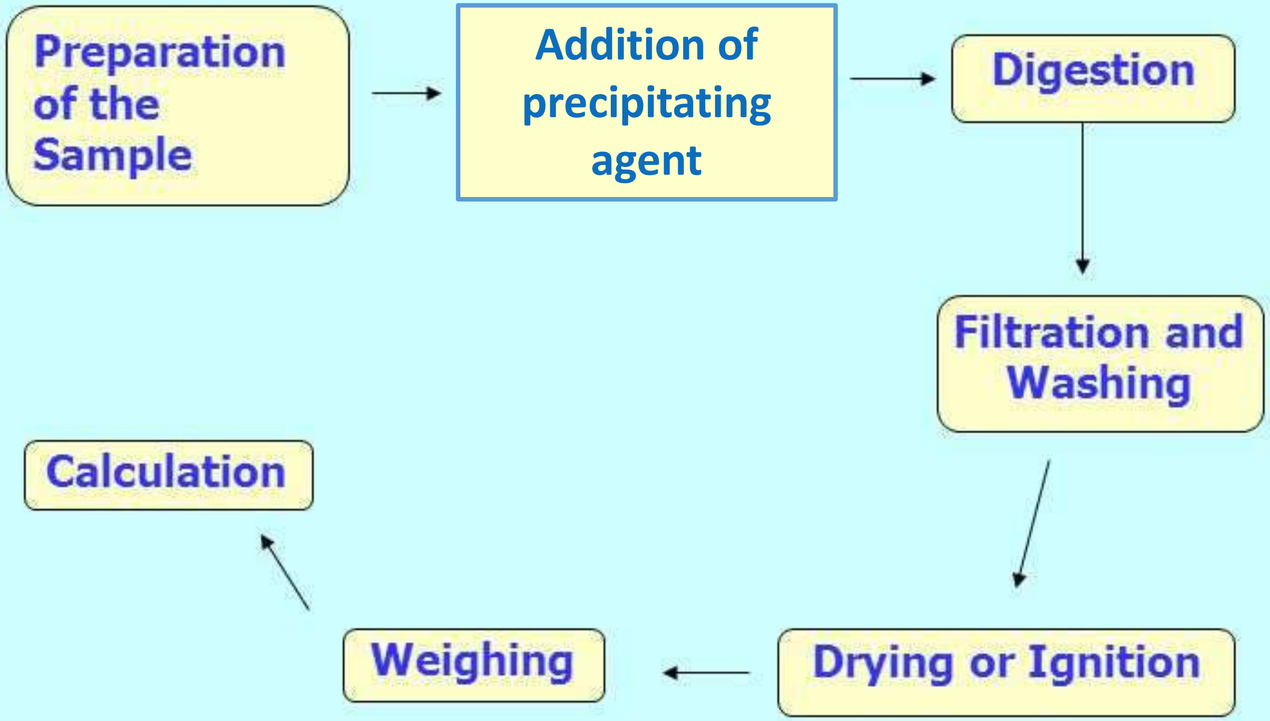
STEPS OF A GRAVIMETRY ANALYSIS



Preparation of the Sample

Addition of precipitating agent

Digestion

Filtration and Washing

Drying or Ignition

Weighing

Calculation

Mechanisms of Co-precipitation

Co-precipitation: is the precipitation of an otherwise soluble substance along with the insoluble material.

Mechanisms of Co-precipitation

1. Surface adsorption
2. Inclusion (mixed crystal formation, Isomorphous)
3. Occlusion
4. Postprecipitation

Mechanisms of Co-precipitation

Surface adsorption

it is a process in which a substance is held on the surface of a solid.

It can be removed by washing and digestion.

Inclusion (mixed crystal formation, Isomorphous)

Ions of the same charge and size are trapped within crystal lattice.

K^+ replaces NH_4^+ in $MgNH_4PO_4$, Sr^{+2} in BaSO4 and Mn^{+2} in CdS.

Mechanisms of Co-precipitation

Occlusion

In this process material that is not part of crystal structure is trapped in a pocket of a rapidly growing precipitate .

Both occlusion and occlusion can not be improved by washing. Digestion and re-precipitation can remove such impurities.

Mechanisms of Co-precipitation

Postprecipitation: CaC_2O_4 & Mg^{+2}
The precipitate causes a localized high concentration of unwanted species, when the precipitate allowed to stand in contact with the mother liquor.

To avoid post-precipitation a rapid filtration and removal of undesired ions before the precipitation are required.

Colloidal precipitate

Colloidal particles : According to particle size

$\geq 10^{-5}$	10^{-5} - 10^{-7}	$\leq 10^{-7}$ cm
suspension	colloid	solution

Colloidal particles do not settle out. Filtration is difficult due to plugging of pores in the filter, or passing through the filter.

$$\textbf{Colloid} \; \underset{\textbf{peptization}}{\overset{\textbf{Coagulation}}{\rightleftarrows}} \; \textbf{ppt}$$

Coagulation is accomplished by: Stirring, heating and by adding of an electrolyte

Colloidal precipitate

For example: precipitation of Cl^- with an excess of $AgNO_3$

NO_3^- NO_3^- NO_3^- } Counter-ion layer

Ag^+ Ag^+ Ag^+ }Primary adsorptive layer

Ag^+ Cl^- Ag^+ Cl^- Ag^+ Cl^- }Crystal

Colloidal precipitate

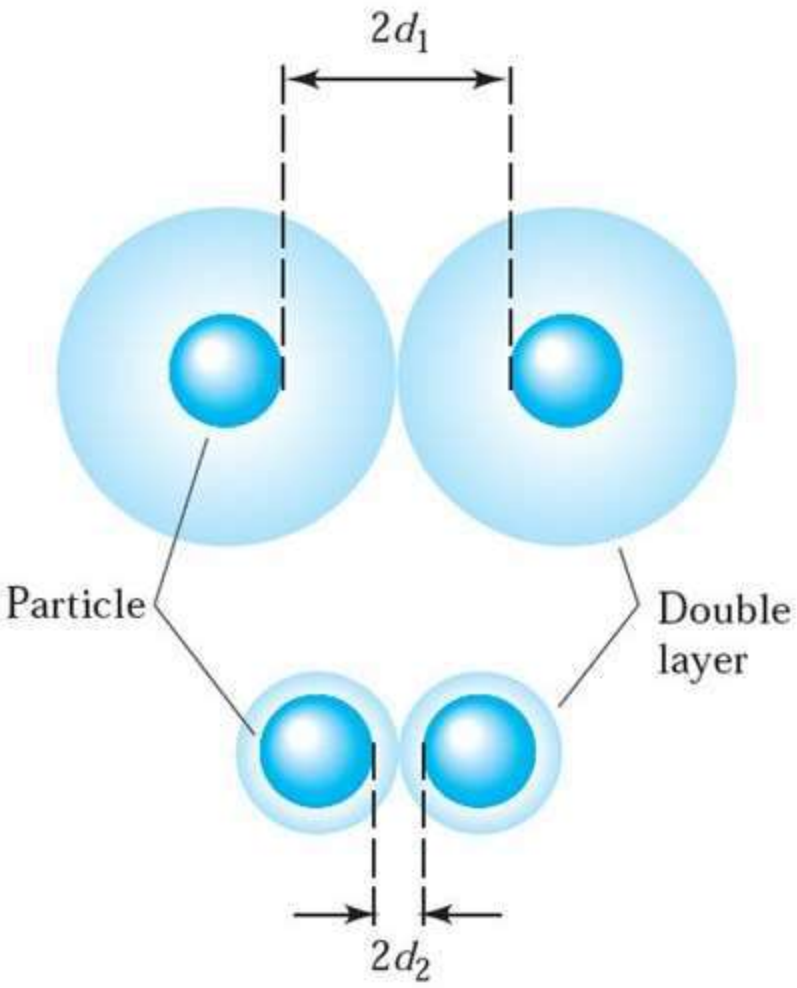


Figure 4-4 The electric double layer of a colloid consists of a layer of charge adsorbed on the surface of the particle (the primary adsorption layer) and a layer of opposite charge (the counter-ion layer) in the solution surrounding the particle. Increasing the electrolyte concentration has the effect of decreasing the volume of the counter-ion layer, thereby increasing the chances for coagulation.

Precipitation from homogenous solution

It is a technique in which a precipitating agent is generated in a solution of the analyte by a slow chemical reaction.

The relative supersaturation is kept low.

The precipitating agent is formed homogenously and reacts immediatly with the analyte.

Precipitation from homogenous solution

Example: Urea for Fe (III) and Al (III)

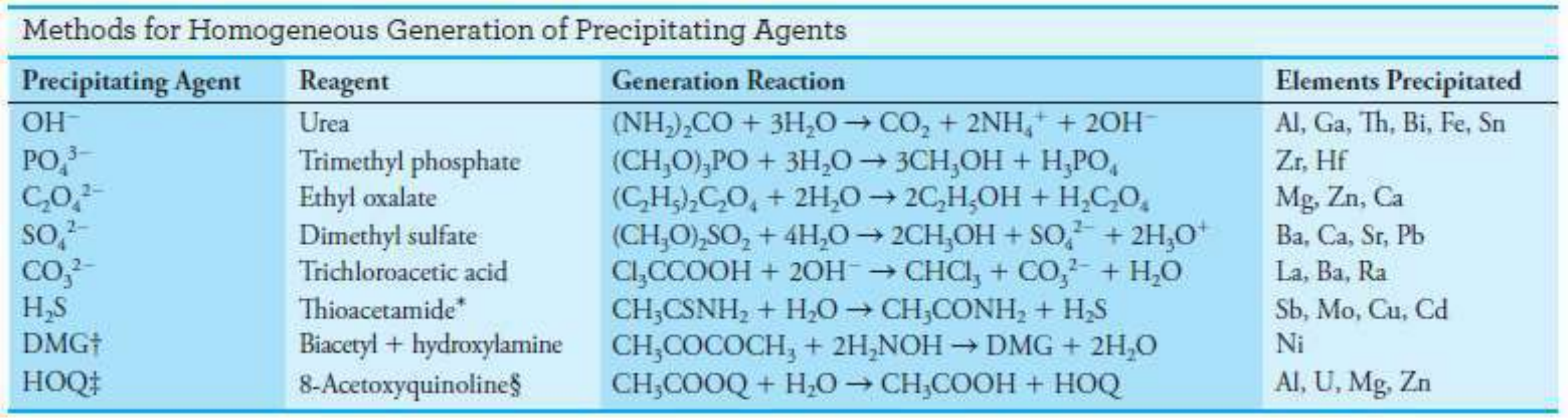
$$NH_2CONH_2 + 3\ H_2O \xrightarrow{\hspace{3cm}} CO_2 + 2\ NH_4^+ + 2\ OH^-$$

$$Fe^{+3} + 3\ OH^- \xrightarrow{\hspace{3cm}} Fe(OH)_3$$

Others: ethyl oxalate, trimethyl phosphate, dimethyl sulfate,

Thioacetamide (see table 5-3)

Precipitation from homogenous solution



Methods for Homogeneous Generation of Precipitating Agents

Precipitating Agent	Reagent	Generation Reaction	Elements Precipitated
OH^-	Urea	$(NH_2)_2CO + 3H_2O \rightarrow CO_2 + 2NH_4^+ + 2OH^-$	Al, Ga, Th, Bi, Fe, Sn
PO_4^{3-}	Trimethyl phosphate	$(CH_3O)_3PO + 3H_2O \rightarrow 3CH_3OH + H_3PO_4$	Zr, Hf
$C_2O_4^{2-}$	Ethyl oxalate	$(C_2H_5)_2C_2O_4 + 2H_2O \rightarrow 2C_2H_5OH + H_2C_2O_4$	Mg, Zn, Ca
SO_4^{2-}	Dimethyl sulfate	$(CH_3O)_2SO_2 + 4H_2O \rightarrow 2CH_3OH + SO_4^{2-} + 2H_3O^+$	Ba, Ca, Sr, Pb
CO_3^{2-}	Trichloroacetic acid	$Cl_3CCOOH + 2OH^- \rightarrow CHCl_3 + CO_3^{2-} + H_2O$	La, Ba, Ra
H_2S	Thioacetamide*	$CH_3CSNH_2 + H_2O \rightarrow CH_3CONH_2 + H_2S$	Sb, Mo, Cu, Cd
DMG†	Biacetyl + hydroxylamine	$CH_3COCOCH_3 + 2H_2NOH \rightarrow DMG + 2H_2O$	Ni
HOQ‡	8-Acetoxyquinoline§	$CH_3COOQ + H_2O \rightarrow CH_3COOH + HOQ$	Al, U, Mg, Zn

Precipitating agents

Precipitating agents

Inorganic

See table (5-4)

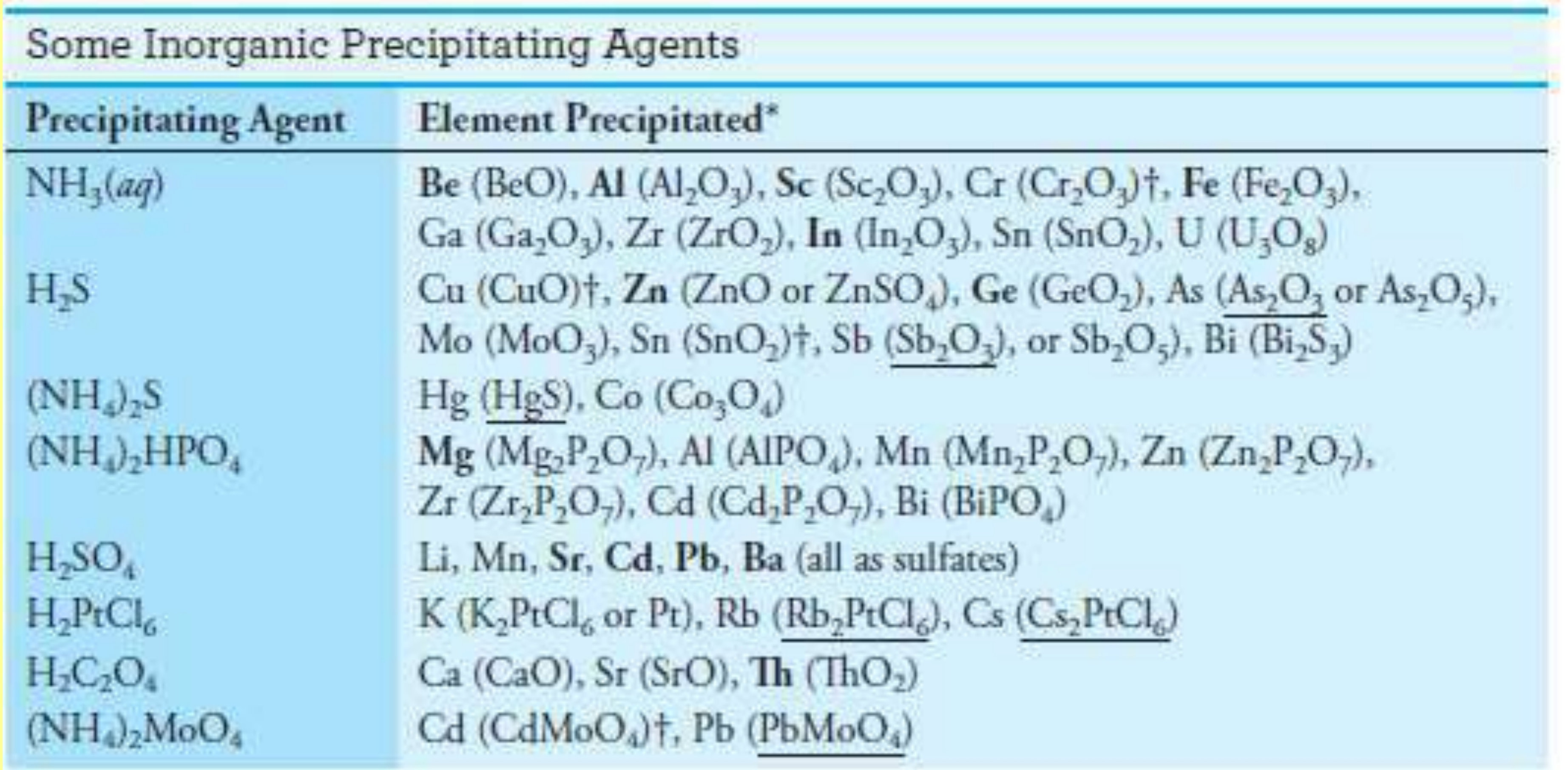
Notice:
precipitating form and weighing form

Organic

Chelating agent: 8-OHquinoline, Dimethylglyoxime

Salt formation: $NaB(C_6H_5)_4$

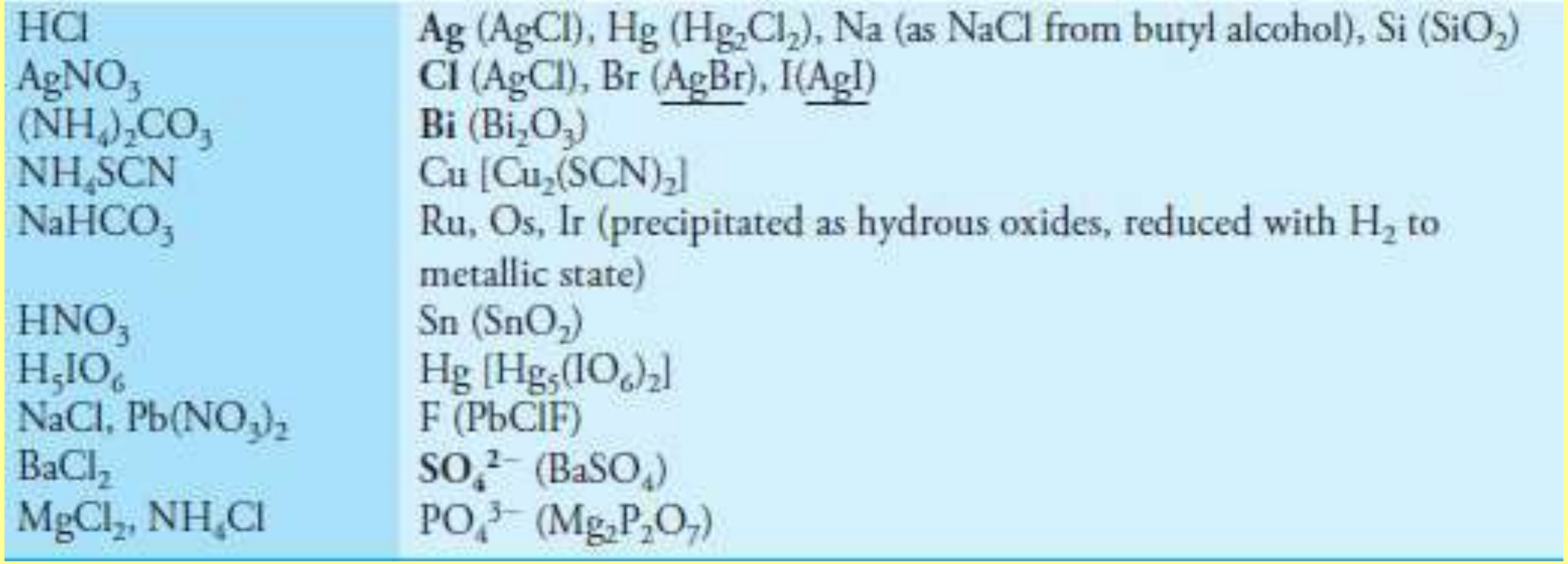
Inorganic precipitating agents



Some Inorganic Precipitating Agents

Precipitating Agent	Element Precipitated*
$NH_3(aq)$	**Be** (BeO), **Al** (Al_2O_3), **Sc** (Sc_2O_3), Cr (Cr_2O_3)†, **Fe** (Fe_2O_3), Ga (Ga_2O_3), Zr (ZrO_2), **In** (In_2O_3), Sn (SnO_2), U (U_3O_8)
H_2S	Cu (CuO)†, **Zn** (ZnO or $ZnSO_4$), **Ge** (GeO_2), As (As_2O_3 or As_2O_5), Mo (MoO_3), Sn (SnO_2)†, Sb (Sb_2O_3), or Sb_2O_5), Bi (Bi_2S_3)
$(NH_4)_2S$	Hg (HgS), Co (Co_3O_4)
$(NH_4)_2HPO_4$	**Mg** ($Mg_2P_2O_7$), Al ($AlPO_4$), Mn ($Mn_2P_2O_7$), Zn ($Zn_2P_2O_7$), Zr ($Zr_2P_2O_7$), Cd ($Cd_2P_2O_7$), Bi ($BiPO_4$)
H_2SO_4	Li, Mn, **Sr**, **Cd**, **Pb**, **Ba** (all as sulfates)
H_2PtCl_6	K (K_2PtCl_6 or Pt), Rb (Rb_2PtCl_6), Cs (Cs_2PtCl_6)
$H_2C_2O_4$	Ca (CaO), Sr (SrO), **Th** (ThO_2)
$(NH_4)_2MoO_4$	Cd ($CdMoO_4$)†, Pb ($PbMoO_4$)

Inorganic precipitating agents



HCl	**Ag** ($AgCl$), Hg (Hg_2Cl_2), Na (as $NaCl$ from butyl alcohol), Si (SiO_2)
$AgNO_3$	**Cl** ($AgCl$), Br ($AgBr$), I(AgI)
$(NH_4)_2CO_3$	**Bi** (Bi_2O_3)
NH_4SCN	Cu [$Cu_2(SCN)_2$]
$NaHCO_3$	Ru, Os, Ir (precipitated as hydrous oxides, reduced with H_2 to metallic state)
HNO_3	Sn (SnO_2)
H_5IO_6	Hg [$Hg_5(IO_6)_2$]
$NaCl$, $Pb(NO_3)_2$	F ($PbClF$)
$BaCl_2$	$\mathbf{SO_4^{2-}}$ ($BaSO_4$)
$MgCl_2$, NH_4Cl	PO_4^{3-} ($Mg_2P_2O_7$)

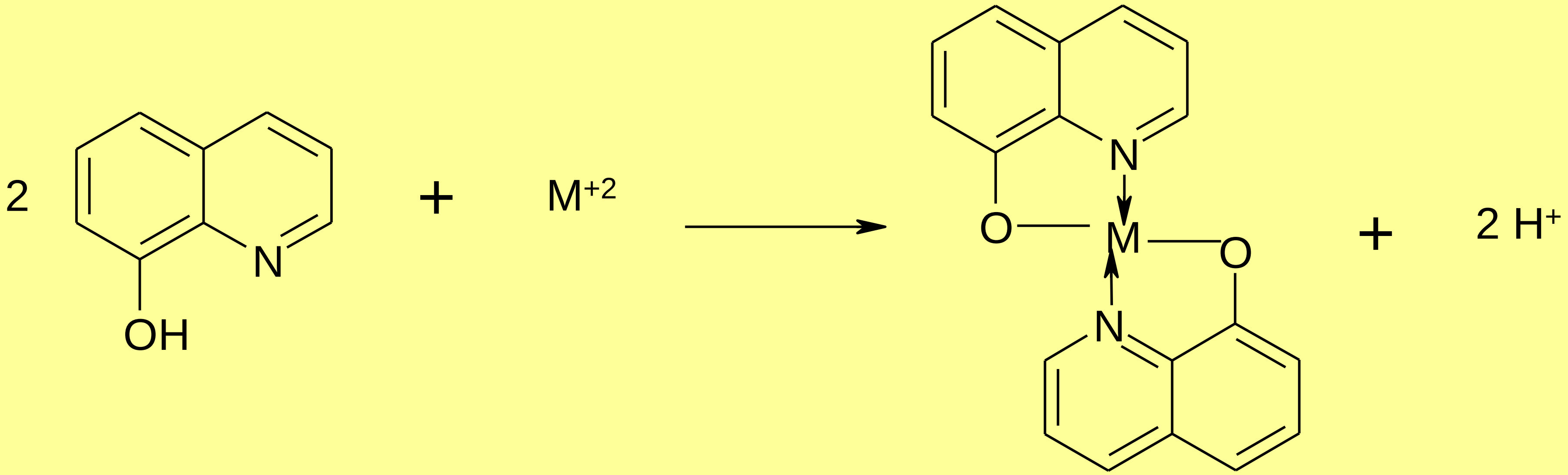
Organic precipitating agents

- **Chelating agent**
  - 8-hydroxyquinoline
  - Dimethylglyoxime
- **Salt formation**
  - Sodium tetraphenylboron

Organic precipitating agents

Chelating agent

8-hydroxyquinoline: used for Mg^{+2}, Zn^{+2}, A^{+3}l, Cd^{+2}, Cu^{+2},--



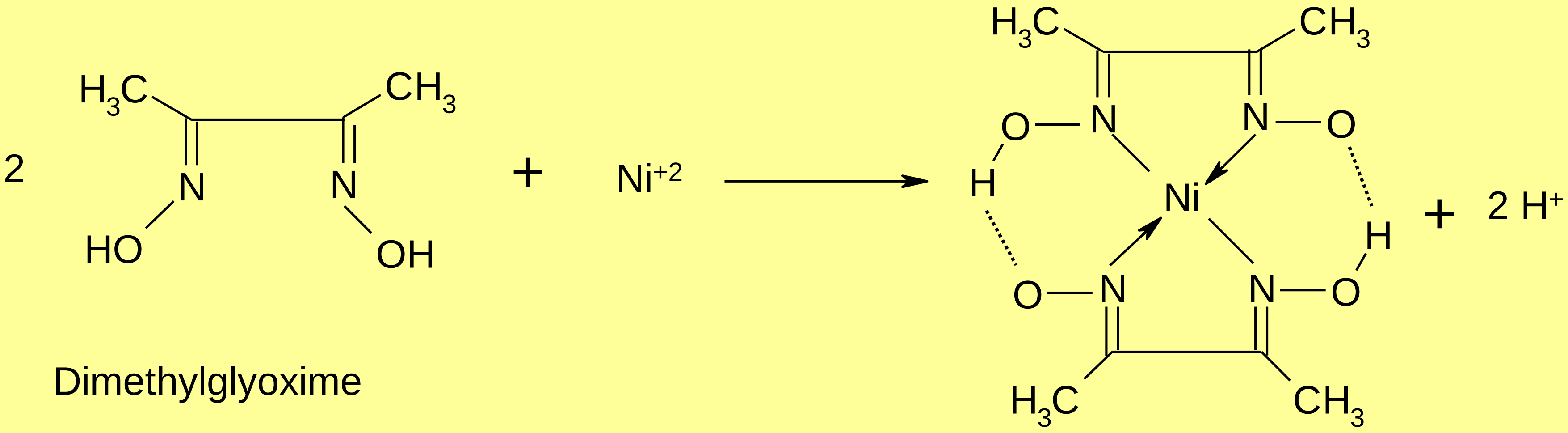
8-hydroxyquinoline

8-hydroxyquinolate complex

Organic precipitating agents

Chelating agent

Dimethylglyoxime (DMG): for Ni^{+2}



Organic precipitating agents

Salt formation:

Sodium tetraphenylboron $NaB(C_6H_5)_4$: for K^+, NH_4^+, Cs^+

$$NaB(C_6H_5)_4 + K^+ \longrightarrow KB(C_6H_5)_4\downarrow + Na^+$$

Gravimetry
part 3

Dr. Mai Ramadan

Calculation

Stoichiometry: the weight relationships among reacting chemical spieces

Mole: one mole of a chemical spiece is $6.022 * 10^{23}$ atoms, molecules, ions or ion pairs.

No. moles = Weight (g)/formula weight (g/mol)

No. millimoles = weight (mg)/formula weight (mg/mmol)

Calculation

Treatment of a 0.400 g sample of impure potassium chloride with an excess of $AgNO_3$ resulted in the formation of 0.7332 g AgCl. ***Calculate the percentage of KCl in the sample***.
(FW AgCl =143.42, KCl= 74.56)

$$AgNO_3 + KCl \xrightarrow{\hspace{3em}} AgCl\downarrow + KNO_3$$

No. Mol AgCl = weight (g)/ MW (g/mol)

No. Mol AgCl = 0.7332 (g) / 143.42 (g/mol) = $5.112*10^{-3}$ mol

Calculation

$$\text{No. mol KCl} = \frac{\text{1mol KCl}}{\text{1 mol AgCl}} \times \text{No. mol AgCl}$$

No. mol KCl= $5.112*10^{-3}$ (mol)

Wt of KCl = no.mol KCl * MW=

= $5.112*10^{-3}$ (mol) * 74.56 (g/mol)

= 0.3812 (g)

$$\% \text{ KCl} = \frac{\text{Wt of KCl (g)}}{\text{Wt of sample (g)}} \times 100 = 95.3\%$$

Stoichiometric factor

$$a\ X + b\ Y \longrightarrow c\ W + d\ Z$$

You look for no mol. X???????? and no moles W is known

No. moles X = $\boxed{\dfrac{a}{c}}$ * no. moles W

a & c are no moles of the unknown (X) and no moles of known (W) according to the balanced equation

Calculation

What weight of $BaCl_2.2H_2O$ (fw = 244.25) is needed to react with 0.1503 g of:

$AgNO_3$ (fw = 169.9 g)? (AgCl, FW= 143.32)

$MgSO_4$? ($BaSO_4$)

H_3PO_4 ? ($Ba_3(PO_4)_2$)

What is the weight of the resulting precipitate?

Calculation

$$BaCl_2.2H_2O + 2\ AgNO_3 \longrightarrow 2\ AgCl\downarrow + Ba^{+2} + 2\ NO_3^{-} + 2\ H_2O$$

$$\text{No. mol } BaCl_2.2H_2O = \frac{1 \text{ mol } BaCl_2.2H_2O}{2 \text{ mol AgNO3}} \times \text{No. mol AgNO3}$$

$$\text{No. mol } BaCl_2.2H_2O = \frac{1}{2} \times \frac{0.1503\ (g)}{169.9\ (g/mol)} = 4.4232 * 10^{-4}\ (mol)$$

$$\text{Wt } BaCl_2.2H_2O = \text{No. mol } BaCl_2.2H_2O \times \text{MWt}$$

$$\text{Wt } BaCl_2.2H_2O = 4.4232 * 10^{-4}\ (mol) \times 244.25\ (g/mol) = 0.1080\ (g)$$

Calculation

$$BaCl_2.2H_2O + 2\ AgNO_3 \longrightarrow 2\ AgCl\downarrow + Ba^{+2} + 2\ NO_3^{-} + 2\ H_2O$$

$$\text{No. mol AgCl produced} = \frac{2\text{ mol AgCl}}{2\text{ mol AgNO3}} \times \text{No. mol AgNO3}$$

$$\text{No. mol AgCl} = \frac{2}{2} \times \frac{0.1503\text{ (g)}}{169.9\text{ (g/mol)}} = 8.8464 * 10^{-4}\text{ (mol)}$$

$$\text{Wt AgCl} = \text{No. mol AgCl} \times \text{MWt}$$

$$\text{Wt AgCl} = 8.8464 * 10^{-4}\text{ (mol)} \times 143.32\text{ (g/mol)} = 0.1268\text{ (g)}$$

Calculation

$$BaCl_2.2H_2O + MgSO_4 \longrightarrow BaSO_4\downarrow + Mg^{+2} + 2\ Cl^- + 2\ H_2O$$

$$3\ BaCl_2.2H_2O + 2H_3PO_4 \longrightarrow Ba_3(PO_4)_2\downarrow + 6\ HCl + 6\ H_2O$$

Calculation

The mercury in a 0.7152 g sample was precipitated with an excess of paraperiodic acid H_5IO_6

$$5\ Hg^{+2} + 2\ H_5IO_6 \longrightarrow Hg_5(IO_6)_2\ (S) + 10\ H^+$$

The precipitate was filtered, washed free of precipitating agent, dried and found to weigh 0.3408 g. ***Calculate the percentage of Hg_2Cl_2 in the sample***

(FW $Hg_5(IO_6)_2$ =1448.76, Hg_2Cl_2 = 472.09)

Calculation

$$\text{No. Mol Hg}^{+2} = \frac{5\ \text{mol Hg}^{+2}}{1\ \text{mol Hg}_5(\text{IO}_6)_2} \text{ X } \text{No. mol Hg}_5(\text{IO}_6)_2$$

$$\text{No. Mol Hg}^{+2} = \frac{5}{1} \text{ X } \frac{0.3408\ (\text{g})}{1448.76\ (\text{g/mol})} = 1.176*10^{-3}\ (\text{mol})$$

$$\text{Hg}_2\text{Cl}_2 \longrightarrow 2\ \text{Hg}^{+} + 2\ \text{Cl}^{-}$$

$$\text{No. Mol Hg}_2\text{Cl}_2 = \frac{1\ \text{mol Hg}_2\text{Cl}_2}{2\ \text{mol Hg}^{+2}} \text{ X } \text{no. mol Hg}^{+2} = 5.881*10^{-4}\ (\text{mol})$$

Calculation

Wt Hg_2Cl_2 = No. Mol Hg_2Cl_2 X MWt

Wt Hg_2Cl_2 = $5.881*10^{-4}$ (mol) X 472.09 (g/mol) = 0.2777 (g)

$$\% \ Hg_2Cl_2 = \frac{\text{Wt of } Hg_2Cl_2 \text{ (g)}}{\text{Wt of sample (g)}} \times 100 =$$

% Hg_2Cl_2 = 38.83%

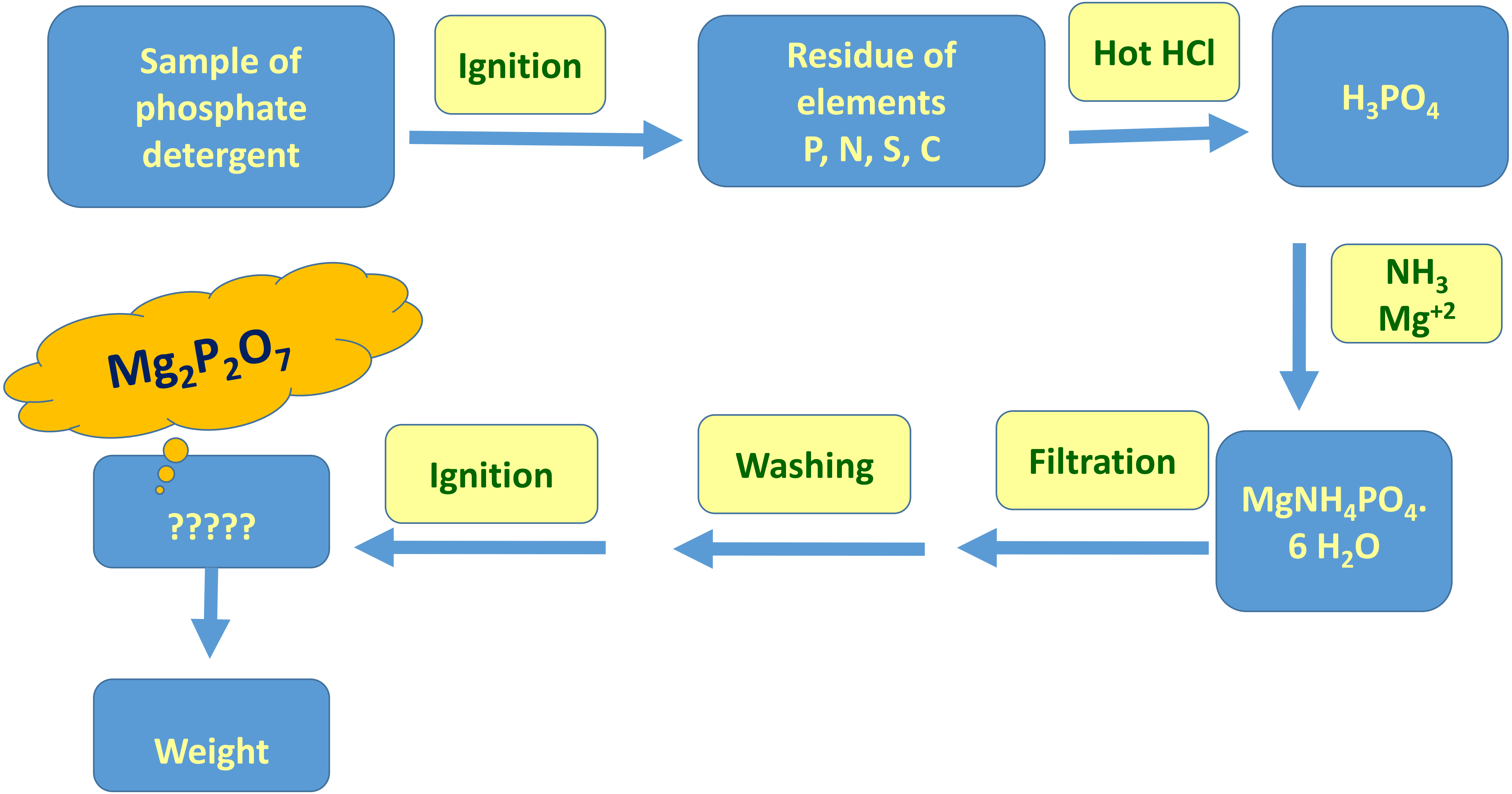
Gravimetry
part 4

Dr. Mai Ramadan

Calculation

A 0.3516 g sample of a commercial phosphate detergents was ignited at red heat to destroy the organic matter. The residue was then taken up in hot HCl, which converts the P to H_3PO_4 . The phosphate was precipitated as $MgNH_4PO_4.6H_2O$ by addition of Mg^{+2} followed by aq. NH_3 After being filtered and washed, the precipitate was ignited at 1000 °C (*what is the weighing form*). The residue weighed 0.2161 g. ***Calculate the percent P in the sample***

(FW $Mg_2P_2O_7$ = 222.57, P= 30.974)


Sample of phosphate detergent

Ignition

Residue of elements P, N, S, C

Hot HCl

H_3PO_4

NH_3

Mg^{+2}

$MgNH_4PO_4 \cdot 6\ H_2O$

Filtration

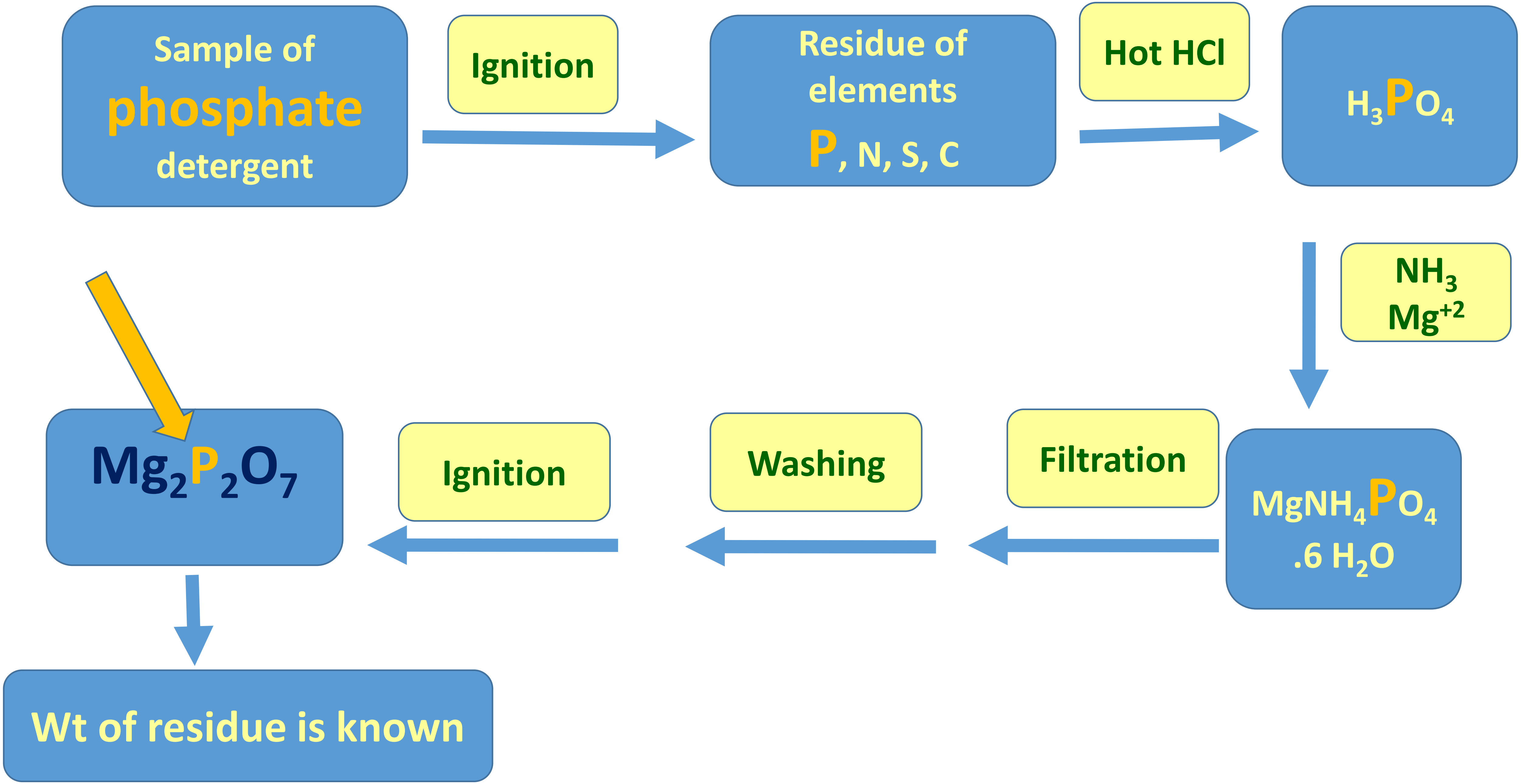
Washing

Ignition

?????

$Mg_2P_2O_7$

Weight



Sample of **phosphate** detergent

Ignition

Residue of elements

P, N, S, C

Hot HCl

H_3PO_4

NH_3

Mg^{+2}

$MgNH_4PO_4$

$.6\ H_2O$

Filtration

Washing

Ignition

$Mg_2P_2O_7$

Wt of residue is known

Calculation

The weighing form is $Mg_2P_2O_7$

MWt of $Mg_2P_2O_7$ = 222.57 (g/mol)

$$\text{No. Mol P} = \frac{2\text{ mol P}}{1\text{ mol }Mg_2P_2O_7} \times \text{No. mol }Mg_2P_2O_7$$

$$\text{No. Mol P} = \frac{2\text{ mol P}}{1\text{ mol }Mg_2P_2O_7} \times \frac{0.2161\text{ (g)}}{222.57\text{ (g/mol)}} = 1.9419*10^{-3}\text{ (mol)}$$

Wt P = No.mol P X MWt =

$= 1.9419*10^{-3}$ (mol) X 30.974 (g/mol)

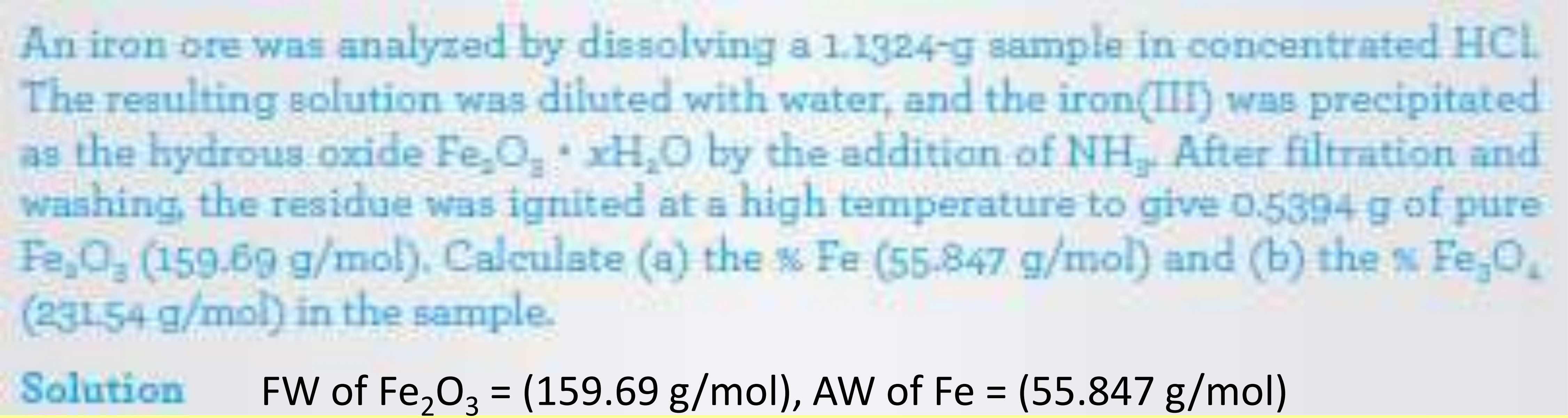
= 0.060 (g)

Calculation

The source of phosphor in the final ppt $Mg_2P_2O_7$

$$\% \text{ P in sample} = \frac{\text{Wt of P (g)}}{\text{Wt of sample (g)}} \times 100 =$$

$$\% \text{ P in sample} = \frac{0.060\ (g)}{0.3516\ (g)} \times 100 = 17.11\%$$



An iron ore was analyzed by dissolving a 1.1324-g sample in concentrated HCl. The resulting solution was diluted with water, and the iron(III) was precipitated as the hydrous oxide $Fe_2O_3 \cdot xH_2O$ by the addition of NH_3. After filtration and washing, the residue was ignited at a high temperature to give 0.5394 g of pure Fe_2O_3 (159.69 g/mol). Calculate (a) the % Fe (55.847 g/mol) and (b) the % Fe_3O_4 (231.54 g/mol) in the sample.

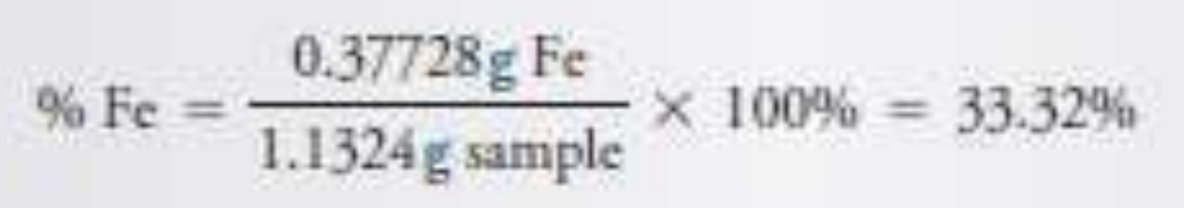
Solution FW of Fe_2O_3 = (159.69 g/mol), AW of Fe = (55.847 g/mol)

No. moles Fe_2O_3 = Wt / FW of Fe_2O_3 = $3.3778*10^{-3}$ mol Fe_2O_3

$$Fe_2O_3 \longrightarrow 2\ Fe$$

$$\text{No moles Fe} = \frac{2\ \text{mol Fe}}{1\ \text{mol } Fe_2O_3} * \text{mol } Fe_2O_3 = 6.7556*10^{-3}\ \text{mol}$$

Wt of Fe =No. moles Fe * AW =0.37728 g Fe



$$\% \text{ Fe} = \frac{0.37728 \text{ g Fe}}{1.1324 \text{ g sample}} \times 100\% = 33.32\%$$

$Fe_3O_4 \longrightarrow 3\ Fe$, $Fe_2O_3 \longrightarrow 2\ Fe$

$$\text{No moles } Fe_3O_4 = \frac{1 \text{ mol } Fe_3O_4}{3 \text{ mol Fe}} * \text{ no. mol Fe} =$$

$$\text{No moles Fe} = \frac{2 \text{ mol Fe}}{1 \text{ mol } Fe_2O_3} * \text{ no mol } Fe_2O_3 =$$

$$\text{No moles } Fe_3O_4 = \frac{1 \text{ mol } Fe_3O_4}{3\ \cancel{\text{mol Fe}}} * \frac{2\ \cancel{\text{mol Fe}}}{1 \text{ mol } Fe_2O_3} * \text{ no mol } Fe_2O_3$$

$$\text{No moles } Fe_3O_4 = \frac{2 \text{ mol } Fe_3O_4}{3 \text{ mol } Fe_2O_3} * \text{ no mol } Fe_2O_3$$

$$\text{No moles } Fe_3O_4 = \frac{2 \text{ mol } Fe_3O_4}{3 \text{ mol } Fe_2O_3} * 3.3778*10^{-3} \text{ mol } Fe_2O_3 \text{ mol} =$$

$$\mathbf{No\ moles\ Fe_3O_4 = 2.2519*10^{-3}\ mol}$$

$$\text{wt } Fe_3O_4 = \mathbf{2.2519*10^{-3}\ (mol) * (231.54\ g/mol) = 0.52140\ (}g)$$

$$\% \; Fe_3O_4 = \frac{\text{Wt } Fe_3O_4 \text{ (g)}}{\text{Wt sample (g)}} * 100\% = 46.04\%$$

Problems

Chapter 5 : Questions no. 12,13,14, 15, 18, 24,25, 26, 27, 28, 30, 38

See also example : 5-3, 5-5