NEW CHAPTER

Pharmaceutical Chemistry - I.

Impurities and Their Source.

Pharmaceutical Impurities

The impurities in P'ceuticals are unwanted/undesired chemicals that remain with the active P'ceutical ingredients (API s) or develop during formulation or upon aging of both API and formulation.

(i) Presence of these impurities may influence the efficacy and safety of P'ceutical product.

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Sources of impuritees

According to the ICH (International Conference of Harmonisation) impurities in the new drug substance are classified as :-

(i) Organic Impurities.
(ii) Inorganic Impurities.
(iii) Residual Solvent.

Sources of Organic Impurities.

→ Impurities originating from drug substance synthetic process.

→ Starting material and intermediate.

→ Reagent, ligands and catalyst.

→ By-Product of the synthesis.

→ Product of over reaction.

→ Product of side chain.

Source of Inorganic Impurities

May be derived from manufacturing process and they are identified as ~~reg~~ reagent, ligand, catalyst, inorganic salt, heavy metals, filter aids, charcoal.

Residual solvent are impurities which are introduced /added with solvent in P'ceutical formulation.

Various Source of Impurities

Various source of impurities in P'ceutical substances are follows:-

(1) Raw material

(2) Method of Manufacturing
- → (i) Reagents used.
- → (ii) Intermediate products.
- → (iii) Reagents used to eliminate impurities.
- → (iv) Solvent used.

(3) Manufacturing Hazard.

- → (i) Contamination from matter.
- → (ii) Cross contamination.
- → (iii) Contamination of microbes.
- → (iv) Errors in manufacturing.
- → (v) Error in storage and packaging.

(4) Instability of Product.

- → (i) Chemical Instability.
- → (ii) Physical Instability.
- → (iii) Reaction with container.
- → (iv) Temperature.

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Effects of Impurities on P'ceutical formation

(i) Impurities may bring about incompatibility with other substances.

(ii) Impurities may lower the self-life of the substances.

(iii) Impurities may ~~lower~~ decrease therapeutic effects of P'ceutical product.

(iv) Some impurities may changes the physical, chemical properties of the substance.

(v) Impurities may be show toxic effect after certain period.

(vi) Impurities may change odour, colour, taste of substance.

New Chapter - LIMIT TEST

Q. What is Limit test?

⇒ It is defined as Quantitative test design to identify and control small amount of impurities which is likely to be present in the substance.

Limit test

- → Chloride
- → Sulphate
- → Iron
- → Lead
- → Arsenic

Limit test of chloride

It is based upon chemical reaction between silver nitrate and soluble chloride ion in presence of dilute nitric acid to give opalescence, precipitate (ppt) of silver chloride.

Opalescence produce is compared with the standard solution.
If the opalescence of sample is less than the standard, it passes the test.

If it is more than or equal to the standard it means that it fail the test.

$$AgNO_3 + Cl^- \xrightarrow{HNO_3} AgCl \downarrow \text{ (opalescence)}$$

Reaction:-

$$\underset{\text{Silver Nitrate}}{NaCl + AgNO_3} \xrightarrow{HNO_3} \underset{\text{ppt}}{AgCl} + NaNO_3$$

Procedure:-

Test Sample:

(i) Specific weight of compound / Test sample is dissolved in water.
(ii) Add 10 ml of dil. nitric acid.
(iii) Dilute to 50 ml in Nessler's cylinder.
(iv) Add 1 ml of 0.1 M $AgNO_3$ solution, stir properly and keep aside for 5 min.
(v) Observe the opalescence / turbidity.

Standard Compound.

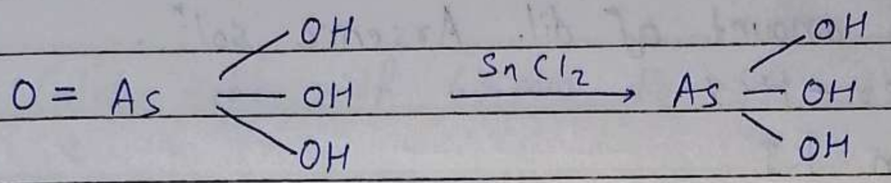
(i) Take 1 ml of 0.05845 % w/v solution of sodium chloride in Nessler's cylinder.

(ii) Add 10 ml of dil. Nitric acid.
(iii) Dilute to 50 ml in Nessler's cylinder.
(iv) Add 1 ml of 0.1 M $AgNO_3$ solution, stir properly. and keep aside for 5 min.

(v) Observe the opalescence / turbidity.

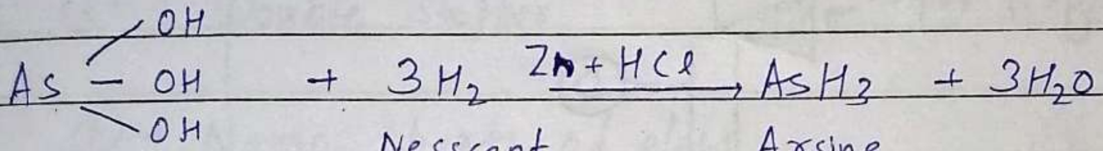
Limit Test for Arsenic - Gutzeit Apparatus.

Rx^n →



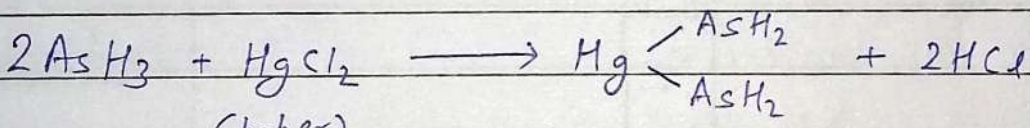
$$O{=}As(OH)_3 \xrightarrow{SnCl_2} As(OH)_3$$

Arsenic acid (Pentavalent) Arsenious Acid.



$$As(OH)_3 + 3H_2 \xrightarrow{Zn + HCl} AsH_3 + 3H_2O$$

Arsenious acid Nesscent Hydrogen Arsine Gas (Arsenic hydride).



$$2AsH_3 + HgCl_2 \longrightarrow Hg(AsH_2)_2 + 2HCl$$

(paper) Yellow stain

① Test Sample

(i) Sample
(ii) HCl (Arsenic Free)
(iii) 1gm KI
(iv) 5ml of stannous chloride ($SnCl_2$) acid.
(v) 10 gm of Zn.

② Preparation of standard solⁿ.

(i) Known amount of dil. Arsenic solⁿ.
(ii) Water + HCl
(iii) 1 gm KI
(iv) 5 ml of stannous chloride ($SnCl_2$) acid.
(v) 10 gm of Zn.

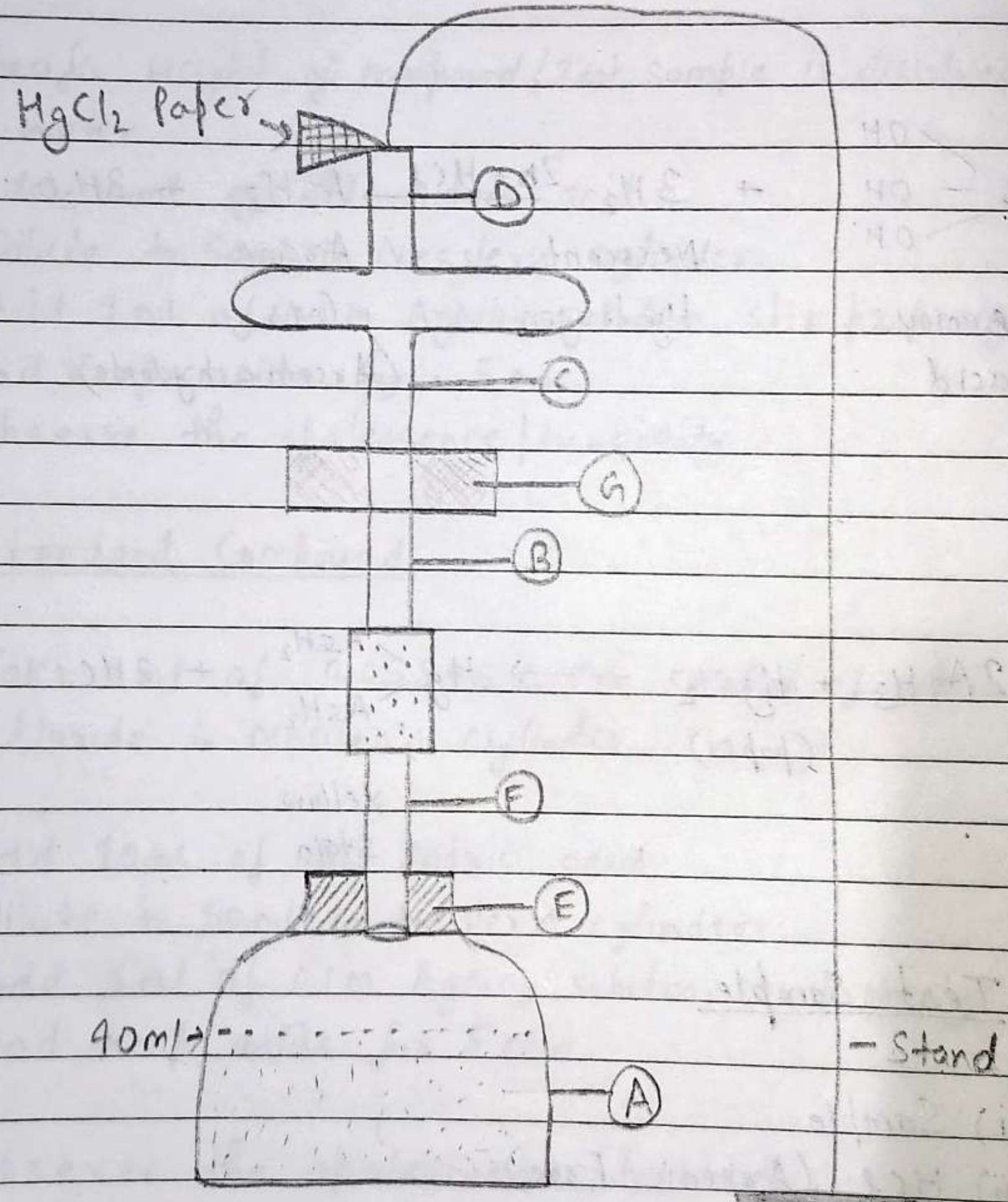


Fig. Gutzeit Apparatus

Ⓐ → Generator bottle (capacity 60 ml)
40 ml indicating line.

Ⓑ → Glass tube with 6.5 mm diameter.

Ⓒ and Ⓓ → Ground joint glass tube
→ Outer diameter 18 mm
→ Inner diameter 6.5 mm

Ⓔ → Double stopper

Ⓕ → Narrow parts of glass

Ⓖ → Rubber Board,
lead acetate cotton plug.

Principle:

Limit test for Arsenic is based on the reaction of Arsine gas with hydrogen ion to form yellow stain on mercuric chloride paper in presence of reducing agent like potassium iodide. It is also called Gutzeit test. Arsenic present as Arsenic acid in the sample is reduced to Arsenious acid by reducing agent like potassium iodide, stannous acid, zinc, HCl.

Limit test of Sulphate

Rx^n :

$$\begin{array}{ccccc} SO_4^{2-} & + BaCl_2 & \xrightarrow{dil.\ HCl} & BaSO_4 & + \ KCl \\ \downarrow & \downarrow & & ppt. & \\ \text{Soluble} & \text{Barium} & & \downarrow & \\ \text{Sulphate} & \text{chloride} & & \text{Barium sulphate} & \\ & & & \text{(it shows turbidity)} & \end{array}$$

Principle:

Limit test for sulphate is based on the reaction between barium chloride and soluble sulphate in presence of dil. HCl. The turbidity form by a given amount of sample is compared with a reference on standard turbidity obtained from an authentic amount of sulphate under the same experimental condition.

Procedure :-

For test solution :-

(i) Specific amount of compound is dissolved in water.

(ii) Transfer into Nessler's cylinder and add 2 ml of dil. HCl.

(iii) Add 5 ml of $BaCl_2$ solⁿ.

(iv) Diluted upto 50 ml with water. (H_2O).

(v) keep aside for 5 min then observe the turbidity.

For standard solution :-

(i) Take 1 ml of 0.1089 % w/v of potassium sulphate in Nessler cylinder.

(ii) Add 2ml of dilute HCl.

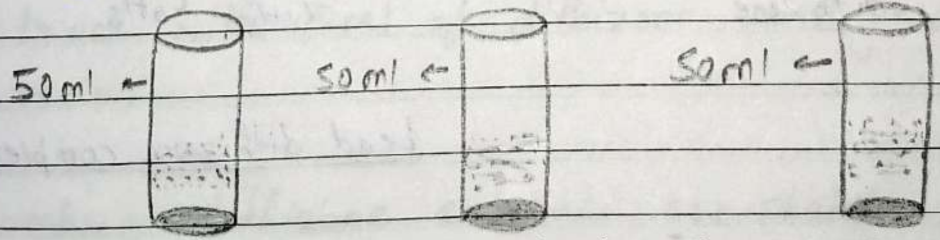
(iii) Add 5 ml of $BaCl_2$ solⁿ

(iv) Dilute upto 50ml with water (H_2O).

(v) Keep aside for 5 min, then observe the turbidity.

Observation

Compare the turbidity against a black background into nessler's cylinder.



T_1 < Standard < T_2

↓ Less turbidity pass

↓ More Turbidity fail

Note :- HCl helps to make solution acidic and Barium sulphate precipitate ($BaSO_4$) formed in insoluble which gaves turbidity.

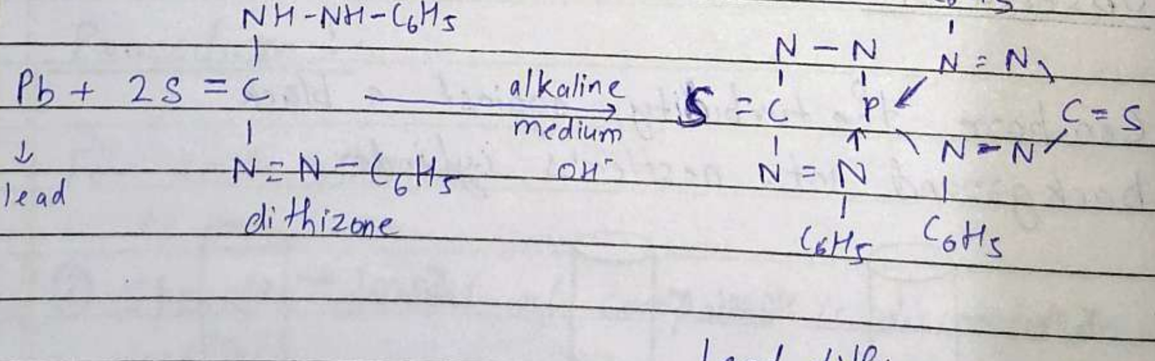
Limit test of lead (Pb)

Principle:

Limit test of lead is based on the reaction of lead and diphenyl thiocarbonate (dithizone) in alkaline solution to form lead dithizone complex which is ~~read~~ red in colour.

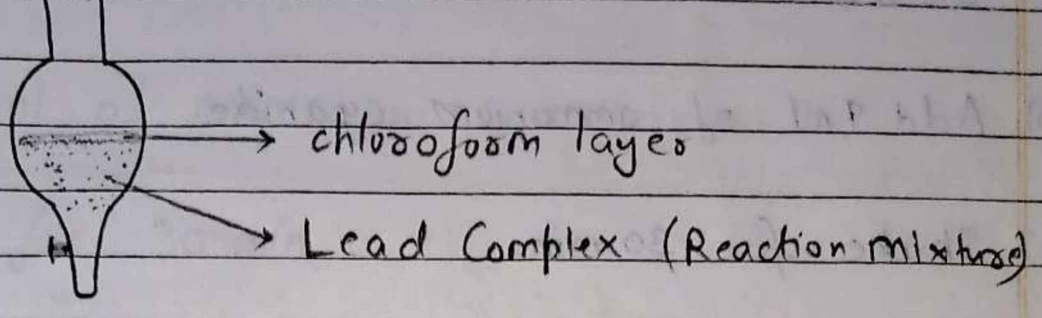
Dithizone is green in colour in chloroform and lead - dithizone complex violet in colour, so the resulting colour at the end of the process is red.

Rx^n



Lead dithizone complex

Test Sample



Separating
Funnel.

Test Solution

(1) A known quantity of sample solution is transferred in a separating funnel.

(2) Add 6ml of ammonium citrate.

(3) Add 2ml of potassium cyanide and 2ml of hydroxylamine hydrochloride. ($NH_2OH_2.HCl$)

(4) Add 4 drops of Phenol Red.

(5) Make solution alkaline by adding ammonia solⁿ.

(6) Extract with 5ml of dithizone until it becomes green.

(7) Combine dithizone extracts are shaken for 30 mins with 30 ml of nitric acid and the chloroform layer is discarded.

(8) To the acidic solution add 5 ml of standard dithizone solution.

(9) Add 4 ml of ammonium cyanide.

(10) Shake for 30 min.

(11) Observe the colour.

Standard Solution

(1) A standard lead solution is prepared equivalent to the amount of lead permitted in the sample under examination.

(2) Add 6 ml of ammonium citrate.

(3) Add 2 ml of potassium cyanide and 2 ml of hydroxylamine hydrochloride ($NH_2OH.HCl$).

(4) Add 2 drops of phenol Red.

(5) Make solution alkaline by adding ammonia solution

(6) Extract with 5 ml of dithizone until it becomes green.

(7) Combine dithizone extracts are shaken for 30 mins with 30 ml of Nitric acid and the chloroform layer is discarded.

(8) To the acidic solution add 5 ml of standard dithizone solution.

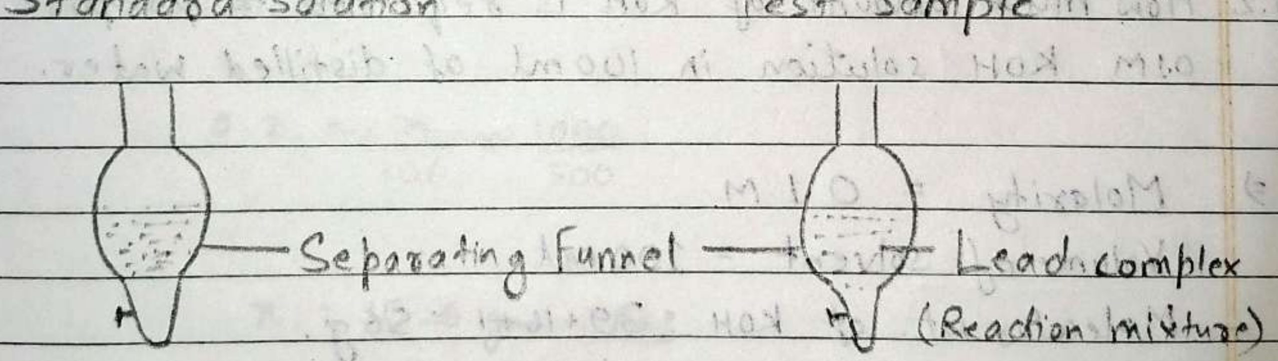
(9) Add 4 ml of ammonium cyanide.

(10) Shake for 30 min.

(11) Observe the colour.

Observation.

The intensity of the ~~complex~~ colour of complex, is depend on the amount of lead in the solution the colour produced in the sample solution should not be greater than standard solution. If colour produced in the sample solution is less than the standard solution. The sample will pass the limit test of lead.



Colour intensity of Standard > Colour intensity of test sample

Limit test pass.

Molarity

$$\text{Molarity} = \frac{\text{weight of solute (g)} \times \cancel{1000\,ml}}{\text{Molecular weight of solute (g/mol)} \times \text{Volume of solvent taken (ml)}}$$

Q1. Calculate the molarity / molar concentration of solution when 5g of NaOH in ~~500ml~~ 50ml of water.

⇒ Weight of NaOH = 5g

Volume of solvent = 50ml

Molecular wt. of NaOH = 23 + 16 + 1 = 40.

$$\text{Molarity} = \frac{\text{Wt} \times 1000\,ml}{\text{M.Wt} \times V\,(ml)} = \frac{5 \times 1000}{40 \times 50} = \frac{5}{2} = 2.5M$$

Ans

Q.2 How much amount of KOH is required to prepare 0.1M KOH solution in 100ml of distilled water.

⇒ Molarity = 0.1 M

Volume of solvent = 100 ml

Molecular wt. of KOH = 39 + 16 + 1 = 56g.

$$M = \frac{\text{Wt}}{\text{M.W}} \times \frac{1000\,ml}{V(ml)}$$

$$\Rightarrow 0.1M = \frac{x}{56} \times \frac{1000}{100}$$

$$\Rightarrow x = \frac{56}{100} = .56\ gm$$

Ans.

Q.3 To prepare 0.2M Na_2CO_3 in 250 ml of distilled water. How much gram of Na_2CO_3 required.

⇒ M = 0.2M

V. of water = 250 ml

M.W of Na_2CO_3 = 46 + 12 + 48 = 106.

$$\therefore M = \frac{x}{M.W} \times \frac{1000\ ml}{V.\ of\ water}$$

$$0.2 = \frac{x}{106} \times \frac{1000}{250}$$

$$x = \frac{106 \times 2}{4 \times 10} = \frac{53}{10} = 5.3\ g$$ Ans.

Q.4. To prepare 0.2 M Na_2CO_3 in 500 ml of distilled water. How much gm of Na_2CO_3 required.

⇒ M = 0.2 M

M.W = 106 g

V = 500 ml

$$M = \frac{Wt}{M.Wt} \times \frac{1000}{V}$$

$$0.2 = \frac{x}{106} \times \frac{1000}{500}$$

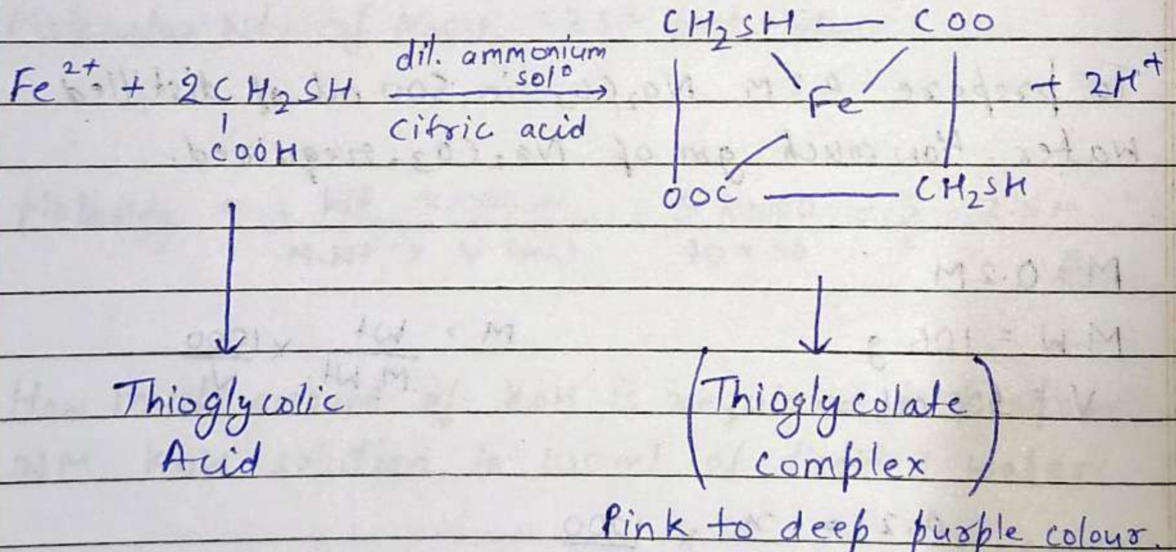
x = 10.6 gm Ans.

Limit test of ~~Chloride~~ Iron (Fe)

Principle / Theory:

The limits test of iron depends upon the reaction of iron in ammonical solution in presence of citric acid with thioglycolic acid to obtain a pink to deep purple colour. Citric acid helps precipitation of iron by ammonia by forming a complex with it. The colour is obtain due to formation of ferrous salt i.e. ferrous thioglucolate which disappear in air due to oxidation.

Reaction.



Procedure.

Test Sample.

(i) Sample is dissolve in specific amount of water and then volume is made upto 40 ml.

(ii) Add 2 ml of 20% w/v of citric acid (iron free).

(iii) Add 2 drops of thioglycolic acid.

(iv) Add ammonia to make the solution alkaline and adjust the volume upto 50 ml.

(v) Keep aside for 5 min.

(vi) Colour developed is viewed vertically and compared with standard solution.

Standard Solution.

(i) Add 2 ml of standard solution of iron diluted with water upto 40 ml.

(ii) Add 2 ml of 20% w/v of citric acid (iron free).

(iii) Add 2 drops of thioglycolic acid.

(iv) Add ammonia to make the solution alkaline and adjust the volume upto 50 ml.

(v) Keep aside for 5 min.

(vi) Colour developed is viewed vertically and compared with standard solution.

Observation.

The purple colour produced in the sample solution should not be greater than standard solution.

Q.1. Calculate the molarity / molar concentration of solution when 10 gm of NaOH in 50ml of distilled water.

⇒ Wt = 10 gm
M.W = 40gm
V = 50ml

$$M = \frac{Wt \times 1000\,ml}{M.Wt \times V}$$

$$\Rightarrow \quad M = \frac{10}{40} \times \frac{1000}{50}$$

M = 5 M Ans.

Q.2. How much amount of KOH is required to prepare 0.2 M KOH solution in 200 ml distilled water.

⇒ M = 0.2 M
V = 200 ml
M.W = 56 gm

$$M = \frac{Wt}{M.Wt} \times \frac{1000}{V}$$

$$\Rightarrow \quad 0.2M = \frac{x}{56} \times \frac{1000}{200} \quad = \cancel{56}$$

$$\Rightarrow x = \frac{56}{25}$$

x = 2.29 gm Ans

Q.3 To prepare 0.5 M Na_2CO_3 in 500 ml of distilled water. How much quantity of Na_2CO_3 is required.

⇒ M = 0.5 M

V = 500 ml

M.W = 106 gm

$$M = \frac{Wt}{M.Wt} \times \frac{1000}{V}$$

$$0.5\,M = \frac{x}{106} \times \frac{1000}{500}$$

$$x = \frac{106}{2} \times \frac{5}{10}$$

$$x = 26.5 \text{ gm}$$ Ans.

Limit test of Heavy Metals.

This limit test is for detecting and limiting the impurities of Heavy metals likely to be present in many drugs.

The Heavy metals are precipitated as their sulphides by the addition of either hydrogen sulphide or sodium sulphide solution under specific conditions.

A dark brown or light brown colour is produced depending upon the amount of heavy metals present.

Procedure:

(i) Preparation of test sample/solution:

- Solution is prepared as per monograph and 25 ml is transferred into Nessler's cylinder.
- Adjust the pH b/w 3-4 by adding dilute ~~acid~~ acetic acid or dilute ammonium solution.
- Add freshly prepared 10 ml of hydrogen sulphide solution.
- Then dilute with water upto 50 ml.
- Allow to stand for 5 mins.
- Then view downwards over a white surface.

(ii) Preparation of standard solution:

- Take 2 ml of standard heavy metal solution and dilute upto 25 ml with distilled water.
- Adjust the pH b/w 3-4 by adding dilute acetic acid or dilute ammonium solution.
- Add freshly prepared 10 ml of hydrogen sulphide solution.
- Then dilute with water upto 50 ml.
- Allow to stand for 5 mins.
- Then view downwards over a white surface.

Observations:

The colour produced in sample solution should not be greater than standard solution. If the colour produced in sample solution is less than the standard solution, the sample will pass the limit test of heavy metal and vice-versa.

CH. 2 → Acidity, Basicity, pH and Buffers.

Acid :-

1. Arrhenius theory :- (1887)

Acid are substances which on dissolution in water provide protons (H^+, hydrogen ions) and Base are substances which on dissolving in water yields hydroxyl ions (OH^-).

Example :-

$$HCl \rightleftharpoons H^+ + Cl^- \quad \text{(Acidic)}$$
$$NaOH \rightleftharpoons Na^+ + OH^- \quad \text{(Basic)}$$
$$HCl + NaOH \Longrightarrow H_2O + \underset{\text{(Salt)}}{NaCl}$$
$$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$$

2. Bronsted - Lowry Theory

According to this theory an acid is a substance that donate a proton and base is a substance that accept a proton.

i.e → Acid is a proton donor.
Base is a proton acceptor.

Example :→ Acid = H^+ + Base (conjugated)

$$HCl \rightleftharpoons H^+ + Cl^- \quad \text{(conjugated)}$$
$$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$$

Ex :- Bronsted Base :- NH_3 , OH^- , Cl^-

$$H_2SO_4 + \underbrace{H_2O \rightleftharpoons H_3O^+}_{\text{Conjugated Acid}} + H_2SO_4^-$$

$$CH_3COOH + H_2O \rightleftharpoons H_3O^+ + CH_3COO^-$$

$$NH_4^+ + H_2O \rightleftharpoons \underset{\substack{\downarrow \\ \text{Hydroxonium ion.}}}{H_3O^+} + NH_3.$$

Amphoteric.

A substance that may be accept proton and donate proton is called amphoteric.

Ex :- H_2O.

$$\underbrace{H_2O + HCl \rightleftharpoons H_3O^+}_{\text{Base} \quad \text{accept proton.}} + Cl^-$$

$$\underbrace{H_2O + NH_3 \rightleftharpoons NH_4^+ + OH^-}_{\text{Acid} \quad \text{donate proton.}}$$

③ Lewis Acid - Base :-

An acid is an electron pair acceptor and a base is an electron pair donor. All compounds or ions containing unshared electron pair are lewis bases.
eg. → hydroxyl ion, amines, ammonia, ethers, alcohol etc.

All Bronsted acids are electron pair acceptor and are also Lewis acids.

All Bronsted bases are also Lewis bases since they donate a pair of electron.

Examples :-

BF_3, $ZnCl_2$, $AlCl_2$ and SO_3 accept pair of electrons from a donor species.

Ag^+, Fe^{2+}, Na^+ and Zn^{2+} accept electron pairs from donor species (eg. NH_3, H_2O, Cl^-, CN^-)

$$Ag^+ : Cl^- \rightarrow Ag:Cl$$

$$Cu^{2+} + 4NH_3 \rightarrow \underbrace{Cu(NH_3)_4^{2+}}_{\text{Cupra - ammonium ion.}}$$

Boric Acid.

H_3BO_3 : Mol. weight = 61.83

→ Boric acid, occurs in nature as the mineral sassolite, contains not less than 95.5 percent and not more than the equivalent of 100.5 % of H_3BO_3, calculated with reference to the dried substance.

Preparation of Boric Acid (H_3BO_3)

① From Natural Sources :

It comes out with jets of steams, called soffioni, from the ground in certain parts of Tuscany. The condensed steam is concentrated by its own heat, cooled and crystallized boric acid is separated.

② By Decomposition of Borax :

$$\underset{\text{Borax}}{Na_2B_4O_7} + H_2SO_4 + 5H_2O \rightarrow Na_2SO_4 + 4H_3BO_3$$

→ A mixture of concentrated sulphuric acid and water is added to a hot aquous solution of borax. The hot solution is filtered, cooled and the crystallised boric acid is filtered off.

③ From Colemanite :

By passing sulphur dioxide through colemanite suspended in water, crystals of boric acid separate out on cooling.

$Ca_2B_6O_{11} + 4SO_2 + 11H_2O \rightarrow 2Ca(HSO_3)_2 + 6H_3BO_3$
colemanite

Physical Characters of Boric Acid :

→ Boric acid occurs as odourless, colourless, transparent plates, crystals or white granules or powder; some what pearly lustrous scales.

→ It is unctuous (greasy) to touch.

→ Melting point 171°c.

→ Sweetish in taste.

→ It volatiled with steam; pH 5.1.

→ Soluble 1 in 20 of water; 16 of alcohol and 4 of glycerol.

→ Solubility in water is increased by HCl, citric, tartaric acids or by heat.

- Most solutions of boric acid contains only small amounts of tetraboric acid.

→ Boric acid is stored in well - closed containers.

Chemical Properties of Boric Acid.

① It is a weak acid and in solution gives a slightly red colour with litmus.

② Heating of boric acid to certain temperatures produces various dehydration products:

For ex:-

$$H_3BO_3 \xrightarrow[-H_2O]{100°C} HBO_2 \xrightarrow[-H_2O]{160°} H_2B_4O_7 \xrightarrow[-H_2O]{\text{Red Heart}} 2B_2O_3$$

ortho Boric Acid	Meta Boric Acid	Tetra Boric acid	Boric Anhydride.

③ It changes tuomeric paper brown which turns blackish when dipped in sodium hydroxide solution.

④ A mixture of ethyl alcohol and boric acid burns with a green flame due to formation of ethyl ~~brok~~ borate.

⑤ The reaction of boric acid with equimolar amounts of glycerin at 140°-150° produces a compound known as Boroglycerin glycerite. ($C_3H_5BO_3$) which is used as a suppository base.

Tests for purity:

→ Test for arsenic; lead; heavy metals; sulphate; alcohol insoluble substances; acidity; clarity and colour of solution; organic matter.

For determining sulphate, an acidified solution in boiled and filtered. The filtrate complies with the limit test for sulphates.

Tests for Identification:

① Boric acid (0.1 g) is dissolved in methanol (5 ml) by heating to which a few drops of sulphuric acid have been added. On ignition the solution the flame has a green colour border.

② An aquous solution of boric acid is acidic in nature (pH: between 3.8 and 4.8).

Incompatibility: Alkali carbonates and hydroxides.

Assay of Boric Acid:-

Boric Acid is a very weak acid and cannot be titrated accurately with a standard solution of a strong alkali if glycerol is first added to the boric acid before starting the titration.

① (I.P.) :- Accurately weighed sample (2g) is dissolved in a mixture of water (50 ml) and glycerin (100ml), previously neutralised to phenolphthalein solution. The solution is titrated with 1 N sodium hydroxide, using phenolphthalein solution as indicator. Each ml of 1N sodium hydroxide is equivalent to 0.06183 of H_3BO_3.

② (B.P.):- An aqueous solution of boric acid (1g) and mannitol (10g) is titrated with 1N sodium hydroxide, using phenolphthalein as indicator. Sodium metaborate is formed by neutralizing one ~~equipment of sodium~~ equivalent of sodium hydroxide. Each ml of 1N sodium hydroxide is equivalent to 61.8 mg. of H_3BO_3.

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Uses of Boric Acid

- Boric acid possesses weak bacteriostatic, fungistatic, astringent and antiseptic properties.

- It is externally used as a buffer and antimicrobial in eye-drops.

- An insecticide for cockroaches and black carpet beetles.

- It is used as mouth washes, skin lotions for local anti-infective action; as douches for irrigating the bladder and vagina; in ointment for emollient and antiseptic action.

- Used in dusting powder due to its smooth-unctious touch

- Boric acid is used in buffer systems such as Ephinephrine bitartrate, ophthalmic solution; Aluminium acetate and Aluminium subacetate solutions.

PDF - start

Hydrochloric Acid (HCl)

HCl ; Mol. weight = 36.46

Synonymes : ~~Measuring~~ Muriatic acid ; Spirit of salt.

Hydrochloric acid is a solution of hydrogen chloride gas (HCl) in water.

Preparation

1. From Sodium Chloride:

Hydrochloric acid is manufactured by treating concentrated sulphuric acid with Sodium chloride (Leblanc Soda Process)

$$NaCl + H_2SO_4 \longrightarrow \underset{\text{sodium hydrogen sulphate}}{NaHSO_4} + HCl$$

The pasty mass of sodium hydrogen sulphate is mixed with more quantity of sodium chloride and heated to redness to yield a further supply of hydrogen chloride leaving behing anhydrous sodium sulphate (salt cake).

$NaCl + NaHSO_4 \rightarrow Na_2SO_4 + HCl$

Sodium
sulphate

Hydrochloric acid gas is collected in a chamber where cold water is spread over the gas. The dilute acid is obtained at the bottom.

The acid so obtained is spread down the tower to absorb more HCl gas for getting concentrated hydrochloric acid.

2. By Synthesis:

Large amount of hydrogen and chlorine gases are obtained as by-products by electrolysis of sodium chloride solution during the manufacture of caustic soda. These gases are dried and then combined to produce hydrogen chloride gas. The gas coded and water is spread over the gas. The solution of hydrochloric acid flows into storage tank.

$NaCl \rightleftharpoons Na^+ + Cl^-$

At the Anode	At the cathode
$Cl^- \rightarrow Cl$	$Na^+ \rightarrow Na$
$Cl + Cl \rightarrow Cl_2$	$2Na + 2H_2O \rightarrow 2NaOH + H_2$

→ ~~H_2+Cl_2~~

$H_2 + Cl_2 \rightarrow 2HCl$

Physical Characters of HCl

- Hydrogen chloride is a colourless gas with an acid irratating odour and an acid taste.

- It is about 25 % heavier than air.

- The gas can be liquited under pressure.

- It is very soluble in water.

- A 0.1 N aquous solution is ionized at 18°c and conducts electricity.

- Muriatic acid is a technical grade of hydrochloric acid containing 35 to 38 % of HCl and a number of impurities including chloride, arsenous and sulphurous acids and iron.

- Hydrochloric acid is a clear colourless fuming aquous solution of hydrogen chloride with a pungent odour and sour taste; specific gravity is about 1.18.

- Reagent grade concentrated hydrochloric acid contains about 38.0 % HCl.

Storage

Hydrochloric acid should be kept in a stopped container of glass or other inert material and stored at a temperature not exceeding 30°.

Chemical Properties of HCl.

1. It turns moist blue litmus to red.
2. It reacts with metals and their salts like oxides, hydroxides and carbonates to form the chlorides of the metals.

$$Mg + 2HCl \rightarrow MgCl_2 + H_2.$$
$$KOH + HCl \rightarrow KCl + H_2O.$$

The hydrogen in the hydrochloric acid is displaced by metals yielding hydrogen gas.

With silver nitrate, hydrochloric acid gives a white precipitate soluble in ammonium hydroxide and insoluble in nitric acid.

$HCl + AgNO_3 \rightarrow AgCl + HNO_3$

$AgCl + 2NH_4OH \rightarrow \underset{\text{Complex compound (soluble)}}{Ag(NH_3)_2Cl} + 2H_2O$

with lead acetate, it gives a white precipitate soluble in hot water.

$(CH_3COO)_2Pb + 2HCl \rightarrow \underset{\text{white precipitate}}{PbCl_2} + 2CH_3COOH$

3. Fluorine decomposes hydrochloric acid to form chloride.

$2HCl + F_2 \longrightarrow 2HF + Cl_2$

4. Hydrochloric acid gas forms dense white fumes ~~of~~ ammonium chloride with ammonia

$HCl + NH_3 \longrightarrow NH_4Cl$

5. A mixture of concentrated hydrochloric acid (3 parts) and concentrated nitric acid (1 part) is called aqua regia which is used for dissolving noble metals, gold and platinum as their chlorides.

$3HCl + HNO_3 \rightarrow NOCl + 2H_2O + Cl_2$

⑥ Hydrochloric acid decomposes salts of weaker acids such as carbonates, bicarbonates, sulphides, sulphites, nitrites and thiosulphates.

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

$Na_2SO_3 + 2HC \rightarrow 2NaCl + SO_2 + H_2O$

$2NaNO_2 + 2HCl \rightarrow 2NaCl + NO + NO_2 + H_2O.$

Hydrochloric acid gives chlorine when warmed with oxidising agents, such as manganese dioxide or potassium permanganate.

$MnO_2 + HCl \rightarrow Mn + H_2O + Cl_2$

$2KMnO_4 + 16HCl \rightarrow 2MnCl_2 + 5Cl_2 + 2KCl + 8H_2O.$

Tests for purity

- Weight per ml; tests for free chlorine; bromide; iodide, sulphate, heavy metals; arsenic, lead, oxidizable substances, clarity and colour and non-volatile matter.

→ For determining bromide and iodide; chloroform and chlorinated lime solution are added with constant shaking. The chloroform layer does not become brown or violet.

- The presence of sulphite is ~~formed~~ found out by treating the acid with barium chloride solution and 0.001 N iodine.

- Sulphate as an impurity is ~~defe~~ detected by dissolving sodium bicarbonate in the acid and evaporating the solution to dryness. The residue complies with the limit test for sulphates.

Incompatibility:-

The chloride ion is precipitated with silver mercurous mercury and lead salts. It is oxidized by oxidizing agents, Chlorine is liberated.

Concentrated Hydrochloric acid.

- Concentrated hydrochloric acid is an aquous solution of hydrogen chloride in water. It contains not less than 35% w/w and not more than 38% w/w of HCl.

Tests for Identification

1. When neutralized and diluted, it gives the reactions of chlorides.

2. When added to potassium permangaanate, chlorine is evolved.

Assay :

Hydrochloric acid is a strong monoprotic acid which can be assayed conveniently by titrating against sodium hydroxide solution using methyl red as an indicator.

Accurately weighed 4g is added to 40ml of water in a stoppered flask and titrated with 1N sodium hydroxide using methyl orange. Each ml of 1N sodium hydroxide is equivalent to 0.3646g of HCl.

$$HCl + NaOH \rightarrow NaCl + H_2O$$

Uses :-

- Used as a pharmaceutical aid or as acidifying agent.
- In dilute form it is used for the treatment of achlorhydria (absence of HCl from the stomach juice).
- It is given intravenously in the management of metabolic alkalosis (increase in alkalinity of the blood).

PDF - start

Ammonium Hydroxide

NH_4OH ; Mol. Weight = 35.0

Preparation :-

1. In laboratory ammonia is prepared by heating ammonium chloride with calcium hydroxide.

$$2NH_4Cl + Ca(OH)_2 \rightarrow 2NH_3 + CaCl_2 + 2H_2O$$

② Commercially ammonia is obtained from the 'ammonical liquor' which is a ~~big~~ by-product during the production of coal-gas. Ammonical gas is obtained by passing the hot gas through cooling pipes. Lime water is added to the ammonical liquor and steam is passed through the mixture.

The mixture of steam and ammonia evolved is bubbled through sulphuric acid. From it, ammonium sulphate is produced which is the most important commercial ammonium salt and used as fertiliser.

$$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4.$$

③ Ammonia is also synthesized by Haber's process in which nitrogen and hydrogen. are combined in the presence of a catalyst (iron and molybdenum) at 450°-500°c at 200-900 atmospheric pressure

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

The reaction is reversible and exothermic. The ammonia produced is stored in liquid form in metal cylinder or absorbed in water, or converted into ammonium seats by combination with acids.

④ Hydrolysis of cyanamide with superheated steam gives ammonia. Atmospheric nitrogen is passed over calcium carbide and heated to a high temperature in an electric furnace to yield calcium cyanamide which is used as a fertilizer.

$$CaC_2 + N_2 \rightarrow \underset{\text{Calcium Cyanamide}}{CaN.CN} + C$$

$$CaN.CN + 3H_2O \longrightarrow CaCO_3 + 2NH_3.$$

⑤ Ammonia is also obtained as a by-product in the purification of bauxite (serpek's process) Bauxite and coke are heated in a current of nitrogen to form aluminium nitride which is hydrolyzed with water.

$Al_2O_3 + 3C + N_2 \rightarrow 2AlN + 3CO\uparrow$

$AlN + 3H_2O \longrightarrow Al(OH)_3 + NH_3\uparrow$

Physical Characters:

- Ammonia is a colourless gas; very pungent odour; lighter than air; specific gravity is 0.596; extremely soluble in water. One volume of water dissolves 1300 volumes of ammonia at 0°c and 760 mm to form ammonium hydroxide which is a base.

$$NH_3 + H_2O \rightarrow NH_4OH \rightleftharpoons NH_4^+ + OH^-$$

- Mixture of ammonia and air explode when ignited under favourable conditions.

- The gas may be liquefied at atmospheric pressure by cooling to 60°c or by cooling to 10°c at pressures of 6.5 or 7 atmospheres

- Liquid ammonia is a good solvent and ionizing medium.

Chemical Properties:

Ammonia molecule possesses an unshared pair of electrons, therefore, it acts as a ligand in forming soluble complex ion with many metal cations, eg. Cu, Ag, Zn, Cd, Cr, Ni, Co, Mn and Pt. The hydroxides or insoluble salts of these metals dissolve in ammonia solution. It reacts with certain metallic salts and precipitates hydroxides of the metals.

$$3NH_4OH + FeCl_3 \rightarrow \underset{\text{Brown ppt.}}{Fe(OH)_3} + 3NH_4Cl.$$

$$2NH_4OH + ZnSO_4 \longrightarrow \underset{\text{white ppt.}}{Zn(OH)_2} + (NH_4)_2SO_4.$$

→ Ammonia forms ammonia-basic salts by ammonolysis when reacts with mercuric chloride.

$$HgCl_2 + NH_3 \longrightarrow Hg(NH_2)Cl + HCl$$

→ Salts of ammonia reacts as acid in the presence of bases. Depending upon the particular salt, the pH of aqueous solutions of ammonia compounds will range from neutral to acidic.

$NH_4Cl + NaOH \rightarrow NH_3\uparrow + NaCl + H_2O$

→ Ammonia is burnt in an atmosphere of oxygen:

$4NH_3 + 3O_2 \rightarrow 2N_2 + 6H_2O$

→ Ammonia is a typical weak base. It turns red litmus blue, phenolphthalein solution pink and forms salts with acids.

$NH_3 + HCl \longrightarrow NH_4Cl.$

→ Ammonia is decomposed into nitrogen and hydrogen at red heat.

$2NH_3 \longrightarrow N_2 + 3H_2$

→ Ammonia is oxidized when passed over heated copper oxide.

$3CuO + 2NH_3 \longrightarrow 3Cu + N_2 + 3H_2O$

→ Both chlorine and bromine oxidise ammonia to give nitrogen.

$8NH_3 + 3Cl_2 \longrightarrow N_2 + 6NH_4Cl$

→ When ammonia is passed over heated sodium or potassium at 300°c, amides are produced.

$2NH_3 + 2Na \longrightarrow \underset{\text{Sodamide}}{2NaNH_2} + H_2$

→ Liquid ammonia dissolves alkali and alkaline earth metals to form blue solutions which decomposes slowly in the presence of impurities, yielding hydrogen and amide of the metal, eg. $NaNH_2$.

Strong Ammonia Solution

It is a clear colourless liquid with a strongly pungent characteristic odour, containing 27 to 30% w/w of ammonia. It is not quite saturated with the gas at ordinary temperatures. The most concentrated commercial solution contains about 35% of NH_3 and has a specific gravity of 0.880. It is stored at a temperature not exceeding 20° in airtight containers.

Test for Identification

1. Strongly alkaline, even when freely diluted with water.
2. When the vapour is brought into contact with gaseous hydrochloric acid; dense white fumes are produced.

Test for purity:

Weight per ml; tests for arsenic; heavy metals; pyridine and homologous; tarry matter; non-volatile matter.

Assay:-

Strong ammonia solution is assayed via residual titration. The solution (2g) is added to 1M hydrochloric acid (50 ml), taking precautions during the addition to avoid loss of ammonia and the excess of acid titrated with 1M sodium hydroxide using methyl red solution as indicator. Each ml of 1M hydrochloric acid is equivalent to 17.03 mg of NH_3.

Dilute Ammonia Solution :-

It is prepared by diluting strong Ammonia solution with freshly boiled and cooled purified water. It contains 9.5 to 10.5 % of NH_3; stored at a temperature not exceeding 20°c in well closed containers.

Uses :-

Dilute solution of ammonia have been used as reflex stimulants, ~~re~~ rubefacients and counter-irritants and to neutralize insect stings.

- Strong ammonia solution is used in the preparation of Aromatic ammonia spirit and ~~commercial~~ ammonical silver nitrate solution. Dilute ammonia solution may be used as reflex stimulant infainted persons.

- It is also used in the manufacture of nitric acid; sodium bicarbonate and ammonium salts of acids, Aromatic spirit of ammonia and strong ammonium acetate solution.

→ Ingestion of strong solutions of ammonia causes severe pain in the mouth, throat ~~of~~ and gastrointestinal tract, with cough, vomiting and shock.

PDF-start.

CALCIUM HYDROXIDE (SLAKED LIME)

$Ca(OH)_2$, Mol. weight = 74.09

Calcium hydroxide contains not less than 90% of $Ca(OH)_2$. It is ~~maintained~~ manufactured by spraying water on to q quicklime which is itself is prepared by heating limestone. The lamps of quicklime break into powder and heat is evolved. This process is known is slaking.

$$CaCO_3 \rightleftharpoons CaO + CO_2$$

$$CaO + H_2O \longrightarrow Ca(OH)_2$$

Water is absorbed by the oxide with the evolution of excess of heat; swelling of CaO lumps and finally disintegration into a fine powder take place.

Physical Characters:

Calcium hydroxide occurs as crystals or soft, odourless, granules or powder with slightly bitter alkaline taste. It is almost entirely soluble in water (1 in 600); soluble in aquous solution of glycerol and sugars. The aquous solution is alkaline to phenolphthalein and readily absorbs Ca from air forming $CaCO_3$.

PDF-end.

- Solubility of $Ca(OH)_2$ diminishes with increasing temperature.

- It is preserved in air tight container.

Chemical Properties :-

1. Calcium hydroxide absorbs carbon dioxide from air forming calcium carbonate. In presence of excess of CO_2, soluble calcium bicarbonate is formed.

$$Ca(OH)_2 + CO_2 \xrightarrow{-H_2O} CaCO_3 \xrightarrow{+CO_2} Ca(HCO_3)_2$$

2. Calcium Hydroxide loses water when ignited forming calcium oxide.

$$2\,Ca(OH)_2 \xrightarrow{Heat} 2\,CaO + H_2O$$

When calcium hydroxide is mixed with 3 to 4 times it weight of water, the suspension is called Milk of lime.

3. When H_2O_2 is added to a solution of calcium hydroxide, calcium peroxide is precipitated.

$$Ca(OH)_2 + H_2O_2 \longrightarrow CaO_2 \cdot 8H_2O \downarrow$$

4. Chlorine reacts with cold Milk of lime to form calcium hypochlorite.

$$2Ca(OH)_2 + 2Cl_2 \rightarrow Ca(ClO)_2 + CaCl_2 + 2H_2O$$

With hot Milk of lime chlorine yields Calcium chlorate.

$$6Ca(OH)_2 + 6Cl_2 \rightarrow \underset{\text{Calcium Chloorate}}{Ca(ClO_3)_2} + 5CaCl_2 + 6H_2O$$

Chlorine reacts with cold dry calcium hydroxide to form a mixture of calcium hypochlorite and basic calcium chloride (bleaching powder).

$$3Ca(OH)_2 + 2Cl_2 \rightarrow \underset{\text{Bleaching powder}}{Ca(ClO)_2 + CaCl_2Ca(OH)_2} + 2H_2O$$

Test for purity:

Tests for aluminium, iron, phosphate, and matter insoluble in hydrochloric acid; heavy metals; arsenic; lead; chloride; and sulphate.

Test for Identification :

A solution in acetic acid gives the reactions of calcium..

Assay :

Calcium hydroxide solutions are basic, pH 12.3, and are neutralized by acids.

i.) Accurately weighed sample (3g) is shaken with alcohol (10 ml),

ii) 10 % solution of sucrose (490 ml) is added.

iii) The mixture is shaken vigorously for 5 minutes and then at frequent intervals during four hours.

iv) The solution (250 ml) is filtered off and titrated with 1N HCl, using phenolphthalein solution as indicator.

Each ml of 1N HCl is equivalent to 0.03705 g of $Ca(OH)_2$.

$$Ca(OH)_2 + 2HCl \rightleftharpoons CaCl_2 + 2H_2O.$$

Calcium Hydroxide Solution

It contains not less than 0.15 per cent w/v of $Ca(OH)_2$, containing in each 100 ml, not less than 140 mg of $Ca(OH)_2$.

Uses:-

1. Calcium hydroxide is internally used as on antacid; as lime water in ~~inflate~~ infantile diarrhoea and vomiting (astringent).

2. In skin lotions, ~~and oily~~ soaps, dentistry, as pesticides, as egg preservative.

3. Calcium is used medicinally as a fluid electrolyte and a topical astringent.

Sodium Hydroxide (Caustic Soda)

Chemical formula : $NaOH$; Mol. weight : 40.

Standard :-

Contains not less than 97.0 percent of total alkali calculated as $NaOH$ and not more than 2.5% of Na_2CO_3.

Preparation :

1. When milk of lime is added to hot Sodium Carbonate solution (20%), sodium carbonate solution (20%), sodium hydroxide and precipitate of calcium carbonate are obtained.

The reaction is reversible.

$$Na_2CO_3 + Ca(OH)_2 \rightleftharpoons 2NaOH + CaCO_3 \downarrow$$

2. Electrolysis of sodium chloride : ($NaCl$)

At Cathode (-) : $Na^+ \rightarrow Na$

$$2Na + 2H_2O \rightarrow 2NaOH + H_2 \uparrow$$

At Anode (+) : $Cl^- \rightarrow Cl$

$$Cl + Cl \rightarrow Cl_2 \uparrow$$

Electrolytic cell

↓

Mercury diaphragm cell → Caster-kellner cell

Cathode made of mercury.

Anode made of Graphite.

NaCl solution is also known as Brine solution.

★ Physical Character:

Dry sodium hydroxide is very deliquescent, white sticks, pellets, spherical particles, masses or scales.

Melting point → 318°c.

Strongly alkaline and corrosive to animal and vegetable tissue.

Solubility :- 1 gm dissolve in 0.9 ml of water, 0.3 ml boiling water, 7.2 ml absolute alcohol, also soluble in glycerol.

* Chemical Properties:

1. Neutralization Reactions:

$NaOH + HCl \longrightarrow NaCl + H_2O$

2. It precipitates hydroxides of metals by reacting with salts of all metals in solution.

$Fe(SO_4)_3 + 6NaOH \rightarrow 2Fe(OH)_3\downarrow + 3Na_2SO_4$

Ferrous sulphate — Red ppt.

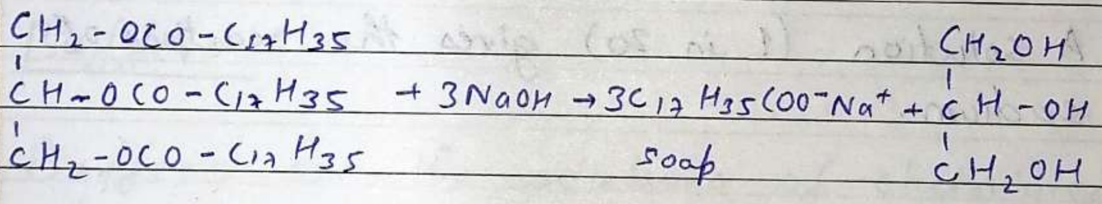
$Zn(OH)_2 + 2NaOH \rightarrow Na_2ZnO_2 + 2H_2O$

Sodium Zincate

$Al(OH)_3 + NaOH \rightarrow NaAlO_2 + 2H_2O$

Sodium meta aluminate.

Saponification:



$$\begin{array}{l} CH_2-OCO-C_{17}H_{35} \\ | \\ CH-OCO-C_{17}H_{35} \\ | \\ CH_2-OCO-C_{17}H_{35} \end{array} + 3NaOH \rightarrow \underset{\text{soap}}{3C_{17}H_{35}COO^-Na^+} + \begin{array}{l} CH_2OH \\ | \\ CH-OH \\ | \\ CH_2OH \end{array}$$

Stearin

Glycerin

3. Ammonium salts are decomposed with sodium hydroxide and form ammonia.

$NH_4Cl + NaOH \rightarrow NaCl + NH_3\uparrow + H_2O$.

4. Sodium Hydroxide solution reacts with zinc, aluminium, tin and silicon to form hydrogen.

$Zn + NaOH + H_2O \rightarrow NaHZnO_2 + H_2 \uparrow$

$4S + 6NaOH \rightarrow 2Na_2S + Na_2S_2O_3 + 3H_2O$

$Si + 2NaOH + H_2O \rightarrow Na_2SiO_3 + 2H_2 \uparrow$.

★ Test for Purity :

Test for aluminium, iron, matter insoluble in hydrochloric acid (HCl), arsenic, heavy metals, potassium chloride, lead, carbonates, sulphates, clarity and colour of solution.

★ Test for identification :

A solution (1 in 20) gives the reactions of sodium.

★ Assay :

A weighed amount of the substance (1.5g) dissolve in CO_2 free water (40ml) is titrated with 1N sulphuric acid using phenolphthalein solution as indicator. When the pink colour of solution is discharged, volume of acid solution required recorded, methyl orange solution added an the titration is continued until a persistant pink colour is produced.

Each ml of 1N H_2SO_4 is equivalent to 0.040 g of total alkali, calculated as NaOH and each ml of acid consumed in the titration with methyl orange is equivalent 0.106 g of Na_2CO_3.

★ Uses:

1. A 2.5% solution in glycerol is used as a cuticle solvent and remove warts.

2. Used as an ~~est~~ esharotic preparation of sodium hydroxide and calcium oxide, known as london paste.

3. Used for adjusting the pH of solution.

Buffers :

Buffers are the solutions of electrolytes which do not change their pH value as :-

(i) Standing for a long time.

(ii) Exposure to atmospheric condition.

(iii) Slight dilution.

(iv) Addition of small amount of acids or bases.

Basic Buffer :

PH value of basic buffer is greater than 7.

Ex:- NH_4OH and NH_4Cl.

Buffer capacity.

Moles of strong acid or strong base required to change the pH of one litre of buffer solution by one unit.

Physiological Buffers :

Blood (PH → 7.3 - 7.4)

Standard Buffer Solution

Standard buffer solution are solⁿ of std. pH. They are used for reference purposes in pH measurements and for carrying out many pharmacoepial traits which require adjustments to specific pH.

eg. →

① Hydrochloric acid buffer (PH range 1.2 to 2.2)

② Acid phthalate buffer (PH - 2.2 to 4.0)

③ Neutralized phthalate Buffer (PH - 4.2 to 5.8)

4. Phosphate buffer (PH - 5.8 to 8.0)

5. Alkaline Borate Buffer (PH - 8.0 to 10.0)

6. Acetate buffer (PH → 2.8)
other acetate buffer (PH - 3.5 to 5.0)

7. Glycine Buffer solution (Aminoacetate buffer solⁿ) (PH - 2.0 → 2.5)

8. Imidazole Buffer (PH → 7.4)

CHAPTER - 4.

Gastrointestinal Agents :

A Acidifying Agents

The condition of the absence of hydrochloric acid in the gastric secreations may be due to free of gastric hydrochloric acid after stimulation with histamine phosphate or due to lack of gastric hydrochloric acid though there may be stimulation by histamine.

The first condition is found in persons with a gastectomy, a trophic gastritis, carcinoma of stomach or gastric polyps.

The second condition is caused by chronic nephritis and alcoholism, tuburculosis, hyperthyroidism, pellagra (Nutritional disorder), diarrhoea, parasitic infections.

eg. Dilute HCl.

Dilute HCl is 9.5 to 10.5 percent W/v of HCl prepared by mixing HCl acid (274 gm) with water (726 gm). It is stored below 30°c in air tight container of glass.

When diluted HCl is further diluted with 25 to 50 volumes of water, it may be used as gastric acidifier to treat Achlorohydria.

Antacids.

Systemic
(absorbable)

Example:
- $NaHCO_3$
- Sodium Bicarbonate

Non - systemic
(Non - absorbable)

Example:
- Aluminium Hydroxide
- Magnesium oxide
- Calcium carbonate
- Sodium Carboxymethyl cellulose

Ideal Antacid Features:

i) Should be quick acting.

ii) Should not causes rebound acidity.

iii) Should not produce systemic alkalisis.

iv) Should not interface with adsorption of food

v) Should be palatable and inexpensive.

Aluminium Hydroxide Gel ($Al(OH)_3$, Mol. Wt → 78) is an aquous suspension of hydrated aluminium oxide with different amount of basic aluminium carbonate and bicarbonate.

It contains about 3.5% to 4.4% Al_2O_3
It may contain glycerine, sorbitol, sucrose or saccharin as sweetening agent, pippermint oil as flavour.
It may also contain suitable antimicrobial agent and preservative.

Preparation:

$$AlCl_3 + 3NH_4OH \rightarrow Al(OH)_3 + 3NH_4Cl$$

Physical Characters:

Aluminium hydroxide is a white, light, odourless, tasteless, amorphous powder containing some aggregates. It is soluble in dilute mineral acids and in solutions of alkali hydroxides.

Chemical Properties

In presence of alkali, it behaves as an acid.

$$Al(OH)_3 \rightleftharpoons 3H^+ + AlO_3^{3-}$$

In acidic medium, it acts as a weak base.

$$Al(OH)_3 \rightleftharpoons Al^{3+} + 3OH^-$$

Chemical Properties.

$$Al(OH)_3 + 3NaOH \rightarrow Na_3AlO_3 + 3H_2O$$

Sodium aluminate

Test for purity

Tests for arsenic, ammonium salts; chloride; lead; sulphate;

Test for Identification

Test	Observation	Inference
Dissolve the sample in dilute HCl + Add drops blue litmus + Ammonium hydroxide ~~added~~ added till the solution is alkaline	Blue coloured precipitate floated on the surface	Al^{3+} Confirmed.

Uses.

1. Aluminium hydroxide is a gastric antacid.
2. It is used as a phosphate binder in patient with chronic renal failure.
3. As an adjuvant in the manufacturing of absorbed vaccines.
4. It is also used in antiperspirants. and dentifrices.

Aluminium Phosphate ($AlPO_4$)

→ Mainly exist in the form of hydrated aluminium orthophosphate, containing not less than 80% of $AlPO_4$.

→ Mineral ore : angelite, wavelite, lucinite.

$NaAlO_2 + H_3PO_4 \rightarrow AlPO_4 + H_2O + NaOH$
Aluminium sodium oxide   Phosphoric acid

Physical Character

It is white infusible powder containing some friable aggregates, M.P. 1460°c, it is practically insoluble water and very ~~soluble~~ slightly soluble in conc^d HCl and nitric acid. Aluminium phosphate gel is white, viscous suspension from which small amount of water may separate on standing it may contain suitable preservatives.

The gel has a pH in the range 6.02 to 7.2.

Test for Purity

Test for arsenic, heavy metals, fluoride, sulphate, soluble phosphate neutralizing capacity.

Test for identification

A solution in 2N HCl gives a reaction of aluminium salt.

A solution in 2N Nitric acid gives a reactions of phosphate.

Assay:

The assay is based on complexometric titration.

It is assayed in terms of Aluminium phosphate content.

0.8g of sample + Acid + Disodium acetate + Ammonia + Ammonium acetate (7.7g)

→ PH adjusted to 4.5. with glacial acetic acid.

→ Dithizone in ethanol is added.

→ Titrated with 0.5N zinc chloride until the colour change to Red.

Each ml of 0.05M disodium edatate is equivalent to 6.098 mg of $AlPO_4$.

Uses.

Used as an adjuvant in manufacture of adsorbed vaccines.

It is used in place of aluminium hydroxide gel where loss of phosphate may be problem to the patient.

Calcium Carbonate :
(Precipitated chalk)

- $CaCO_3$. Mol. Wt - 100.0

* Natural Sources :- limestone, marble, calcite, iceland spar, domomite, shells of sea animal.

Preparation :-

$CaCl_2 + Na_2CO_3 \rightarrow CaCO_3 + 2NaCl$

$\underset{\text{insoluble}}{CaCO_3} + CO_2 + H_2O \rightarrow \underset{\text{soluble}}{Ca(HCO_3)_2}$

Physical Properties:

i) $CaCO_3$ occurs as a white odourless, tasteless, microcrystalline powder which is stable in air.

ii) It is dimorphous, orthorhombic
eg :- Aragonite M.P: 825°C.

iii) It is practically insoluble in water and alcohol, and soluble with acetic acid, Hydrochloric acid, Nitric acid.

Chemical Properties:

$$CoCO_3 \xrightarrow{>83} CaO + CO_2$$

$$\underset{\text{insoluble}}{CaCO_3} + CO_2 + H_2O \rightarrow \underset{\text{calcium bicarbonate soluble}}{Ca(HCO_3)_2}.$$

Test for purity:

Test for Al, Arsenic, iron, lead, barium, magnesium and alkali metal, phosphate, sulphate, chloride and heavy metal.

Test for identification:

When calcium carbonate is added to acidic acid effervescence is produces and the resulting solution after boling give the rxn of calcium.

Incompatibility :

Acids, Alum, Ammonium salt.

Assay :

0.1 gm of calcium carbonate + 3ml of dil HCl + 10 ml water.

↓ Boiled for 10 min and cooled.

Further diluted to 50 ml with water.

↓

Titrated with 0.05 M disodium ethylenediamine tetracetate and NaOH solution and calcon mixture are added to get the end point.

↓

Titration is continue until the colour change pink to blue.

↓

Each ml of 0.05 M disodium ethylenediamine tetracetate is eq. to 0.0050 of $CaCO_3$.

Uses :-

i) $CaCO_3$ is used as antacids.

ii) Calcium supplement in homoopathic medicine.

iii) Use in dentifrices, insecticides, cosmetics antibiotic, antidiarrheal agent.

18/04/2022

Magnesium Carbonate.

Molecular formula : $(MgCO_3)_4 \cdot Mg(OH)_2 \cdot 5H_2O$.

Approx Mol. Weight → 485

i) Natural Source :- Magnesite, Lansfordite.

ii) Preparation :

$$MgCl_2 + 2NaHCO_3 + CO_2 + H_2O \rightarrow MgCO_3\downarrow + 2NaCl + 2H_2CO_3$$

Heavy Magnesium Carbonate :- $(MgCO_3)_3 \cdot Mg(OH)_2 \cdot 4H_2O$

Light Magnesium Carbonate : $(MgCO_3)_3 \cdot Mg(OH)_2 \cdot 3H_2O$

40-45% MgO.

iii) Physical property :-

Both are white odourless powder or light, white, friable masses. They are stable in air practically insoluble in water and alcohol but dissolve in dilute acids.

iv) Chemical Properties :

$$MgCO_3 \xrightarrow{700°C} MgO + CO_2.$$

$$4MgCO_3 \cdot Mg(OH)_2 \cdot 5H_2O \rightarrow 5MgO + 4CO_2 + 6H_2O.$$

v) Test for purity :

Test for arsenic, Calcium, Chloride, copper, iron, lead, sulphate, heavy metal, soluble matter, substance insoluble in acetic acid.

vi) Test for Identification :

A solution in dilute nitric acid gives the reaction of magnesium and of carbonates.

(vii) Assay of Magnesium Carbonate :

0.18g of sample + dil. HCl (2ml) + 50 ml water + Strong Ammonium chloride solution (10ml)

$\Big\downarrow$ titrated with

0.05M disodium EDTA
↓
Using 0.1g of mordant black 11 mixture as indicator
↓
Pink colour is discharged from the blue.

Uses:

- Used as antacid.
- Used as cathartic and laxative,
- Used as food additive.
- Tooth powder and face powder.

23/04/22

☆ Magnesium Oxide (Magnesia)

MgO :- Mol. Wt :- 40.3

Magnesium oxide contains not less than 98.0% of MgO.

Natural Source:

Mineral Periclase.

Preparation :

$$MgCO_3 \xrightarrow{\Delta \text{ slightly}} MgO + CO_2$$

$$3MgCO_3 \cdot Mg(OH) \cdot 3H_2O \xrightarrow[\Delta]{\text{Red Heat}} 4MgO + 3CO_2 \uparrow + 4H_2O.$$

Physical Character :

Light magnesium oxide is very light, bulky, white powder whereas heavy magnesium oxide is dense mass.

Both oxides are odourless, slightly alkaline taste.

Practically insoluble in water.

They absorb moisture and CO_2 when exposed to air.

Chemical Properties:

$$MgO + H_3O^+ \longrightarrow Mg(OH)_2 + 2H_2O.$$

$$MgO + 2HCl \longrightarrow \underset{\text{Magnesium chloride (salt)}}{MgCl_2} + H_2O$$

~~Cat~~ $CaC_2 + MgO \rightarrow \underset{\text{Magnesium carbide}}{MgC} + CaO + C$

Test for purity

Test for arsenic lead, copper, iron chloride, sulphate, heavy metals.

Test for identification.

→ A solution in dilute HNO_3 gives the reaction of magnesium.

Assay :

Assay is based on ~~complexation~~ complexometric titration.

0.1 g. sample + 2 ml HCl.

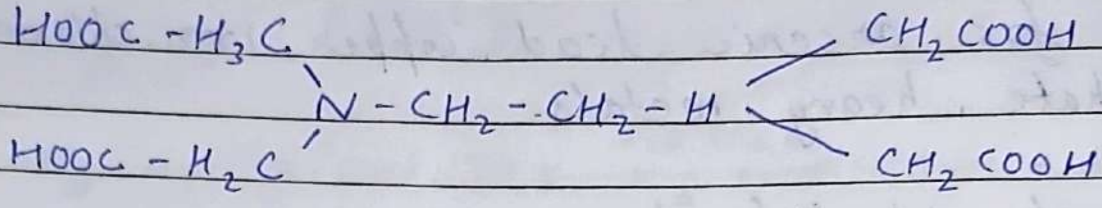
↓ strong NH_4Cl solution added.

Then titrate with 0.05M disodium EDTA using 0.1 g of ~~moderate~~ mordant black 11 mixture as indicator.

↓

At End point colour changes pink to blue. Each ml of 0.05 M disodium EDTA is equivalent to 0.002015 g of MgO.

Ethylene tetraacetic acid (EDTA)



$$\begin{matrix} HOOC-H_3C \\ \quad\quad\quad\quad\quad\quad \diagdown \\ \quad\quad\quad\quad\quad\quad\quad\quad N-CH_2-CH_2-N \\ \quad\quad\quad\quad\quad\quad \diagup \\ HOOC-H_2C \end{matrix} \begin{matrix} CH_2COOH \\ \diagup \\ \\ \diagdown \\ CH_2COOH \end{matrix}$$

Uses :-

1. As osmotic laxative.
2. Food additive
3. In hypomagnesemia.
4. As antacid in gastric ulcer.
5. Compounding and preserving fluid extract due to its absorptive properties.
6. In dentrifices.

25/07/22

☆ Magnesium Trisilicate.

$2MgO \cdot 3SiO_2 \cdot 3H_2O$.

Mol. wt :- 260.86.

It contains about 29 to 32% of MgO and 68.5% of SiO_2

Preparation

① Prepared by adding HCl to a solution of sodium silicate followed by addition of precipitated magnesium hydroxide.

⑪ $2MgSO_4 + 2Na_2O.3SiO_2 \rightarrow 2MgO.3SiO_2.3H_2O + Na_2SO_4 + H_2O$.

Physical Properties.

It is an colourless, fine, white, tasteless powder.

It is practically insoluble in water and alcohol.

Chemical Properties.

$2MgO.3SiO_2 + 4HCl \rightarrow MgCl + H_4Si_3O_8\downarrow$

Trisilicic acid

Test for purity :

Test for Arsenic, chloride, Lead, Sulphate, Heavy metals.

Test for identification

0.5g of somple boil with 10 ml NaOH solution.

↓ filtered

Acidified with dil. HCl and boiled.

↓

The residue is washed on the filter paper

↓

Dissolved in HCl and filtered.

↓

Filterate ~~gas~~ gives the reaction of ~~mg~~ magnesium

Uses:

1. As an antacid.
2. Used as an adsorbent.
3. It relieves pain in gastric ~~acid~~ and duodenal ulcers and possibly absorbs the pepsin.

★ Antacid Combination.

1. Aluminium hydroxide magnesium carbonate co-dried gel. Dose upto 1 gm.

2. Algicon tablet:

   Aluminium hydroxide magnesium co-dried gel (360 mg), magnesium alginate (500 mg) magnesium carbonate (320 mg) and potassium bicarbonate (100 mg).

3. Simeco tablet:

   Contains aluminium hydroxide - magnesium carbonate co-dried gel (282 mg), magnesium hydroxide (85 mg) and activated dimethicone (25 mg).

4. Megaldrate:

   Chemical composition of Aluminium hydroxide magnesium hydroxide.

   It contains the equivalent of 28 to 39 % magnesium hydroxide and 17 to 25 % aluminium hydroxides.

☆ Protective and adsorbent.

☆ Bismuth Subcarbonate $[(BiO_2)CO_3]_2 \cdot H_2O$.

→ Bismuth subcarbonate contains not less than 82.5% of Bi and 79% of Bi_2O_3. It is a basic salt of variable composition.

Preparation

$$2Bi + 8HNO_3 \longrightarrow 2Bi(NO_3)_3 + 2NO + 4H_2O.$$

Metallic
Bismuth

$$Bi(NO_3)_2 \xrightarrow[Na_2CO_3]{H_2O} (BiO)_2CO_3$$

Physical properties.

It is a white, heavy, odourless, micro-crystalline, tasteless, slightly hygroscopic powder.

Practically insoluble in water and alcohol, readily soluble in Nitric acid.

Test for purity:

Test for chloride nitrate, alkali and alkaline earth metal, arsenic, copper, silver, lead.

Chemical Property

$$[(BiO_2)_2CO_3]_2 \cdot H_2O$$

$$\Big\downarrow \Delta \text{ Red Heat}$$

Bi_2O_3 + Nitrogen oxides
NO_2, N_2O.

Test for identification

It gives the reaction characteristic of bismuth compounds and of carbonates

Assay:

0.5g sample dissolved in HNO_3

$$\Big\downarrow \text{diluted with } H_2O \text{ (250ml)}$$

Carried out the complexometric titration of bismuth with disodium EDTA.

Each ml of 0.1N disodium EDTA is equivalent to 20.90 mg of Bi.

Uses:- (i) As antacid
(ii) Mild astringent
(iii) Dusting powder
(iv) Antiseptic
(v) Protective and adsorbent.

☆ Kaolin ($Al_2O_3 . 2SiO_2 . 2H_2O$)

China Clay.

Natural Source:

Decomposition of feldspar of granitic rocks. Kaolin consists of mainly aluminium silicate with traces of compounds of magnesium, calcium, iron.

Preparation:

Kaolin is prepared when the rock is mined, excavated and the impurities are washed with water and then powdered.

Physical properties:

Kaolin is slightly plastic-like and is normally white. It has an earthy or clay-like taste. Its colour may be tinged gray, yellow, brown, blue or red due to impurities. Its fusion points in between 1700-1800. On heating it losses water.

Heavy Kaolin:

→ It's particle are 20 μm in diameter, flat and irregularly arranged.

→ White or greyish-white, Practically insoluble in water.

Light kaolin.

- → Particle size 2 um in diameter.
- → Light kaolin is a white light, odourless, unctous powder, free from gritty particles.
- → It is practically insoluble in water and mineral acids.

Test for purity.

Test for arsenic, carbonates, chloride, heavy metal, sulphate, calcium, iron, loss on dry, organic impurities, absorption power, swelling power, particle size, alkalinity and acidity.

Uses :-

i) Used as adsorbent.
ii) Antidiarrhoeal.
iii) Used as ~~dysent~~ dusting powder and food additive.
iv) Heavy kaolin is used in the preparation of kaolin poultice.

v) Used as detoxifying agent.

★ Saline Catharatics (Purgatives)

- Fasten and increase evacuation of bowels.
- Used for patient having problem in defecation.
- Used in painful haemorrhoids (piles)
- In acute contipation.
- To remove solid materials from the intestinal tract prior to certain x-rays studies.

→ Laxative are mild catharotics that are used for short term therapy.

→ Laxative may be used for evacuation which are of four types.

① Stimulant laxative.
ii) Bulk forming laxative
iii) Emollient laxative
iv) Saline laxative:

☆ Laxative (Mild Cathartics)

1) Stimulant :

Phenolphthalein, aloin, extract of cascara, castor oil, sennahubarb etc.

ii) Bulk forming:

Psyllium seed, methyl cellulose, sodium carboxymethyl cellulose and karaya gum etc.

iii) Emollient :

Mineral oil and d-octyl sodium sulphosuccinate.

iv) Saline.

a) Cationic → Magnesium salts.

b) Anionic → $H_2PO_4^-$, HPO_4^-, sulphate, ~~tar~~tartrate.

☆ Magnesium Sulphate.

$MgSO_4 \cdot 7H_2O$, Mol. wt = 246.47.

Natural Source:

Kieserite, epsomite.

Preparation :

(i) $MgCO_3 + H_2SO_4 \rightarrow MgSO_4 + H_2O + CO_2$

(ii) $MgO + H_2SO_4 \rightarrow MgSO_4 + H_2O$.

(iii) $MgCO_3 . CaCO_3 + H_2SO_4 \rightarrow MgSO_4 + CaSO_4 + 2CO_2 + 2H_2O$.
Dolomite

✯ Physical character of $MgSO_4$.

→ Odourless, colourless crystals or white crystalline powder, bitter, saline and cooling taste. It is soluble in water (1 in 1.5) and very soluble in warm water Practically insoluble in water when exposed to moist air. It is stored in a well closed container.

Test for purity :

Test for arsenic, iron, lead, zinc, chloride, heavy metals loss on drying (51.1 %).

Test for identification :

A solution (1 in 20) gives the reaction of Mg and sulphate.

Assay :

Assay is based on the complexometric titration carried out with EDTA.

+ 0.3g of sample + 50 ml of water
↓

Add 10 ml of strong Ammonium chloride solution

The reaction mixture is titrated with 0.05 M disodium EDTA using 0.1 of mordant black 11 mixture as indicator, until the pink colour is discharged from the blue.

Each ml of 0.05M EDTA ≡ 0.00602 g of $MgSO_4$.

Uses :

① As a saline laxative.
(ii) Treatment of ~~Mg~~ Magnesium deficiency.
(iii) As anticonvulsant.
(iv) Local anti-inflamatory agent in infected wounds.

☆ Sodium Potassium Tartrate :

$COONa . CH(OH) . CH(OH) . COOK . 4H_2O$.
or $NaKC_4H_4O_6 . 4H_2O$.

Mol. wt - 282.17.

→ It contains 99 to 104% of $NaKC_4H_4O_6 . 4H_2O$

Preparation :

i) $2KHC_4H_4O_6 + Na_2CO_3 \xrightarrow{60°C} 2KNaC_4H_4O_6 + CO_2 + H_2O$.
Potassium bitartrate   Sodium Carbonate

Physical Properties :-

Odourless, Colourless, crystals or white crystalline powder with a cooling saline taste.

Cooling saline taste.

M.P. → 70°- 80°C

Soluble in water (1:1), Insoluble in alcohol
Aquous solution is slightly alkaline to litmus. pH 7-8. It is stored in air tight container.

☆ Chemical Properties :

i) It gives characteristic reaction of sodium potassium and tartrates.

ii) CH_3COOH (5%) + $2KNaC_4H_4O_6 . 4H_2O \rightarrow 2KHC_4H_4O_6$ ~~$2KHC_4H_4O_6$~~

Potassium titrate
(white ppt.)

☆ Test for purity :

Test for arsenic, chloride, iron, heavy metals, sulphate, loss on drying.

☆ Assay :

A weighed ammount (2g) is heated until Carbonized cooled.

↓

Residue boiled with 50ml of water and 0.5 N H_2SO_4.

↓ filtered ~~with~~ washed with water.

Then titrated with 0.5N NaOH solution using methyl orange solution as indicator.

↓

Each ml of 0.5N $H_2SO_4 \cong$ 0.07056g of $NaKC_4H_4O_6 . 4H_2O$.

☆ Uses :-

i) Used as laxative.

ii) Stabiliser in cheese and meat prooduct.

iii) It is used in seidlitz powder and Fehling's solution.

DNA Nor CH

electrolyte

Electrolyte

Date 09/05/21
Page 1

Physiological Acid-Base balance:

Acids are constantly being produced during metabolism. Most of the metabolic reaction occurs only during a very narrow pH range of 7.38 to 7.42.

Therefore, the body utilises several efficient buffer system. Two of them are ① bicarbonate - carbonic acid ($HCO_3^{3-} : H_2CO_3$) present in plasma entity.
⑪ monohydrogen phosphate - dihydrogen phosphate ($HPO_4^{2-} : H_2PO_4^-$). found in cells ~~and~~ and kidney.

Carbonic Anhydrase:

$$H_2O + CO_2 \xrightarrow[\text{Anhydrase}]{\text{Carbonic}} H_2CO_3$$

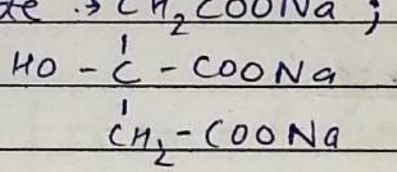
$$H_2CO_3 + K^+ + HbO_2^- \rightarrow K^+ + HCO_3^- + HHb + O_2$$

Electrolytes used in Acid-Base Therapy.

① Ex:- Sodium acetate.
$CH_3COONa.3H_2O$ Mol. wt :- 136.08.

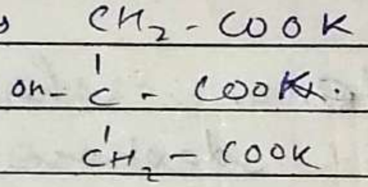
② Potassium acetate - CH_3COOK . Mol. wt - 98.14

③ Sodium Citrate :>



$$\begin{array}{l} CH_2COONa\ ; \\ HO-\overset{|}{\underset{|}{C}}-COONa \\ CH_2-COONa \end{array}$$

④ Potassium citrate →



$$\begin{array}{l} CH_2-COOK \\ OH-\overset{|}{\underset{|}{C}}-COOK \\ CH_2-COOK \end{array}$$

Electrolyte Combination Therapy:

→ Fluid Maintenance . Glucose of saline solution required
short term therapy
→ Electrolyte replacement:
↓ severe deficits.
additional electrolyte required.

Text

Fluid Maintenance:

→ Intravenous.

→ All maintenance should contain at least 5% dextrose; the other ions are sodium (25-30 mEq/L), Potassium (15-20 mEq/L), chloride (22 mEq/l), bicarbonate (20-33 mEq/L), Magnesium (3 mEq/L) and Phosphorous (3 mEq/L).

Replacement therapy:-

Conditions:- Excess loss of Electrolytes
and water, due to fever,
severe vomiting and diarrhoea.

Two types of solutions are used in replacement therapy.

i) a solution for rapid initial replacement.

ii) a solution for subsequent replacement.

i) a solution for rapid initial replacement

→ Almost similar to the electrolytic conc. found in the extracellular fluid.

Electrolytes	Concentration in 1. mEq/L	Concentration in 2. mEq/L.
Na^+	130-150	40-120
K^+	4-12	16-35
Cl	98-109	30-103
HCO_3	28-55	16-53
Ca^{+2}	3-5	0-5
Mg^{+2}	3	3-6

Oral Rehydration Therapy (ORS).

The oral administration of fluid that contains suitable combinations of carbohydrates and electrolyte is known as oral rehydration therapy.

0.9 % NaCl solution and glucose and Electrolytes.

There are two basic treatment phases
i) Rehydration phase:

ii) Maintenance phase:

Sodium - 60-90 mmol/L
Potassium - 20-25 mmol/L
Lactate
Glucose - 56- 140 mmol/L

Multiple Electrolyte powder

☆ Oral Rehydration Salt.

→ Each packet (35g) contains

- Sodium chloride (1.25g)
- Potassium chloride (1.50g)
- Sodium Citrate (2.90g)
- Anhydrous dextrose (27g).

☆ Electrolytes

- Sodium (52) mEq/L
- Potassium (20) mEq/L
- Chloride (41) mEq/L
- Citrate (30) mEq/L
- dextrose (150) m.mol/L

☆ Oral rehydration Salt (WHO, UNICEF).

→ It contains for 1L solⁿ :-

- Sodium chloride (3.5g)
- Potassium chloride (1.5g)
- Sodium bicarbonate (2.5g)
- Sodium citrate dihydrate (2.9g), and
- Anhydrous glucose (20g).

→ Multiple Electrolyte solution :

i) Oralyte Ready -b oral solution
ii) Paediametric solution for Intravenous use.
iii) Elliot's B solution.
iv) Ringer's injection (U.S.P) 100 ml :-
A sterile solution containing NaCl (860 mg), KCl (30 mg), calcium chloride dihydrate (33 mg) and water for injection to 100 ml.

★ Dialysis solution :

→ Intraperitoneal Dialysis Fluid (I.P.)

→ It contains :-

- Sodium chloride (5.56 g)
- Sodium acetate (4.76 g)
- Calcium chloride (0.22 g)
- Magnesium chloride (0.152 g
- Sodium metabisulphite (0.15 g)
- Dextrose anhydrous (12.0 g)
- Purified water Q.S. to 1000 ml.

* Respiratory Stimulant:

- → Chronic obstructive Airways Disease.
- → Chronic obstructive Pulmunary disease.
- → It contain the equivalent of not less than 30% of NH_3.
- → Ammonium carbonate - $[NH_4HCO_3]m \cdot [NH_2CO_2NH_4]_m$

→ $(NH_4)_2SO_4 + CaCO_3 \rightarrow (NH_4)_2CO_3 + CaSO_4$
(Ammonium sulphate). (Calcium Carbonate)

* Physical character:

It occurs as translucent, hard, crystalline masses.

→ Odour is strongly ammonical, taste is pungent.

→ It is freely soluble in water, alkaline to litmus. It volatizes at about 60°.

* Chemical properties

$$NH_4CO_3 \xrightarrow{\Delta 60°C} NH_3\uparrow + CO_2\uparrow + H_2O$$

$$(NH_4)_2CO_3 \xrightarrow{\Delta 60°C} 2NH_3\uparrow + CO_2\uparrow + H_2O$$

$NH_4HCO_3 + NH_3 \xrightarrow{\text{Dil. Ammonia}} (NH_4)_2CO_3$.

$NH_4CO_2NH_4 + H_2O \xrightarrow{\text{water}} (NH_4)_2CO_3$.

✻ Test for purity:

Test for iron, chloride, sulphate, tarry matter, non-volatile matter

✻ Incompatibility

Acid and acid salts, ~~salf~~ salt of iron, zinc, alkaloids, alum, calomel.

✻ Assay:

2g of sample + 50ml of 1N H_2SO_4 + 5 ml of H_2O.

↓ Boiled and then cooled.

Titrate with 1N NaOH, using methyl red solution as indicator.

Each ml of 1N H_2SO_4 $\cong$ 0.01703g NH_3

✻ Uses.

Ammonium carbonate is used as respiratory ~~stimu~~ stimulant, expectorant and pcentical aid.

Haematinics

⇒ A haemtinic is a nutrient required for the formation of the blood cell.

⇒ A compound that contain iron salt is called haematinic agent.

⇒ They are used in the treament of Iron deficiency disease, eg Anaemia.

Example :- Ferrous sulfate ($FeSO_4.7H_2O$)
Ferrous Fumarate: ($^-OOC-CH=CH-COO^-$) Fe^{2+}
Ferrous Gluconate $[HOCH_2(CHOH)_4COO^-]_2 Fe^{2+}.2H_2O$
Iron and Ammonium citrate.
Iron Dextran Injection.

Ferrous Sulfate :-
$FeSO_4.7H_2O$, M.W = 278.0

IP limit:- It contain not less than 98.0 % of $FeSO_4.7H_2O$.

Prepration :-
Ferous sulfate is prepeared by adding a slight excess of iron to dilute H_2SO_4.

$$Fe + H_2SO_4 \longrightarrow FeSO_4 + H_2$$

Properties:-
→ It occurs as odourless bluish-green crystalline powder
→ On exposure to moist air it is oxidized and becomes brown in colour due to the formation of basic sulfate.

→ It is complete dissolve in water.

→ It is stored in tightly-closed container.

→ Ferrous sulfate ~~con~~ oxidised to convert ferric sulfate on exposure to air.

$$4FeSO_4 + 2H_2O + O_2 \longrightarrow 4Fe(OH)SO_4$$

Ferric sulfate
(Brown colour.

Assay:-

→ Assay is based on oxidation-reduction (redox) titration.

→ Acidified Solution of the substance is ~~to~~ titrated with cerric ammonium sulfate, in the presence of H_2SO_4.

→ Ferroin sulfate solution as an indicator.

Method:-

weighed amount of $FeSO_4 \cdot 7H_2O$ (1gm)
↓ dissolve in H_2O_2 (30ml)
Solution
↓ add H_2SO_4 (20ml)
To make it acidified
↓ titrated with
~~0.1N ceric~~
0.1N Cerric ammonium sulfate
↓ using indicator
Ferroin Solution.

Each ml of 0.1N cerric ammonium sulfate is equivalent to 0.0278 g of $FeSO_4 \cdot 7H_2O$.

Iron and haematinics

→ Iron and its official compounds are used haematinic agent.

→ They are also used in the treatment of iron deficiency eg anaemia.

→ Their are some official compound of Iron.

Ferrous sulphate - $FeSO_4 \cdot 7H_2O$
Ferrous Fumarate. $C_4H_2FeO_4$ $FeC_2H_4(CO_2)_2$
Ferrous Gluconate. $FeC_{12}H_{22}O_{14} \cdot 2H_2O$
Ferric Ammonium citrate.
Iron Dextran Injection
Dried Ferrous Sulphate.

Ferrous Sulphate:-

$FeSO_4 . 7H_2O$ -
Mol. weight - 278.0

Ferrous sulphate contain not less than 98.0% of $FeSO_4 . 7H_2O$.

Prepration. Ferrous sulphate is prepared by adding a slight excess of Iron to dilute sulphuric acid.

$$Fe + H_2SO_4 \longrightarrow FeSO_4 + H_2.$$

Physical properties:-

→ It is odourless bluish-green crystal
→ Its taste metallic and astringent.

Dental Products

Dental caries (tooth decay) is a chronic infectious disease, called dental plague, in which the active agents are members of the indigenous oral flora. It is a colourless sticky mixture of bacterial products, mucin, saliva and foods stuff attached to enamel covering the dentine on the crown. Dental plague is resulted by the combined action of bacteria. Streptococcus mutans, on teeth and a periodental disease in which inflammation and swelling of gingiva occurs. The bacteria survive on carbohydrates and swelling including the sugar taken in tea and produce acids, especially lactic acids, proteolytic enzymes. Calcium salts are dissolved in acidic medium, the remaining organic matrix is readily digested by the proteolytic enzymes and cavities are formed. When a cavity deepens, inflammation of the pulp results. A regular dental care eliminates dental plague.

Modification of food habits such as less frequent eating, particularly less in between meals, and avoidance of use of sugar containing food materials that are retained on tooth surface, are the precautionary measures.

☆ Dicalcium Phosphate.

(Dibasic Calcium Phosphate, Calcium Hydrogen Phosphate).

$CaHPO_4$: Mol. Weight = 136.06.
$CaHPO_4.2H_2O$; Mol. Weight = 172.1.

Dicalcium phosphate is anhydrous or contains two molecules of water of hydration. It contains not less than 30.9 per cent and not more than 31.7 per cent of calcium, calculated with reference to the ignited substance.

Preparation

$$CaCl_2 + Na_2HPO_4 \longrightarrow CaHPO_4 + 2NaCl$$

$$Ca_3(PO_4)_2 + 3H_2SO_4 \longrightarrow \underset{\text{Phosphoric acid}}{2H_3PO_4} + 3CaSO_4.$$

$$H_3PO_4 + Ca(OH)_2 \longrightarrow CaHPO_4 + 2H_2O$$

Physical Characters:

- It occurs as a white, odourless, tasteless - crystalline powder.

- It is stable in air ;
- It is practically insoluble in cold water and alcohol; soluble in dilute hydrochloric acid and nitric acids. It loses water of crystallisation slowly below 100°c.

Test for Purity :

Tests for carbonate ; chloride ; fluoride ; sulphate ; arsenic ; barium ; iron ; monocalcium and tricalcium phosphates ; heavy metals.

Test for Identification

1. The substance is dissolved in dilute hydrochloric acid ; the solution gives the reactions of calcium.
2. A solution gives the reactions of phosphates in dilute nitric acid.

Assay

The assay is based on complexometric titration as discussed for calcium gluconate and magnesium sulphate.

☆ Sodium Fluoride

NaF ; Mol. weight = 42.0

Sodium fluoride contains 98.5 to 100.5% of NaF.

Preparation

$$Na_2CO_3 + 2HF \rightarrow 2NaF + H_2O + CO_2$$

$$Na_2SiF_6 + 2H_2O \rightarrow 2NaF + 4HF + SiO_2$$

Physical Characters :

- Sodium fluoride occurs as a white, odourless powder or colourless crystals; m.p. 99.3°.

Chemical Reactions

$$Na_2SiO_3 + 6HF \longrightarrow Na_2SiF_6 + 3H_2O.$$

Test for Purity :

Tests for lead; fluorosilicate; sulphate; clarity and colour of solution; acidity or alkalinity; loss ~~of~~ on drying.

Tests for Identification :

- The substance is dissolved in water and then calcium chloride solution added. A gelatinous white precipitate is produced which dissolves on adding 5 ml of ferric chloride solution.

Assay.

To the substance (80 mg) a mixture of acetic anhydride and anhydrous acetic acid is mixed and heated to dissolve.

Uses:-

Sodium fluoride is used as an adjunct to diet and oral hygiene for the prevention of dental caries.

★ Sodium Metaphosphate

(Sodium metaphosphosphate, Maddrell's salt)

$(NaPO_3)_n$

Sodium metaphosphate is prepared by dehydration of sodium phosphates (e.g. $Na_2H_2P_2O_7$, NaH_2PO_4, Na_2HPO_4).

$NaH_2PO_4 \rightleftharpoons NaPO_3 + H_2O$.

- It occurs as a white powder; practically insoluble in water but soluble in mineral acids.

- Sodium metaphosphate is used as a 5% dusting powder in hyperhidrosis and bromidrosis, as a prophylactic against athlete's foot, a water softner and in food industry as emulsifying and chelating agent.

★ Stannous Fluoride.

SnF_2 : Mol. Weight = 156.70

Stannous fluoride is prepared by evaporating a solution of stannous oxide in hydrofluoric acid in the absence of oxygen or by reacting tin with hydrogen fluoride

$$SnO + 2HF \longrightarrow SnF_2 + H_2O$$

$$Sn + 2HF \longrightarrow SnF_2 + H_2$$

Test for Purity :

Tests for antimony ; water-insoluble substances ; loss on drying ; pH.

Tests for Identification

→ When calcium chloride solution is added to a solution of the substance, white precipitate of calcium fluoride is formed.

Assay (U.S.P.)

For Stannous Ion :

A mixture of stannous fluoride dissolved in 3N hydrochloric acid and potassium iodide is titrated with 0.1N potassium iodide-iodate, adding starch as the end-point is approached.

Assay for Fluoride :

The standard preparations of 4,5-dihydroxy-3-(p-sulphophenylazo)-2, 7-naphthalene-disulphonic acid trisodium, zirconium oxychloride, hydrochloric acid, and sodium fluoride after addition as indicated in the USP monograph are screened at a wavelength of maximum absorbance at about 590 nm and the quantily of F is determined.

Uses :

→ Stannous fluoride has similar actions to sodium flouride and is used as ingredient of caries-preventing tooth pastes, in dentrifrices and mouth rinses.

→ It increases teeth discolouration.

☆ Strontium Chloride

$SrCl_2$; Mol. Weight = 158.52.

$SrCl_2 . 6H_2O$; Mol. Weight = 266.6

→ Strontium chloride hexahydrate occurs as colourless, odourless crystals or white granules. It efflorescenes in air.

→ It is soluble in water and alcohol.

→ The aqueous solution is neutral.

Uses:

→ Strontium chloride is used as a 10% tooth paste for the relief of dental hypersensitivity.

★ Zinc Chloride

$ZnCl_2$; Mol. Weight = 136.3

Zinc chloride contains 95 to 100.5 per cent of $ZnCl_2$.

Zinc chloride is prepared by heating excess of metallic zinc with mildly concentrated hydrochloric acid.

$$Zn + 2HCl \longrightarrow ZnCl_2 + H_2.$$

$$Zn + HgCl_2 \longrightarrow ZnCl_2 + Hg.$$

Characters

- Zinc chloride occurs as a white, odourless, deliquescent crystalline powder or granules or opaque white masses or sticks ; m.p. 290°.

- It is soluble in water, alcohol and glycerol; freely soluble in acetone.

Test for Purity :

Tests for oxychloride, sulphate; ammonium salts; calcium; iron; magnesium; alkali and alkaline earths; heavy metals; acidity.

Tests for Identification

→ An aqueous solutions is acidified with 2N hydrochloric acid, until the solution is complete. The resulting solution is complies the tests for zinc.

→ A 5% solution in 2N nitric acid gives the reactions of chloride.

Assay :

The assay is based on the complexometric titration as discussed for zinc sulphate and calcium gluconate.

Uses :

→ Zinc chloride is a powerful caustic and astringent (protein precipitant).

→ It is also used as an obtundent in dentistry; as deodorant, disinfecting, embalming material, as a desensitizer of dentin, as mouthwashes, in ulcers, fistulas and pododermatities.

Antioxidants :

Antioxidants are used in pharmaceutical preparations containing easily oxidized substances for mainting these substances to their reduced form. They are chemically reducing agents.

Examples :- Hypophosphorus acid, Sulphur dioxide etc.

☆ Hypophosphorous acid :

Chemical formula :- H_3PO_2.
Mol. Weight :- 66.0

Preparation :

It is conveniently prepared by treating NaH_2PO_2 with an ion-exchange resin.

Physical Character :

It is a colourless or slightly yellow odourless liquid.

Chemical Charater / Properties :

It is a monobasic and reducing agent. It contains 30 to 32 percent of H_3PO_2. It is decomposed by heat into H_3PO_4 and spontaneously flammable PH_3
It is miscible with water, alcohol and ether.

Test for purity:

Tests for barium; calcium; iron; chloride; sulphate; phosphoric acid; oxalic acid; oxalic acid; weight per ml.

Incompatibility:

Combination of hypophosphorous acid with oxidizing agents such as nitrates, chlorates or permanganates forms explosive mixtures in ~~compound~~ concentrated amounts.

Assay:

The acid (10g) is diluted with water (50 ml) and titrated with 0.5 N sodium hydroxide, using methyl orange solution as indicator. Each ml of 0.5 N sodium hydroxide is equivalent to 0.03300 g of H_3PO_2.

Uses:

Hypophosphorus acid is used as an antioxidant.

Salts of hypophosphorus acid, eg. sodium and ammonium hypophosphite, are present as a preservative in certain food and preparations.

★ Sulphur Dioxide

Chemical formula : SO_2
Mol. Weight : 64.06

Preparation :

1. Sulphur dioxide is manufactured by burning sulphur in air or by roasting metallic sulphides like copper, iron or zinc.

$$S + O_2 \longrightarrow SO_2 \uparrow$$

$$4FeS_2 + 11O_2 \rightarrow 8SO_2 \uparrow + 2Fe_2O_3$$

$$2ZnS + 3O_2 \longrightarrow 2ZnO + 2SO_2 \uparrow$$

Physical Character :

Sulphur dioxide is a colourless gas with a typical pungent small of burning sulphur. It condenses readily under pressure to a colourless liquid which boils at about -10°.

Sulphur dioxides forms sulphurous acid in aqueous solution.

$$SO_2 + H_2O \longrightarrow \underset{\text{Sulphurous acid}}{H_2SO_3} \rightleftharpoons 2H^+ + SO_3^{2-}$$

Chemical Properties :

1. Sulphur dioxide is decomposed into sulphur and sulphur trioxide when heated strongly.

$$3SO_2 \rightarrow S + 2SO_3$$

2. Sulphur dioxide is incombustible. However, strongly burning potassium or magnesium ~~contines~~ continues to burn in SO_2 and decomposes it into sulphur and oxygen.

$$3Mg + SO_2 \rightarrow 2MgO + MgS$$

$$4K + 3SO_2 \longrightarrow K_2SO_3 + K_2S_2O_3$$

Test for Purity :

Test for water; sulphuric acid and non-volatile residue. To determine non-volatile residue, a weighed sample is evaporated and the remaining matter is weighed.

Incompatibility :

Under alkaline conditions, sulphur conditions, sulphur dioxide is converted to bisulphite and sulphate.

Assay :

Sulphur dioxide is stable at moderate to strong acidic pH. As the pH becomes neutral to alkaline values, sulphur dioxide is converted into bisulphate and sulphite. This fact is used used in the assay of SO_2.

Uses :

Sulphur dioxide has antioxidant and antimicrobial properties and is used as a preservative for food.

In industry it is used for bleaching wood pulp, fumigating grains and arresting fermentation.

Sodium Bisulphite

Chemical formula : $NaHSO_3$
Mol. Weight : 104

Preparation :

Sulphur bisulphite is prepared by passing sulphur dioxide into a solution of sodium carbonate until the solution is saturated. Evaporation of the solution gives a mixture of sodium bisulphite and metabisulphite.

$$Na_2CO_3 + 2SO_2 + H_2O \longrightarrow 2NaHSO_3 + CO_2 \uparrow$$

$$2NaHSO_3 + SO_2 \longrightarrow Na_2S_2O_5 + H_2SO_3 .$$

Physical Character :

Sodium bisulphite is a white or yellowish white crystalline powder having pungent odour of burning sulphur and disagreeable taste.

Chemical Properties :

On exposure to air it is unstable, loses some SO_2 and is generally oxidized to sulphate. It is soluble in cold water (2 in 3.5) and alcohol (1 in 70). Its aqueous solution is acidic. It is kept in well-closed containers and in a cool place.

Test for Purity :

Tests for arsenic ; heavy metals ; and iron.

Assay :

The assay is dependent on iodimetric titration. The substance is allowed to react with iodine.

Uses :

Sodium bisulphite acts as a disinfectant, antioxidant and bleaching agent, particularly for wool; as antiseptic in fermentation industries; as preservative and bleach in food.

★ Sodium Metabisulphite

Chemical formula : $Na_2S_2O_5$
Mol. Weight : 190.10

Preparation :

It is prepared by saturating hot, concentrated sodium hydroxide solution with sulphur dioxide. Cooling of the solution yields the salt.

$$NaOH + SO_2 \rightarrow \underset{\text{Sodium bisulphite}}{NaHSO_3}$$

$$2NaHSO_3 \longrightarrow Na_2S_2O_5 + H_2O$$

Physical Characters :

It occurs as colourless or white prismatic crystals or a white or yellowish crystalline powder.

Chemical Properties :

When an acid is added to a solution of sodium metabisulphite, SO_2 gas is formed which is dissolved in solution as sulphurous acid (a solution of SO_2 in water).

$$Na_2S_2O_5 \xrightarrow{H^+} SO_2 \xrightarrow{H_2O} H_2SO_3$$

Test for purity :

Tests for acids ; arsenic ; lead ; heavy metals ; and thiosulphate .

Incompatibility :

The bisulphites of alkaline earth metals are less soluble and their sulphites are insoluble. Only alkali metal salts are soluble.

Assay :

Like sulphur dioxide , sodium bisulphite and Sodium metabisulphite are assayed on the basis of reducing a 0.1 N iodine solution which is added to the solutions in excess. The residual iodine is titrated against sodium thiosulphate to determine the amount reduced by the metabisulphite.

Uses :

Sodium metabisulphate is a strong reducing agent and is used as an antioxidant in pharmaceutical preparations to stabilize injections containing salts of adrenaline, apomorphine and sodium salicylate possessing phenol or catechol nucleus.

★ Sodium Thiosulphate

Chemical formula : $Na_2S_2O_3 ; 5H_2O$.
Mol. Weight : 248.17

Preparation :

Sodium thiosulphate is also prepared by reacting sodium hydroxide with sulphur.

$$6NaOH + 4S \longrightarrow Na_2S_2O_3 + 2Na_2S + 3H_2O$$

Physical Character :

Sodium thiosulphate occurs as colourless, odourless, transparent crystals or a coarse crystalline powder; cooling bitter taste; efflorescent in dry air above 33°; deliquescent in moist air.

Chemical Properties :

In sodium thiosulphate sulphur occurs in two different oxidation states. The oxidized sulphur atom is in a +6 state resisting further oxidation. The remaining sulphur atom is in a zero oxidation state. Due to this property the compound acts as a reducing agent or as an antioxidant.

Test for Purity :

Test for arsenic ; calcium ; heavy metals ; chloride ; sulphate ; sulphite ; and sulphide.

Incompatibility :

It is incompatible with metal cations due to the precipitation of the metal thiosulphate. In acid solution, these precipitates may darken due to the formation of the related sulphides.

Assay :

The assay is based on iodimetric titration. A weighed amount (0.8) dissolved in water (30 ml) is titrated with 0.1 N iodine, using 3 ml of starch solution as indicator as the end point is obtained. Each ml of 0.1 N iodine is equivalent to 0.02482 g of $Na_2S_2O.5H_2O$.

$$2Na_2S_2O_3 + I_2 \longrightarrow Na_2S_4O_6 + 2NaI.$$

Uses :

Sodium thiosulphate is used as an antidote in the treatment of cyanide poisoning in combination with sodium nitrite. It has antifungal properties and is used to treat pityriasis versicolour.

★ Nitrogen

Chemical formula : N_2
Mol. Weight : 28

Preparation :

1. Nitrogen is manufactured by fractional distillation of liquid air.

2. Nitrogen is also formed when ammonium dichromate is heated.

$$(NH_4)_2Cr_2O_7 \longrightarrow N_2 + Cr_2O_3 + 4H_2O$$

Physical Characters :

Nitrogen is a colourless, odourless and tasteless gas which is non-inflammable and does not support in combustion.

Chemical Properties :

Nitrogen neither burns nor support in burning. However, burning of magnesium and aluminium continues in an atmosphere of nitrogen forming nitrides.

$$3Mg + N_2 \longrightarrow Mg_3N_2$$

$$2Al + N_2 \rightarrow 2AlN$$

Test for Purity:

Test for CO_2.

Uses:

Nitrogen is used as a diluent for pure oxygen or other active gases and as an inert gas to replace air in containers holding oxidisable substances, e.g. cod liver oil, olive oil, and multivitamin preparations.

☆ Sodium Nitrite

Chemical formula : $NaNO_2$
Mol. weight : 69.0

Preparation:

Sodium nitrite is prepared by strongly heating sodium nitrate;

$$2NaNO_3 \longrightarrow 2NaNO_2 + O_2$$

Physical Characters:

Sodium nitrite occurs as white or slightly yellow granular powder or fused masses or sticks; odourless; taste is saline; deliquescent; hygroscopic; very solwly oxidises to nitrite in air; m.p. 271°.

Chemical Properties :

Sulphuric acid reacts with sodium nitrate solution forming nitrous acid.

$$2NaNO_2 + H_2SO_4 \longrightarrow Na_2SO_4 + 2\underset{\downarrow}{HNO_2}$$

$$H_2O + NO + HNO_3$$

Test for Purity :

Test for heavy metals; chloride; sulphate; loss on drying.

Incompatibility :

It is incompatible with acetanilide, antipyrine, phenazone, caffeine citrate, chlorates, hypophosphites, iodides, mercury salts, etc.

Assay :

The assay is based on oxidation reduction titration as discussed for hydrogen peroxide and ferrous sulphate.

Uses :

Sodium nitrite is used in the treatment of cyanide poisoning in conjugation with sodium thiosulphate.

Unit - 10

Miscellaneous Agents

Expectorant :-

- These are the agents which help in the elimination of bronchial secretion from the respiratory tract.
- Expectorants are used in the t/t of respiratory disorders

Expectorant

Sedatives

which cause irritation on the gastric mucuous which produce cough thereby bronchial secretion is removed.

eg :- Ammonium chloride, potassium iodine

Stimulant

which cause stimulation of the cell in the respiration tract which directly or indirectly causes secretion of bronchial fluid.

eg :- Terpin hydrate.

Ammonium chloride :-

Formula : NH_4Cl

Mol. wt. :- 53.49

- It is having not less than 99.5% of NH_4Cl which is calculated with reference to substance dried over silica gel for 4 hours.

Preparation :-

① commercially, it is prepared by neutralizing ammonia with HCl.
The sol^n is evaporated till crude, vitreous, crystalline mass of NH4Cl is obtained.

$NH_3 + HCl \longrightarrow NH_4Cl$.

② It is also prepared by treating ammonical gas liquors with lime & liberated NH_3 is passed into HCl sol^n. The crude NH_4Cl obtained is known in commerce as Salt ammoniac & occus as tough, crystalline masses.

③ NH_4Cl is also produced by heating ammonium sulphate c̄ NaCl.

$$2NaCl + (NH_4)_2SO_4 \longrightarrow 2NH_3 + 2HCl + Na_2SO_4$$

$$NH_3 + HCl \longrightarrow NH_4Cl$$

Properties :-

- It is white, fine or coarse crystalline powder.
- It is odourless.
- cooling saline taste.
- Hygroscopic
- NH_4Cl sol^n is incompatible with alkalis, carbonates of alkaline earths & lead salts.

Tests for purity :-

It is tested for As, Fe, heavy metals, loss on drying & sulphate Ash.

The pH of a 5% w/v sol^n is b/w 4.5 & 6.0.

Storage :-

It is stored in tightly closed container.

Assay :-

It is based on acid-base titration in c̄ specified weight of substance is dissolve in water & treated c̄ formaldehyde sol^n liberating equivalent amount of HCl.

$$4NH_4Cl + 4H_2O \rightarrow 4NH_4OH + 4HCl$$

$$4NH_4OH + 6HCHO \rightarrow \underset{\text{Hexamine}}{(CH_2)_6NH_4} + 10H_2O$$

$$4HCl + 4NaOH \rightarrow 4NaCl + 4H_2O$$

1000 ml 1N NaOH = 53.49 gm of NH_4Cl.

1 ml of 0.1N NaOH = 0.005349 gm of NH_4Cl.

Procedure :-

Weigh accurately about 0.1 gm of sample, dissolve in 20 ml of water & add a mixture of 5ml of Formaldehyd sol^n neutralized to dilute phenolphthalein sol^n &

20ml of water.

- Allow the reaction to take place for 2 minutes & titrate slowly with 0.1N NaOH by using soln of phenolphthalein as an indicator. Appearance of pink colour is the end-point.

Factor :-

1 ml of 0.1N NaOH = 0.005349 gm of NH_4Cl.

Uses :-

① It is used in maintaining acid-base eqbm. of body fluids.

② It is used as diuretics.

③ It is used in mild expectorant & diaphoretic when administered in small doses.

Potassium Iodide :-

Formula : KI

Mol. wt. : 166.0.

It is having not less than 99.0% of KI, which is calculated c̄ reference to the substance dried to a constant weight at 105°C.

Preparation :-

① It may be obtained by the action of Iodine on moist iron fillings to form ferro-ferric iodine (FeI_3 or $FeI_2, 2FeI_3$) which then gets decomposed with potassium carbonate.

$$Fe + I_2 \longrightarrow FeI_2 \cdot 2FeI_3$$

$$FeI_2 \cdot 2FeI_3 + 4K_2CO_3 \longrightarrow 8KI + FeO \cdot Fe_2O_3 + 4CO_3$$

Ferroso-ferric oxide is filtered out. The filtrate is concentrated to get KI. The salt may be purified by recrystallization.

② It is also prepared by treating a hot aqueous solⁿ of KOH with iodine in slight excess to form a mixture of KI & potassium iodate.

$$6KOH + 3I \longrightarrow 5KI + KIO_3 + 3H_2O$$

$$KIO_3 + 3C \longrightarrow KI + 3CO\uparrow$$

Properties :-

- Colourless
- Transparent / opaque crystals / white granular powder.
- odourless
- Saline & bitter taste.
- soluble in water, glycerine & acetone.

Identification :-

It gives reacⁿ which are characteristic of potassium & Iodine.

Tests for purity :-

It is tested for As, Ca, Ba, sulphate loss on drying cyanide & heavy metals.

Storage :-

It should be stored a well closed container.

Uses :-

① It is used internally for supplying iodine for t/t of thyroid deficiency in tablet form.

② It is also used as expectorant & saline diuretic

③ It has also antifungal activity.

Incompatibility :-

KI has been incompatible c̄ salts of iron, bismuth, copper, lead, mercury.

Poison & Antidote

Poison :-

A poison may be defined as any substance when administer produces ill health disease or death, ④ acute poison may be accidental acceptation, suicide, or criminal.

- poisons are substances that are harmful when they get into the body.
- poisoning occurs when a toxin is swallowed, breathed in, absorbed or injected into the skin, or gets into the eyes.
- poisoning can be a medical emergency.

Antidotes :-

- The specific agent c̄ counter act a poison is known as antidotes

Antidotes

Physiological antidotes	Chemical antidotes	Mechanical antidotes
which counter act the effect of poison by producing other effects physiologically	which changes the chemical nature of poison.	which adsorbs the poison & thus prevent the absorption of poison in the body.
Eg:- sodium nitrate which converts Hb into methemoglobin in order to bind cyanide.	eg:- Sodium thiosulphate, which convert systemically toxic cyanide to the non-toxic thiocyanate	eg:- Active charcoal, c̄ adsorb poison prior to absorption ~~act~~ across the intestinal wall.

Cyanide poisoning :-

- cyanide poisoning is poisoning that results from exposure to a number of forms of cyanide.
- For cyanide poisoning two inorganic antidotes such as sodium nitrite & sodium thiosulphate are used. Both are used in conjunction with each other

Sodium Nitrite

Formula : $NaNO_2$
Mol. wt. : 68.99

It contains not less than 97% & not more than 101.0% $NaNO_2$ c̄ reference to substance dried over silica gel.

preparation :-

We can obtained $NaNO_2$ by the catalytic oxidation of ammonia & oxygen in sodium carbonate solⁿ. The solⁿ is concentrated to crystallize out the product.

$$2Na_2CO_3 + 4NO + O_2 \longrightarrow 4NaNO_2 + 2CO_2\uparrow$$

Properties :-

- White granular powder.
- Saline taste.
- water soluble, sparingly soluble in alcohol
- chemically it acts as reducing agent & gets oxidized in acidic medium.

Uses :-

① It is used as vasodilator. but now it is replaced by organic nitrites, nitroglycerin etc.

② Used as antidote in cyanide poisoning & has a hypotensive effect.

③ It has relaxant action on smooth muscles

④ It prevents rusting of surgical instruments by immersing them in a dilute solⁿ & it is also used as food preservative.

Sodium Thiosulphate

Mol. Formula : $Na_2S_2O_3, 5H_2O$

Mol. wt. : 248.18.

It contains not less than 99.0% & not more than 101.0% of $Na_2S_2O_3$.

Preparation :

It can be prepared by boiling sodium sulphate with sulphur.

$$Na_2SO_3 + S \longrightarrow Na_2S_2O_3.$$

Properties :-

- white crystalline solid
- odorless
- Highly water soluble

Assay :-

It is assayed by titration wit std. Iodine solⁿ with starch as an indicators.

$$2Na_2S_2O_3 + I_2 \longrightarrow Na_2S_4O_6 + 2NaI.$$

Uses :-

① Used as an antidote for cyanide poisoning.
② Used as reducing agent.
③ Used in the mangement of extravasation of other antineoplastic.
④ Used for its antifungal properties.

Emetics

- chemical compounds which can be administered to induce vomiting.

eg : Ipecac Syrup.

Mode of action :-

— The act of emesis is controlled by the vomiting centre in the medulla & close to it is other visceral centres in the medulla oblongata.

Copper sulphate

Mol. Formula : $CuSO_4 \cdot 5H_2O$.

Mol. wt. : 159.6.

It contains NLT 98.5% & NMT 101.0% of $CuSO_4 \cdot 5H_2O$

Preparation :-

— It is obtained by treating granulated copper in the presence of air with sulphuric acid. The oxygen of air assists the reaction.

$2Cu + 2H_2SO_4 + O_2 \rightarrow 2CuSO_4 + 2H_2O$ ⑥

The sol^n is filtered, & evaporated to crystallization when crystals of $CuSO_4$ separate out.

Properties :-

- Exist in deep blue crystalline granules/powders.
- soluble in water
- very soluble in boiling water.
- Slowely soluble in glycerol & almost insoluble in alcohol.

Assay :-

cupric iodide which formed in the reacn b/w copper sulphate & potassium iodide & c decomposes to yield Cu_2I_2 c̄ the liberation of free iodine.

$$2CuSO_4 + 4KI \rightarrow 2CuI_2 + 2K_2SO_4$$

cupric iodide

$$2CuI_2 \rightarrow Cu_2I_2 + I_2$$

Storage :-

It has to be protected from air, heat & moisture.

Uses :-

(1) Emetics

(2) chemical antidote in phosphorus poisoning.

(2) Used as astringent.

(3) work as fungicide.

(4) It is an ingredient of Benedicts & Fehling's reagent

Sodium potassium Tartarate

Mol. formulla : $C_4H_4NaKO_6$.
Mol. wt : 210.158

Properties :-

- soluble in water.
- slightly soluble in alcohol.
- Melts on 75°C.

Uses :-

① Mild purgative.
② Ingredient of Fehling's sol^n.
③ It is used in silvering mirror.

Pharmaceutical Aids

Introductions :- For the production of drugs various techniques such as purification, filtration, adsorption, solubilization, absorption, suspension and emulsification are employed.

→ A number of natural products are used in these techniques. Flavouring, colouring, coating and perfuming agents are used in drug industries.

→ These agents posses little or no therapeutic value, but they are used in the preparation of many pharmaceutical products. These agents are called as pharmaceutical aids which may be of plant, animal, mineral or synthetic origin.

→ In pharmaceutical industry starch and Guar gum are used as a disintegrating agent.

→ Glucose and sucrose are sweeting and coating products.

→ Acacia and Tragacanth are credited as binding, suspending and emulsifying agents.

→ Mucilages like Ispaghol and linseed act as demulcent and soothing agents.

→ Gelatin is a suspending agent and used for making capsules.

→ Absorbent cotton, jute, Hemp, flax, wool, silk, viscose and Alginate are used to prepare fibres for ~~coating~~ filtering and surgical dressings.

2

→ shellac is used for coting confections and medicinal tablets.

① Spermaceti

Uses :- ① It is used as a pharmaceutical aid for cold creams and as a base for ointments, cerates and an emulsion with egg yolk or expressed almond oil.

② It is also used in manufacture of candles, soaps, cosmetics, laundry wax, finishing and lustering linens.

② Kaolins

Uses:- (i) Heavy kaolin is used externally as a dusting powder, poultice, carrier of heat, filtering and cleaning agent.

(ii) fine kaolin is used internally as an absorbent and to coat irritated intestinal mucosa in case of diarrhoea, dysentery and intestinal fermentation.

(iii) They are also used to manufacture porcelain, pottery, colour lakes, plaster material.

③ cochineal

Uses :- (i) It is used as a colouring agent for food products, drugs and toilet preparations.

(ii) Carmine and carminic acid are used for manufacture of red and pink inks and lakes.

④ Shellac

Uses :- (i) shellac is used for coating confections and medicinal tablets; finishing leather, grinding wheels, sealing wax, cements, records paper; for stiffening hats.

⑤ lard

Uses :- ① lard is an emollient and used as a base for ointments and cerates.

(ii) lard oil is used as an antifoaming agent in the fermentations and as a tablet lubricant, illuminant, oiling wool and to manufacture soap.

⑥ Wool Fat

Uses :- It is used for the filtration of oils, fats, syrups and in the form of the Berkefeld filter for sterlization.

⑦ prepared chalk

Uses :- ① chalk is used as an absorbent and antacid.

⑧ Fuller's Earth (Multani Mitti)

Uses :- ① It is used in refining oils, greases, lard, liquid fractions of petroleum including crude naptha, crude kerosene and shale oil.

(ii) In laboratory, it is used to detect colouring matter added to butter and whisky.

(iii) In india, it is used as a substitute for soap in washing clothes and hair and in refining vegetable oils.

ASBESTOS

(Sangresha; Shankha palita; Kalnar; Ratinara.)

→ Asbestos is the commercial name given to various-silicate minerals which can be easily split into flexible fibres, capable of being felted or spoun together.

→ The fibres are light, fire-resistant, heat, sound and electrical insulators, and non-corrosive.

→ These properties make asbestos technically a very valuable material.

→ Absestos is used mainly in the manufacture of asbestos cement products and textile products and also in many other industries.

→ There are three modes of occurence of asbestos minerals :-

① Cross-fibre, with fibres at right angles to the walls of the veins;

② Slip-fibre, with long fibres parallel or oblique to the walls of the vein, but of poor quality;

③ Mass-fibre, with interlaced, unoriented, aggregate of fibres, sometimes radially arranged.

→ The comercial varieties of Asbestos are :-

① Chrysotile or fibres Serpentine ($3MgO \cdot 2SiO_2 \cdot 2H_2O$) :- It is a hydrated silicate of magnesium, usually containing small percentage of iron oxide and alumia.

→ A brownish green, lamellar variety of serpentine is called antigorite.

② Amosite [$Fe_5Mg_2Si_8O_{22}(OH)_2$] :- It is a long-fibre Variety of iron-rich anthophylline; the length of the fiber is normally 10-30 cm.

→ It is resistant to acids. The superior grade fibres are used for spinning purposes.

③ **Crocidolite or blue asbestos** [$Na_2O \cdot Fe_2O_3 \cdot 3FeO \cdot 8SiO_2 \cdot H_2O$]

→ It is a sodium iron silicate, usually containing a small percentage of magnesiam and a little time.

→ It is mainly used as an insulator and in asbestos cement products. When infiltered with silica, the variety is sold as Cat's Eye or Tigers Eye for ornamental use.

④ **Tremolite** ($Ca_2 Mg_5 Si_8 O_{22} (OH)_2$] :- It is a silicate of magnesium and calcium.

→ It is a white to dark grey, mineral.

→ It is used for the manufacture of boiler lagging (insulation material) and for filtration purposes.

⑤ **Actinolite** ($Ca_2 (MgFe)_5 Si_8 O_{22} (OH)_2$:- It is a silicate of magnesium and calcium with iron. It is a green coloured mineral of little commercial importance.

⑥ **Anthophyllite** [$(MgFe)_7 Si_8 O_{22} (OH)]_2$:- It is a magnesium iron silicate. It is of white to grey colour, sometimes yellowish-brown, with a vitreous lustre.

Uses :- (i) Asbestos finds several uses in Industry.

(ii) Asbestos fabrics and asbestos-cement products are the largest uses of the mineral.

(iii) Asbestos cloth is used for making protective clothing, blankets for fire fighting filter aids, conveyors for carrying hot material, and oven and furnance insulations.

TALC and STEATITE

→ Steatite is a purer variety of talc which is the softest and the most common hydrated magnessium silicate mineral; a slightly impure variety of talc is termed soapstone.

→ Commercially, the terms steatite, talc and soapstone are used for the same mineral, commonly referred to as talc.

Talc :- [$H_2Mg_3(SiO_3)_4$; MgO - 31.70%, SiO_2 - 63.50%, H_2O - 4.80%.

→ It is an apple-green to white or silvery-white, or greenish-grey or dark-green mineral, crystallizing in orthorhombic or monoclinic system.

→ There are several varieties of talc. steatite is a massive and high-grade variety of talc.

Pyropyllite [$H_2Al_2(SiO_3)_4$] It is an aluminium analog of talc.

→ Talc (including steatite and pyrophyllite) is produced in various countries of the wold. The USA and Japan are the largest talc-producing countries, followed by Russia, france, india and china.

Grades and classification :- Talc is classified according to its colour and softness.

→ Whiter varieties are preferred to dull and other tinted varieties.

→ There is no standard basis for classifying the material. However, in Rajasthan, it is classified into 4- different grades:-

i) Grade-I :- Talc of pure white appearance and smoth feel and free from grit.

ii) Grade-II :- Tinted variety which may be blue or green.

iii) Grade-III :- off-colour variety, having smooth feel.

iv) Grade-IV :- or DDT variety.- White or off colour with grit.

Uses :- i) Talc of very good quality finds use in many cosmetics and pharmaceutical preparation, such as- soaps, creams, tablets, pills and other products.

(ii) Massive Talc is also used in the manufacture of pencils or crayons.

(iii) pulverized talc is used in such industries as paper, ceramics, cosmetics insecticides, paint, rubber and textile.

(iv) Talc is largely used in paints. High grade foliated talc is used as an inert- entender and as a pigment.

(v) Talc is widely used as a filler and for dusting, enpecially in rubber.

Colouring and Flavouring

→ A formulation contains a minture of pharmacological active constituents and other ethical or technical required material such as colouring matters, Flavourings, stabilizers, emulsifiers, thickeners, toblet disintegrants, preservetive and coatings.

→ Under EEC rules, for appropriate foods, such addi:: tives must be included in the labelling.

→ For medicinal purposes these additives are controlled by the Drug and cosmetic Act.

→ The additives used in standard medi~~cinal~~cal practice are covered, and used in herbal preparations, may be included in the EEC list.

In Some cases eg: Raspberry syrup and cherry syrup, the preparation may have the dual role of colourant and flavouring.

→ The oils of clove and peppermint are used as flavours but the former has antibacterial, and the later, carminative properties.

→ Natural gums, which are widely used as thickening, emulsifying and suspending agents have, in larger doses, a therapeutic action.

Natural Colourants

Colourant	Source	shade
① Chochineal	Dactylopius	Red
(ii) Beetroot powder (betanin)	Beta vulgaris	Red
(iii) carmine powder	Dactylopius coccucs	Purplish-red
(iv) Saffron (crocin)	crocces sativus	Yellow-orange.
(v) Annatto (bixin)	Bixa orellana	Yellow-orange.
(vi) Carotenes	various sources, eg. carrot root	Orange.

Colouring agent.

→ The essential requirements of a medicinal colourant are nontoxicity and stability. The effect of pH on colour, solubility in water and oils and stability to light, heat and sugars are to be considered.

ⓐ **ANNATTO** :- It is obtained from Bixa orellana.

Uses :- (i) Bixin and norbixin are quite stable to pH changes, light exposures and oxidation reactions.

(ii) Annato is generally employed in india for colouring butter and cheese.

(iii) In other ~~cou~~ countries annato are used for colouring margarin.

(iv) It is also used for colouring citrues juices, concentrates, drinks, candies and fish, epecially salmon.

ⓑ **Marigold flowers** :-

Uses :- The comonon english garden marigold, calendula officinalis is used to treat colds and cough.

ⓒ **Red beetroot** :-

Uses :- It is widely used as a nontoxic food and pharmaceutical colourants.

ⓓ **Monascus** :- It give a food colourant used in chinese cooking.

ⓔ **Red poppy petals** :- It is used in the form of a syrup for colouring and sweetening liquid medicines.

(f) Red rose petals:- Rosa gallica, are used for preparing the acid infusions of rose. The drug is midly astringent. The infusions are used as a ~~convient~~ convenient vehicle for gargles containing alum or tannin.

Sweetning agents

→ Our body's metabolism demands a continuous supply of its primary fuel, glucose.

→ There are two forms of sugar in the food we eat, namely, naturally occuring sugars in fruits and dairy products and added sugars in many processed foods.

→ Sugar adds calories, which, if eaten more than required will cause weight gain.

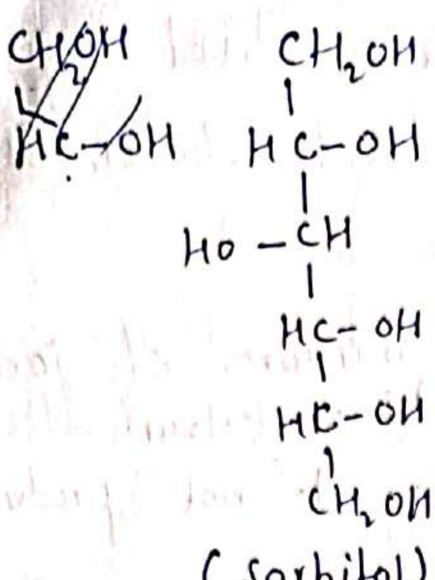
→ Weight gain increases the risk of getting heart disease, diabetes, high blood pressure or even some types of cancer.

→ Sweeting agents to sucrose are used for medical purposes (eg: for diabetics) and for diet improvement.

→ Saccharin is the most widely used substitute. However, important natural products are:-

(a) Sorbitol:- (i) Sorbitol solution (sorbital liquid) contains 70% of mainly sorbitol and is used as a sweeting agents and vehicle in elixirs, linctuses and mixtures.

(ii) It is used as an ingredient in toothpastes, chewing gums; and other noncaloric sweetner in dietetic beverages.



$$\begin{array}{c} CH_2OH \\ | \\ HC-OH \\ | \\ HO-CH \\ | \\ HC-OH \\ | \\ HC-OH \\ | \\ CH_2OH \end{array}$$

(sorbitol)

ⓑ Stevioside :- used in soft drink and food industries

ⓒ Stevia :- (i) Stevia is an herb that has been used as a sweetener in south America for hundreds of years and currently being heralded as a good substitute (not available in india).

(ii) stevia is safe for use with children, is non-glycemic and is plaque-retardant (no cavities).

FIBres

→ Natural and artificial fibres are used in surgical dressings. The natural fibres are obtained from vegetables sources (eg. cotton, flax, Hemp and jute) or from animal sources (eg. Wool and silk).

→ Some fibres, eg:- Nylon and Terylene are synthetic fibres prepared from long chain molecules of polymers.

→ Asbestos and glass are obtained from mineral sources.

→ A number of vegetable fibres have importance in pharmacy, particularly as components of surgical dressings and for the manufacture of artificial fibres and haemostatic dressings.

Tests of vegetable and regenerated carbohydrate fibres :-

i) With Molisch regent they produce voilet colour.

ii) On heating with aqueous picric acid solution they are not stained permanently.

iii) With chlor-zinc iodine or a mixture of iodine and sulphuric acid they yield blue colour.

iv) On boiling with Millon's reggent they do not produce red colour.

Test of Animal fibres

i) on ignition they produce disagreeable odour.

ii) They are dissolved in 5% aqueous potassium hydroxide solution.

iii) They respond positively with Millon's test.

iv) They are stained permanently with picric acid.

COTTON, RAW COTTON

→ cotton consists of the epidermal trichomes of the seeds of Gossypium herbaceum, G. barbadense and other cultivated species of Gossypium (Malvaceae).

① ABSORBENT COTTON :-

i) It is used for surgical dressings.

ii) cotton is also used in textile industry

② Jute :-

i) Jute is used to prepare medicated tows, as a filtering and straining medium and to make gunny bags, yarns and ropes.

③ **Hemp :-** Hemp is used to manufacture rope, twine and sail-cloth.

④ **Flex** :- It is used as a filtering medium.

⑤ **Wool** :- Wool is used to prepare crepe bandages and dressings and as a medium for filtration and staining.

⑥ **Silk** :- Silk is used for making ligatures and sieves.

Regeneration fibres

→ Regenerated fibres are prepared from naturally occuring polysaccharides.

① **Viscose** :- Viscose rayon is used to manufacture fabrics, surgical dressings, absorbent wool, enzyme and cellophane.

② **Methylcellulose** :- In pharmacy

i) Methylcellulose is used to increase the viscosity and to stabilize lotions, suspensions, pastes, opthalmic prepⁿs some ointments.

ii) In medicine it is used as a hydrophilic colloid, laxative in chronic constipation and to curb appetite in obese persons as it gives a feeling of fullness.

iii) It is also used as a substitute for water-soluble gums, to render paper grease proof, in adhesives, as thickening agent in cosmetics.

iv) Hydroxyethyl cellulose :- It is used as a thickening agent and as an ingredient in some formulations for artificial tears.

(v) Hydroxypropylcellulose is a hydroxypropyl ether of cellulose. It is used as a stabilizer and thickener in liquid prepn and as a binder and film coating in tablet formulations.

③ Cellulose Acetate :- C.A. rayon is used to manufactur rubber and celluloid, substitutes, non-flammable photographic and cinema films, airplane dopes etc.

④ Pyroxylin (Cellulose nitrate) :- It is used for making flexible colloidion BP.

⑤ Oxidized cellulose :- used as an absorbable haemostati in surgery,

⑥ Alginate fibres :- They are used internally in neurosurgery, endural and dental surgery to be subsequently absorbed. Externally, they are used (eg :- for burns or sites from which skin grafts have been taken) to arrest bleeding.

Synthetic fibres

→ S.F. are produced by polycondensation of organic molecules which are more stronger than the natural fibles.

① Nylon :- Nylon is used to prepare filter cloth, sieves, non-absorable sutures, nylon syringes, film, textile fibres, monofilament, tire cord, fishing lines and tow ropes.

② ~~Ty~~ Terylene (Dacron) :- Terylene is used in the same way as nylon.

③ Orlon :- ④ Polyethylene :- ~~used to~~ used as laboratory tubing. in making protheses, packing materials and textile.

Surgical Dressings

→ A material used to protect a wound and a heal is called a surgical dressings.

→ They remove wound enudates from the site, prevent infection, give physical protection to the healing wound and mechanical support to the supporting tissues.

→ Surgical dressings are classified as :-

i.) primary wound dressings :- P.W.D. are applied over the wound surface to absorb pus, mucus and blood.

ii) Absorbent :- Absorbent cotton is widely used to absorb wound secretion. other absorbent materials are rayon wool, cotton wool, gauze pads, nursing pads. They are used in the shape of balls or pads.

iii) Bandages :- A bandges is a material which holds dressings at the required site, applies pressure or supports - an injured part or checks haemorrhage.

→ The bandage may be elastic or non-elastic in nature.

iv) Adhesive tapes :- surgical adhesive tapes may be a rubber-based adhesive or an acrylate adhesive. ~~Ra~~

→ Rubber adhesive tapes are cheap, superior and provide strength of backing.

→ Adhesive tapes are used to reduce skin trauma.

(v.) protectives :- p. are employed to cover wet dressings, poultices and for retention of heat.

→ They prevent the escape of moisture from the dressings.

→ Some protectives are plastic sheeting, rubber sheeting, waxed oil-coated papers and plastic-coated papers.

Sutures and ligatures

→ A surgical suture is a thread or sting used for sewing or stiching together tissues, muscles and tendons with the help of a needle.

→ If these threads or fibres are used to tie a blood vessel to stop bleeding without the use of a needles, then they are digested in animal tissues eg:- catgut, Kangaroo tendon and synthetic polyesters.

→ These are 2-types of sutures

① Absorable sutures

② Non " "

① Absorable sutures :- ⓐ surgical cutgut

→ catgut is a sterlized fibre or strand prepared from callagen of connective tissues obtained from healthy animals like sheep and cattle.

ⓑ synthetic polyesters :- These sutures ~~are~~ have high tensile strength and degradated by hydrolysis and absorbed in the tissue.

② **Non-absorable sutures** :- Non-absorable sutures are not affected by the fluid and remained unchange for a long period.

→ They are removed after healing of the wounds. silk, cottons, nylon and metallic sutures are classified as non-absorable sutures.

a) **Silk sutures** :- Silk sutures are prepared by spinning ~~and~~ or twisting silk fibres into a single strand of varying diameters.

→ The strands are sterilized and boiled with water so soften them.

b) **cotton Sutures** :- C.S. have uniform size and recommended in critical part where strength of the sutures is required for long them.

ⓒ **Nylon Sutures** :- The microfilaments of nylon are braid into strands of required diameter.

→ These sutures are strong, water resistant and used in skin and plastic surgery

ⓓ **linen sutures** :- A linen suture is cheap, very strong under moist condition but not uniform in diameter.

ⓔ **Metallic sutures** :- M. wires of silver or stainless steel are used as surgical aid.

→ These wires are available as mono-filaments, twists and braids.

Radiopharmaceuticals: Radio activity, Measurement of radioactivity, Properties of α, β, γ radiations, Half-life, radio isotopes and study of radio Isotopes - Sodium Iodide 131, Storage conditions, precautions & pharmaceutical application of radioactive substances.

• Defination:

- Radiopharmaceuticals, as the name suggests, are pharmaceutical formulations consisting of radioactive substances (radioisotopes and molecules labelled with radioisotopes), which are intended for use either in diagnosis or therapy or diagnosis.
- The use of radioactive material necessitates careful and safe handling of these products by trained and authorized personnel, in approved/authorized laboratory facility as per the guide lines of Atomic Energy Regulatory Board (AERB) of India.

• Units of Radioactivity:

- In the International System (**SI**), the unit of radioactivity is one nuclear transmutation per second and is expressed in **Becquerel (Bq)**, named after the scientist *Henri Bequerel*.
- The old unit of radioactivity was **Curie (Ci)**, named after the scientists *Madame Marie Curie* and *Pierre Curie*, the pioneers who studied the phenomenon of radioactivity.
- One **Ci** is the number of disintegrations emanating from **1 g** of **Radium-226**, and is equal to **3.7 x 10^{10} Bq**.
  - ■ The **Becquerel (Bq)** is the SI derived unit of radioactivity. One becquerel is defined as the activity of a quantity of radioactive material in which one nucleus decays per second. The activity of a source is measured in bacquerels.
  - ✓ This is a very small unit, and multiples are often used:

    1 MBq = 1 mega Becquerel = 1,000,000 Bq; 1 GBq = 1 giga Becquerel = 1,000,000,000 Bq;

    1 TBq = 1 tera Becquerel = 1,000,000,000,000 Bq
  - ✓ The radioactivity of an environment, a material or a foodstuff is given in Becquerel's per kilogram or per liter.
  - ■ The **gray (Gy)** is defined as the absorbed dose of radiation per unit mass of tissue. One gray is the absorption of one joule of radiation energy per kilogram of matter. The amount of radiation your cells absorb is measured in grays.

    1 Gy = 1 joule per kilogram

    Sub-multiples are often used:

    1 mGy = 1 milligray = 0.001 Gy; 1 µGy = 1 microgray = 0.000001 Gy

    1 nGy = 1 nanogray = 0.000000001 Gy
  - ■ The **Sievert (Sv)** is a measure of the health effects of low levels of ionizing radiation on the human body. At equal doses, the effects of radioactivity on living tissue depends on the type of radiation (alpha, beta, gamma, etc.), on the organ concerned and also on the length of exposure.

    Contrary to the Becquerel, the sievert is a very large unit, and we often use sub-multiples:

    1 mSv = 1 millisievert = 0.001 Sv; 1 µSv = 1 microsievert = 0.000001 Sv

• Half-Life Period:

- The time in which a given quantity of a radionuclide decays to half its initial value is termed as half-life (**$T_{1/2}$**).
- Formulas for half-life in exponential decay.

$$N\left(t_{1/2}\right) = \frac{1}{2}N_0 \text{ as expected (this is the definition of half-life)}$$

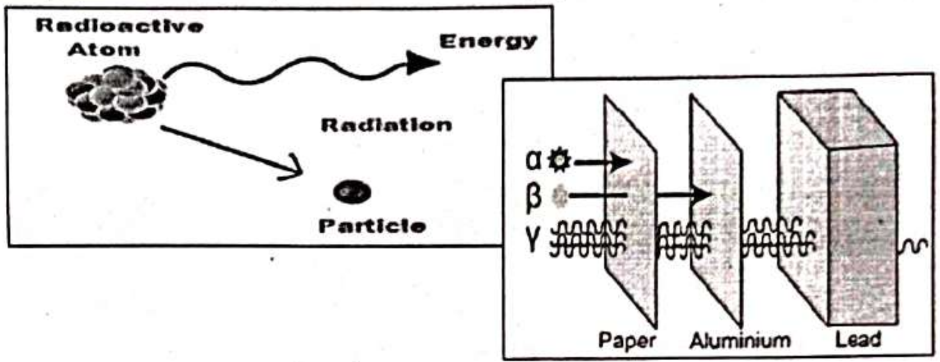
$$N(t) = N_0\left(\frac{1}{2}\right)^{\frac{t}{t_{1/2}}}$$
$$N(t) = N_0 e^{-\frac{t}{\tau}}$$
$$N(t) = N_0 e^{-\lambda t}$$

Where:

- ■ **N_0** is the initial quantity of the substance that will decay (this quantity may be measured in grams, moles, number of atoms, etc.),
- ■ **N(t)** is the quantity that still remains and has not yet decayed after a time **t**,
- ■ $t_{1/2}$ is the half-life of the decaying quantity,
- ■ τ is a positive number called the mean lifetime of the decaying quantity,
- ■ λ is a positive number called the decay constant of the decaying quantity.

• Properties of α, β, γ radiations:

- All substances are made of atoms. These have **electrons** (*e*) around the outside, and a nucleus in the middle. The nucleus consists of **protons** (p) and **neutrons** (n), and is extremely small. (Atoms are almost entirely made of empty space!).
- In some types of atom, the nucleus is unstable, and will decay into a more stable atom. This radioactive decay is completely spontaneous.
- When an unstable nucleus decays, there are three ways that it can do so. It may give out:-
  - an alpha particle (α)
  - a beta particle (β)
  - a gamma ray (γ)



✓ Alpha particles

- Alpha particle radiation consists of two neutrons and two protons, as they are charged they are affected by both electric and magnetic fields.
- The speed of the α -particle depends very much on the source, but typically are about 10% of the speed of light.
- The capacity of the α -particle to penetrate materials is not very great, it usually penetrates no more than a few centimetres in air and is absorbed by a relatively small thickness of paper or human skin. However, because of their speed and size, they are capable of ionising a large number of atoms over a very short range of penetration.
- This makes them relatively harmless for most sources that are about a metre or more away, as the radiation is easily absorbed by the air.
- But if the radiation sources are close to sensitive organs α -particle radiation is extremely dangerous.

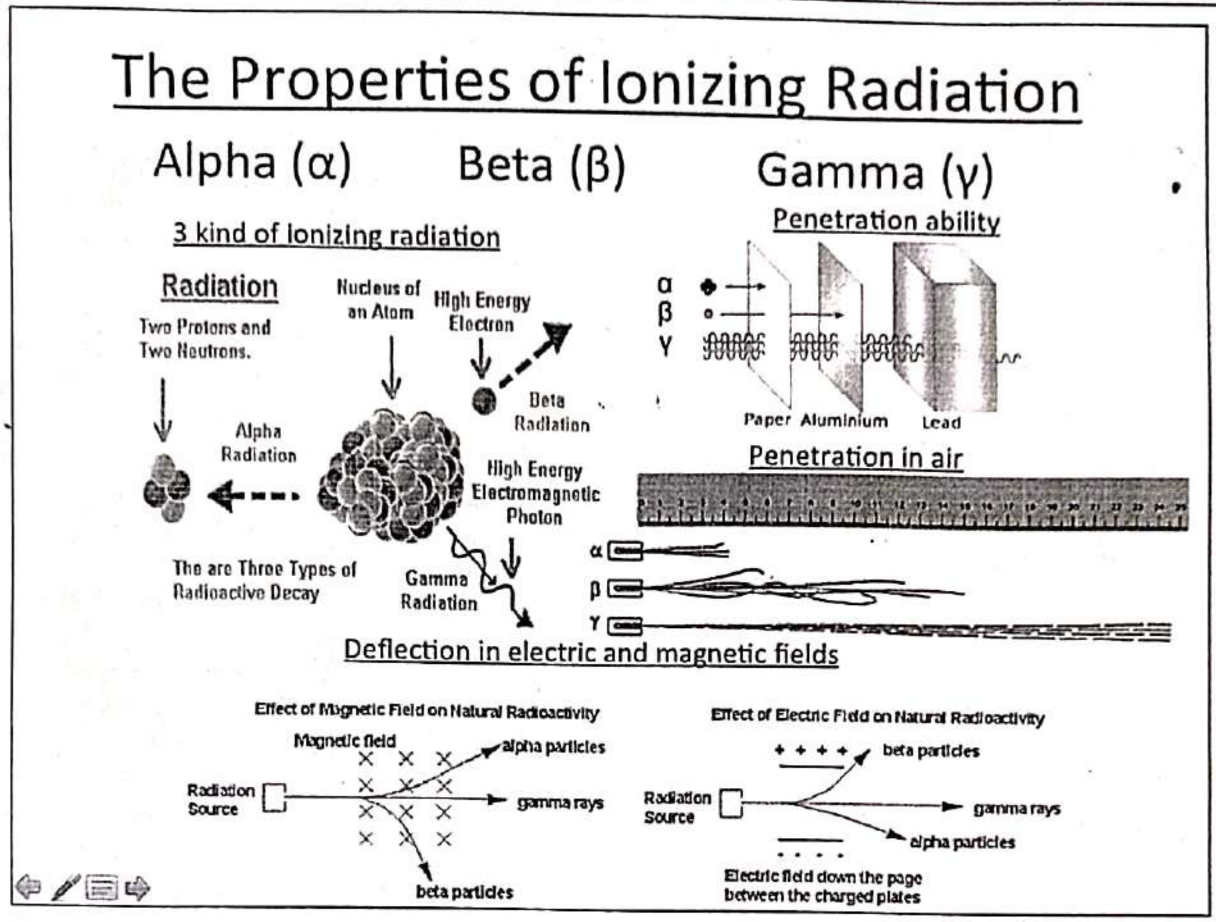
✓ Beta particles

- Beta-particle radiation consists of fast moving electrons. Every β -particle carries either one negative or one positive electronic charge (± 1.6×10^{-19} coulomb: -e, +e). They are affected by electric and magnetic fields.
- The speed depends on the source, but it can be up to 90% of the speed of light.
- β particles can penetrate up to 1 m of air. They are stopped by a few millimetres of aluminium or perspex.
- Their ionising capacity is much less than that of α -radiation. They are very dangerous if ingested.

✓ Gamma rays

- Gamma radiation does not consist of charged particles, it is a form of very short wavelength electromagnetic energy. They travel at the speed of light (3×10^8 m/s).
- Gamma radiation is very difficult to stop, it takes up to 30mm of lead. Although the ionising capacity of γ radiation is considerably smaller than that of beta-radiation, their high penetration power means that they are dangerous even at a distance.
- They can penetrate our bodies and hit sensitive organs. They are particularly dangerous if ingested or inhaled.

Property	**α ray**	**β ray**	**γ ray**
Nature	Positive charged particles, 2He 4 nucleus	Negatively charged particles (electrons).	Uncharged γ~0.01a, electromagnetic radiation
Charge	+2e	–e	0
Mass	6.6466×10^{-27} kg	9.109×10^{-31} kg	0
Natural Sources	By natural radioisotopes e.g. $^{92}U_{236}$	By radioisotopes e.g. $^{29}Co_{68}$	Excited nuclei formed as a result of α, β decay



The Properties of Ionizing Radiation

Alpha (α) Beta (β) Gamma (γ)

3 kind of Ionizing radiation

Penetration ability

Penetration in air

Deflection in electric and magnetic fields

- **Measurement of Radioactivity**

- For measuring radioactivity, three types of devices are available:
  1. Gas-filled tube counters e.g. the Geiger Muller Counter
  2. Scintillation Counters
  3. Semi-conductor Detectors

The Geiger Counter:

A potential difference just below that required to produce a discharge is applied to the tube (1000 V). Any atoms of the gas struck by the γ-rays entering the tube are ionized, causing a discharge. Discharges are monitored and counted by electronic circuitry and the output is reported as counts/sec or Rontgens/hr or mR/hr.

Scintillation Counters:

Crystals of certain substances e.g. cesium fluoride, cadmium tungstate, anthracine and sodium iodide emit small flashes of light when bombarded by γ-rays. The most commonly used phosphor in scintillation counters is NaI with a minute quantity of thallium added. In the instrument, the crystal is positioned against a photocell which in turn is linked to a recording unit. The number of flashes produced per unit time is proportional to the intensity of radiation. Small portable scintillation counters are available.

Semi-Conductor Detectors:

A semi-conductor is a substance whose electrical conductivity is between that of a metal and an insulator. It is noted that Ge(Li) semi-conductors ate excellent detectors of γ-rays with a resolution ten times higher than NaI (Th) scintillometers. The main disadvantage of these is a lower efficiency for higher energy x-rays. Besides, Ge(Li) semiconductors need to be cooled by liquid nitrogen & are hence cumbersome and not suitable as field instruments.

Pharmaceutical Application Of Radioactive Substances

- *Treatment of Cancers and Tumours*
  - Americium 241 used as antineoplastic.
  - Californium 252 used as antineoplastic."
  - Cobalt 60 used as antineoplastic.
  - Gold 94 used as antineoplasatic.
  - Holmium 66 (26 h) being developed for diagnosis and treatment of liver tumours.
  - Iodine-125 (60 d) used in cancer brachytherapy (prostate and brain).
- *Treatment of Thyroid Disease with Iodine 131*
  - **Iodine-131** is therapeutically used for to treat thyroid cancer, hyperthyroidism (including Graves' disease, toxic multinodular goiter, and toxic autonomously functioning thyroid nodules), and Nontoxic multinodular goiter.
- *Palliative Treatment of Bone Metastasis*
  - Various radioisotopes and pharmaceuticals are used to deliver palliative treatment of bone metastases, including samarium-153 (Sm-153), strontium-89 (Sr-89) chloride, and phosphorus-32 (P-32) sodium phosphate. The two most common side effects occurring from radiopharmaceutical therapy for metastatic bone disease are initial increased bone pain (flare) and a decrease in WBC and platelet counts.
- *Treatment of Arthritis*
  - **Erbium-169:** Use for relieving arthritis pain in synovial joints
- *Diagnostic Radiopharmaceuticals*
  - **Ammonia N 13** Injection used for diagnostic coronary artery disease.
  - **Chromium 51** used for diagnosis of pernicious anaemia.
  - **Holmium 166** used for diagnosis and treatment of liver tumours.
  - **Iodine 125** used diagnostically to evaluate the filtration rate of kidneys.

Storage of Radioactive Substances

- Radiopharmaceuticals should be kept in well-closed containers and stored in an area assigned for the purpose. The storage conditions should be such that the maximum radiation dose rate to which persons may be exposed is reduced to an acceptable level.
- Care should be taken to comply with national regulations for protection against ionizing radiation.
- Radiopharmaceutical preparations that are intended for parenteral use should be kept in a glass vial, ampoule or syringe that is sufficiently transparent to permit the visual inspection of the contents. Glass containers may darken under the effect of radiation.

• Precautions For Handling Radioactive Substances

✓ The following guidelines provide information on the safe handling of radioactive substances. They are based on the relevant legislation and on the Code of Practice for Handling Radioactive Substances.

- The radioactive substances used should comply with the following characteristics:
    - Radiotoxicity must be as low as possible.
    - Short-living isotopes are preferred to long-living ones
    - The amounts used must be kept to a minimum.
- Never work alone in a radioactive lab, especially not outside normal working hours. Always make sure to have someone nearby in case of emergency.
- Take all precautions to prevent radioactive contamination:
    - Always separate radioactive activities from non-radioactive activities.
    - As far as possible, limit the area where radioactive substances are used and mark the area, e.g. by using containers with absorbent paper.
    - Apply a radiation symbol to any containers and items that have come into contact with radioactive substances.
    - Never bring documents such as notes into the radioactive zone.
- When handling radioactive materials, always wear the appropriate protective clothing:
    - Wear a lab coat. If there is a risk of serious contamination, wear disposable clothing. Store your lab coat away from your regular clothes.
    - Always wear gloves when handling radioactive substances. Regularly check the radiation level of these gloves. Never touch anything with potentially contaminated gloves; use paper tissues instead.
    - Wear shoe covers in rooms where the floor may be contaminated.
    - Keep personal items such as handbags, etc., outside the lab.
- Use appropriate radiation shields. Return the stock solution to storage immediately after removing the amount needed.
- To avoid internal contamination, strict hygiene is essential when handling radioactive materials
    - Eating, smoking, drinking, and applying cosmetics are prohibited in radioactive labs.
    - Never pipette by mouth. Use pipetting devices instead.
    - Wash your hands thoroughly when you leave the lab.
- Regularly check the radiation level of your working area and all objects used, or at least at the end of each working day. Replace contaminated absorption paper. Decontaminate contaminated objects.
- Dispose of all radioactive waste in the appropriate containers. Limit the amount of waste to a bare minimum. Separate short-living and long-living radioactive waste.

Constant quantities:

- The *half-life*: ($t_{1/2}$) is the time taken for the activity of a given amount of a radioactive substance to decay to half of its initial value; see List of nuclides.
- The *decay constant*: (λ) "lambda" the inverse of the mean lifetime, sometimes referred to as simply *decay rate*.
- The *mean lifetime*: (τ) "tau" the average lifetime (1/e life) of a radioactive particle before decay.

- **Labelling of Radioactive Substances**

- Every radiopharmaceutical preparation must comply with the labelling requirements established under Good Manufacturing Practice.
- The label on the primary container should include:
  - A statement that the product is radioactive or the international symbol for radioactivity
  - The name of the radiopharmaceutical preparation;
  - Where appropriate, that the preparation is for diagnostic or for therapeutic use;
  - The route of administration;
  - The total radioactivity present at a stated date and, where necessary, time; for solutions, a statement of the radioactivity in a suitable volume (for example, in MBq per ml of the solution) may be given instead;
  - The expiry date and, where necessary, time;
  - The batch (lot) number assigned by the manufacturer;
  - For solutions, the total volume.
- The label on the outer package should include:
  - A statement that the product is radioactive *or* the international symbol for radioactivity
  - The name of the radiopharmaceutical preparation;
  - Where appropriate, that the preparation is for diagnostic or for therapeutic use;
  - The route of administration;
  - The total radioactivity present at a stated date and, where necessary, time; for solutions, a statement of the radioactivity in a suitable volume (for example, in MBq per ml of the solution) may be given instead;
  - The expiry date and, where necessary, time;
  - The batch (lot) number assigned by the manufacturer;
  - For solutions, the total volume;
  - Any special storage requirements with respect to temperature and light;
  - Where applicable, the name and concentration of any added microbial preservatives or, where necessary, that no antimicrobial preservative has been added.

		
The trefoil symbol used to indicate ionising radiation.	2007 ISO radioactivity danger symbol intended for IAEA Category 1, 2 and 3 sources defined as dangerous sources capable of death or serious injury	The dangerous goods transport classification sign for radioactive materials

PHARMACEUTICAL CHEMISTRY-I

USE OF CHELATING AGENTS IN MEDICINE

What is Chelation??

Chelation describes a particular way that ions and molecules bind metal ions..

According to IUPAC,

the formation or presence of two or more separate coordinate bonds between a polydentate (multiple bonded) ligand and a single central atom.

Usually these ligands are organic compounds, and are called chelants, chelators, chelating agents, or sequestering agents.

Chelation therapy

Administration of chelating agents to remove heavy metal ions from body

Injecting Chelating agents (in liquid form) into body..

That form bonds with specific toxic metals like As, Hg, Pb

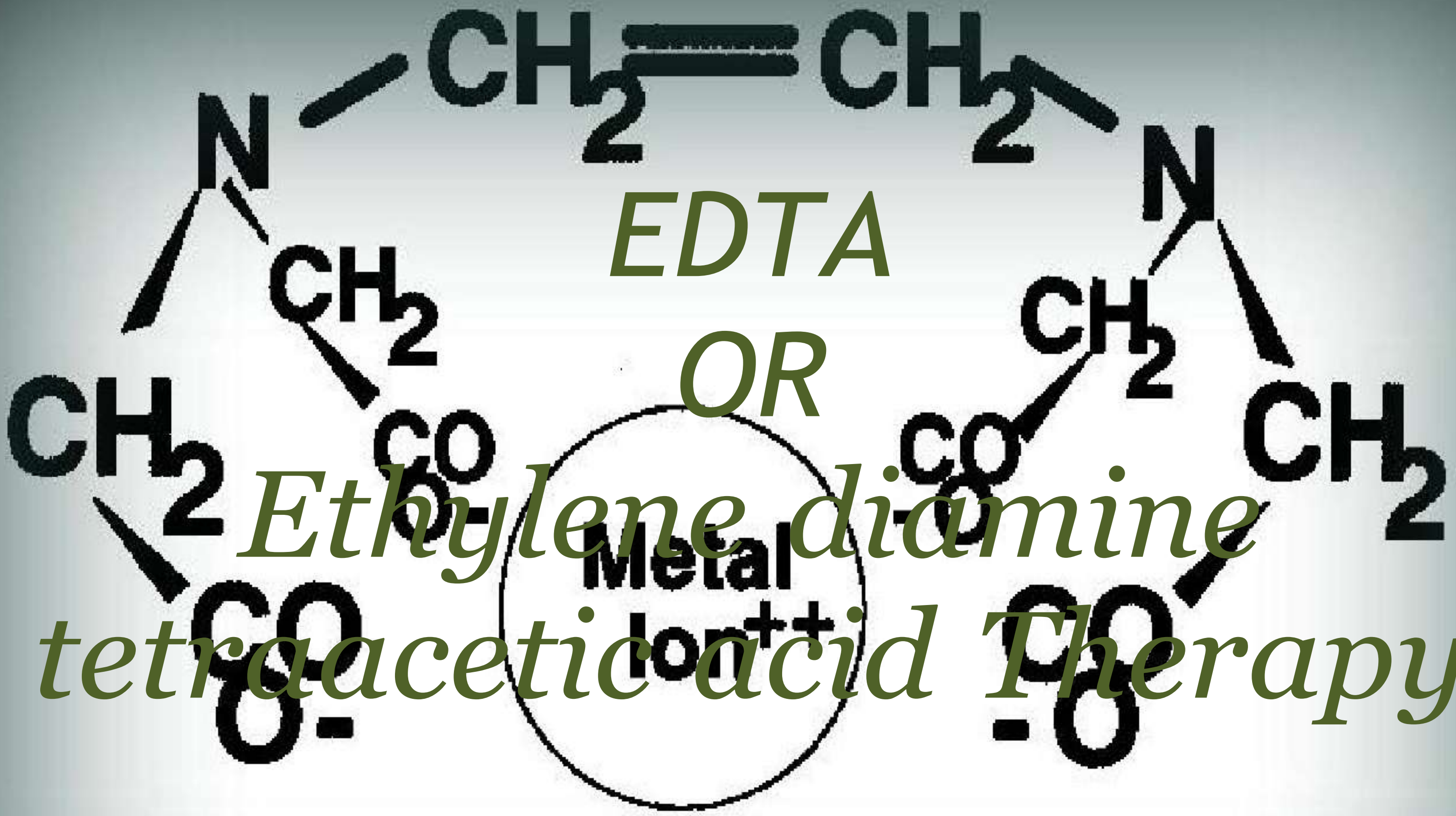
The toxic metals then extracted from that tissue or organ of the body

Both chelating agent and toxic metal are simply excreted from kidneys

Some chelating agents with their uses approved by orange book of F.D.A. (U.S. Food and Drug Administration)

Chelator	Used in
Dimercaprol (British anti-Lewisite; BAL)	• acute arsenic poisoning • acute mercury poisoning • Lead poisoning (in addition to EDTA) • Lewisite poisoning (for which it was developed as an antidote)
Dimercaptosuccinic acid(DMSA)	• Lead poisoning • arsenic poisoning • mercury poisoning
Dimercapto -propane sulfonate (DMPS)	• severe acute arsenic poisoning • severe acute mercury poisoning
Penicillamine	• *Mainly in:* copper toxicity *Occasionally adjunctive therapy in:* • gold toxicity • arsenic poisoning • Lead poisoning • rheumatoid arthritis
Ethylenediamine tetraacetic acid (calcium disodium versante) ($CaNa_2$-EDTA)	• Lead poisoning
Deferoxamine and Deferasirox	• acute iron poisoning • Iron overload

EDTA
OR
Ethylene diamine tetraacetic acid Therapy



Ethylenediaminetetraacetic acid (EDTA) chelates a metal ion

- EDTA Chelation therapy is a treatment that involves repeated intravenous administration of a chemical solution of ethylenediaminetetraacetic acid.

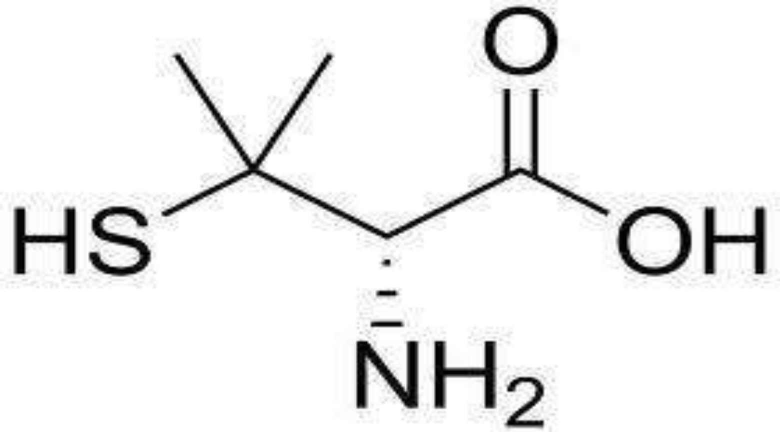
- Injected intravenously and once in the bloodstream, EDTA traps lead and other metals, forming a compound that the body can get rid of in the urine. The process generally takes 1-3 hours.

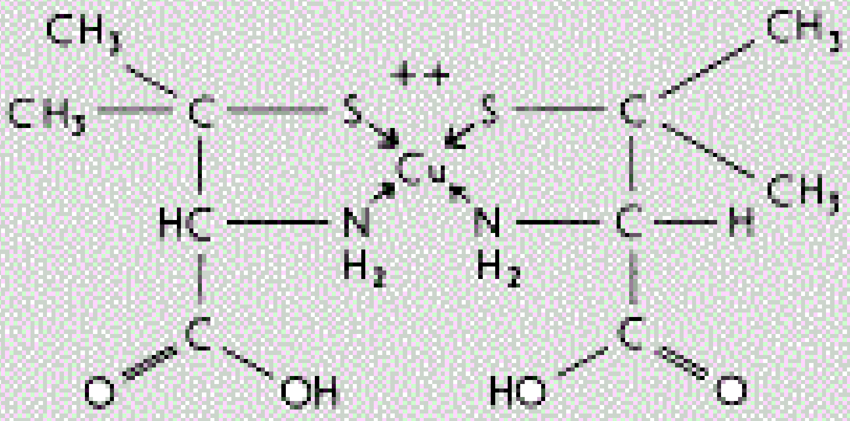
- Is regarded by the body as a foreign substance, so the body eliminates the entire particle - the heavy particle coated with EDTA.

- Has been used extensively in mainstream medical settings to remove the toxic metal lead from the human body.
- Acts as a powerful antioxidant to protect blood vessels from free radical damage.

- EDTA chelation therapy is approved by the U.S. Food and Drug Administration (FDA) as a treatment for lead and heavy metal poisoning. It is used to treat acute and chronic lead poisoning by pulling toxins (including heavy metals such as lead, cadmium, and mercury) from the bloodstream.

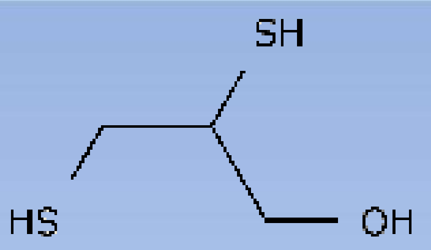
D-Penicillamine/ Cuprimine/ Depen
(2*S*)-2-amino-3-methyl-3-sulfanyl-butanoic acid





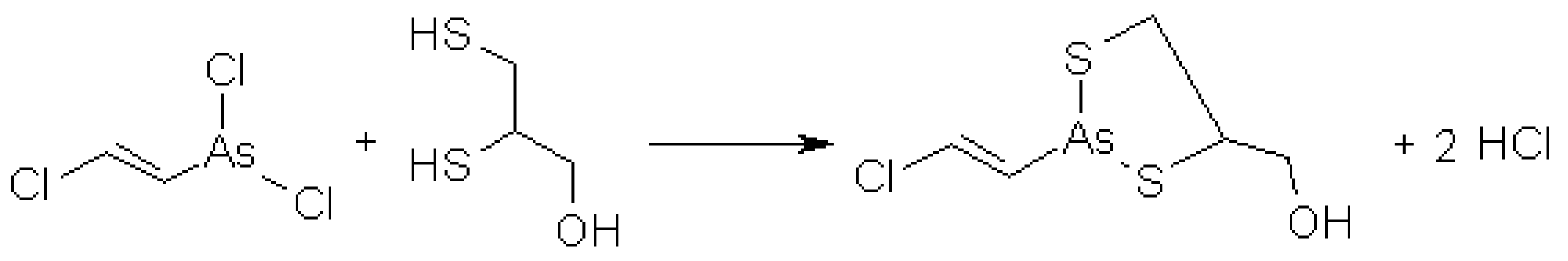
Penicillamine in Action

BAL/ British anti-Lewisite (Dimercaprol)



2,3-dimercaptopropanol

Lewisite Gas: $CH_2=CHAsCl_2$



USES:

In poisoning due to

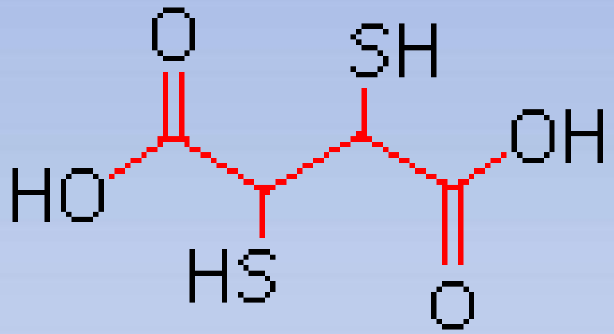
1. **Arsenic(10 days), gold(3 months), bismuth, antimony, thallium, mercury (until recovery); Pb, Hg**

2. **Oily solution of Dimercaprol instilled in to conjunctival sac in arsenic (vesicant) contamination of eye (within 5 min).**

3. **Wilson’s disease – allergic to penicillamine; increases excretion of copper in urine.**

Later on BAL was modified into DMSA

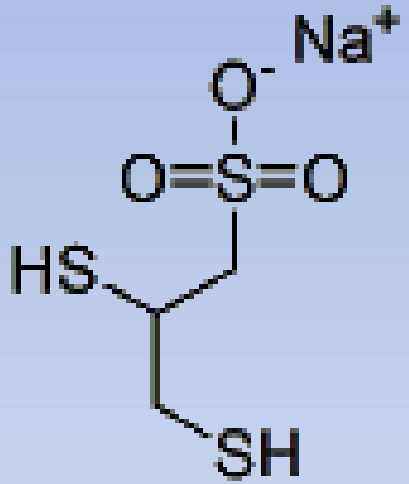
DMSA/ DIMERCAPTOSUCCINIC ACID
meso-2,3-dimercaptosuccinic acid (1995)



Hg, Pb

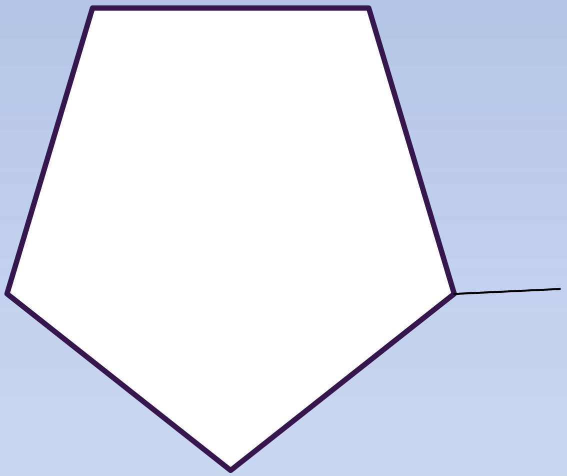
It can cross the blood brain barrier and is used for extracting heavy metal ions from brain.

DMPS/ Dimercapto -propane sulfonate Therapy 2,3,-dimercaptopropane-1-sulfonate (1956)



Used in heavy metal poisining of Po$_{210}$

ALA: Alpha Lipoic Acid



CH2 – CH2 – CH2 – CH2 – COOH

Respiratory Stimullants

Chronic obstructive Airways Disease (COAD)
Chronic obstructive pulmunary Disease (COPD)

Ammonium Carbonate

$[NH_4HCO_3]_m [NH_2CO_2NH_4]_m$

It contains the equivalent of not less 30% of NH_3.

Preparation

$(NH_4)_2SO_4 + CaCO_3 \rightarrow (NH_4)_2CO_3 + CaSO_4$
Ammonium sulphate, Calcium carbonate.

Physical character:

It occurs as translucent, hard, crystalline masses, odour is strongly ammonical, taste is pungent.

It is freely soluble in water, partially soluble in alcohol

A solution in water alkaline to litmus.
It volatizes at about 60°.

Chemical character:

$$NH_4HCO_3 \xrightarrow{\Delta 60^\circ C} NH_3\uparrow + CO_2\uparrow + H_2O.$$

$(NH_4)_2CO_3 \xrightarrow{\Delta 60^\circ} 2NH_3\uparrow + CO_2\uparrow + H_2O$

$NH_4HCO_3 + NH_3 \xrightarrow[\text{acid}]{\text{dil. ammonia}} (NH_4)_2CO_3$

$NH_4CO_2NH_4 + H_2O \rightarrow (NH_4)_2CO_3$

Test for purity

Test for iron, chloride, sulphate, tarry matter, non-volatile matter.

Incompatibility:

Acids and acid salts, salts of iron; zinc, alkaloids, alum, calomel.

Assay

2g of sample + 50ml of 1N H_2SO_4 + 50 ml of Water

$\downarrow$ Boiled and then cooled.

Titrate with 1N NaOH, using methyl red solution as indicator.

Each ml of 1N H_2SO_4 $\cong$ 0.01703g of NH_3

Uses:

Ammonium carbonate is used as respiratory stimulant expectorant and pharmaceutical aid.

Quality control system.

1) Good manufacturing Practice (GMP) requirement
2) Environment control and sanitisation.
3) Manufacturing working formula procedures.
4) Raw material → API Excipient
5) Manufacturing Equipment
6) Analytical control.
7) Inspection control.
8) Sampling Procedure.
9) Documentation
10) New advances
11.) Drug control Administration.

BMR → Batch Manufacturing Record.
SOP → standard Operating Procedure.