D.PHARM (PART-I) SYLLABUS FOR PHARMACEUTICAL CHEMISTRY - I

(75 hours)

1) General discussions on the following inorganic compounds including important physical and chemical properties, medicinal and pharmaceutical uses storage conditions and chemical incompatibility.

   a) Acids, bases and buffers - Boric acid*, hydrochloric acid; strong ammonium hydroxide, calcium hydroxide, sodium hydroxide, and official buffers.

   b) Antioxidants-Hypophosphorous acid, Sulphur dioxide, Sodium bisulphite, Sodium meta bisulphite, Sodium thiosulphate, Nitrogen and Sodium Nitrite.

   c) Gastrointestinal agents

      i) Acidifying agents - Dilute hydrochloric acid

      ii) Antacid - Sodium bicarbonate, aluminium hydroxidegel, aluminium phosphate, calcium carbonate, magnesium carbonate, magnesium trisilicate, magnesium oxide, combinations of antacid preparations.

      iii) Protectives and Adsorbent - Bismuth subcarbonate, Kaolin.

      iv) Saline cathartics, Sodium Pottassium tartate and magnesium sulphate,

   d) Topical agents

      i) Protectives, Zinc Oxide, calamine, Zinc stearate, Titanium dioxide, Silicon polymers.

      ii) Antimicrobials and Astringents-Hydrogen peroxide*, Potassium . permanganate. Chlorinated lime, iodine, Solutions of iodine, Providone-iodine, Boric acid, Borax. Silver nitrate, Mild silver protein, Mercury, yellow mercuricoxide, Ammoniated mercury.

      iii) Sulphur and its compounds Sublimed sulphur, precipitated sulphur, Selenium sulphide.

      iv) Astringents: Alum and Zinc Sulphate.

e. Dental products - Sodium fluroide, stannous fluoride, Calcium carbonate, sodiummetaphosphate, dicalcium phosphate, Strontium chloride, Zinc chloride.

f. Inhalants - Oxygen, Carbon dioxide, Nitrous oxide.

g. Respiratory stimulants - Ammonium carbonate. Expectorants and Emetics - Ammonium chloride, Potassium iodide. Antimony Potassium tartrate.

1) Antidotes - Sodium nitrite

2) Major Intra and Extracellular eletrolytes.

a) Electrolytes used for replacement therapy-Sodium chloride and its preparations, Potassium chloride and its preparations.

b) Physiological acid base balance and electrolytes used, sodium acetate, potassium acetate, sodium bicarbonate injection, sodium citrate, potassium citrate, sodium lactate injection Ammonium chloride and its injection

c) Combination of oral electrolyte powders and solutions.

3) Inorganic Official compounds of Iron Iodine, and Calcium Ferrous Sulfate and calcium gluconate.

4) Radio pharmaceuticals and Contrast media - Radio activity - Alpha, Beta and Gamma Radiations, Biological effects of radiations, Measurement of radio activity G.M. Counter - Radio Isotopes - their uses storage and precautions with special reference to the official preparations. Radio opaque Contrast media-Barium sulphate.

5) Quality control of Drugs and Pharmaceuticals importance of quality control, Significant errors, methods used for quality control, sources of impurities in Pharmaceuticals, Limit tests for Arsenic, chloride, sulfate, Iron and Heavy metals.

6) Identification tests for cations and anions as per Indian Pharmacopoeia.

ACIDS, BASES AND BUFFERS

Theories of Acid and Base

Three important theories are

1. Arrhenius theory
2. Lowry and Bronsted theory
3. Lewis theory

1. Arrhenius Theory (Dissociation concept) According to this theory

i. Acid is a substance, dissociates to give hydrogen ions (H^+) in water.

eg: $HCl \xrightarrow{H_2O} H^+ + Cl^-$

ii. Base is substance, dissociates to give hydroxide ions (OH^-) in water.

eg: $NaOH \xrightarrow{H_2O} Na^+ + OH^-$

2. Lowry-Bronsted Theory (Proton Concept)

According to them

i. Acids are called as proton donors which donates protons in solution to any other substance

ii. Bases are called as proton acceptors which accept protons in solution from any other substance.

$NH_3 + HCl \rightarrow NH_4^+Cl^-$

In the above reaction, HCl donates a proton and ammonia accepts that proton forming ammonium chloride.

So, according to this theory HCl is an acid and ammonia is a base.

3. Lewis Theory (Electron Concept)

Based on this theory, acids are called as electron acceptors which accept a lone pair of electrons. Bases are called as electron donors which donate a lone pair of electrons in solution.

Eg : $H^+ + NH_3 \rightarrow NH_4^+$

In the above reaction, proton (H^+) accepts one electron pair from NH_3 and is therefore an acid, where as NH_3 molecule donates an electron pair is a base.

BORIC ACID

M.F. H_3BO_3

Syn : Ortho Boric Acid

Preparation :

(i) Laboratory Method

Adding a mixture of concentrated sulphuric acid and water to a boiling solution of borax, the solution is allowed to cool. The boric acid is filtered and then washed until they become free from sulphate ions.

$Na_2 B_4O_7 + H_2SO_4 + 5H_2O \rightarrow Na_2 SO_4 + 4H_3 BO_3$

(ii) Commercial Method or Industrial Method

It is prepared commercially by decomposing certain naturally occurring borates such as colemanite, resonite, borax, etc. eg. Cole manite is suspended in boiling water then sulphur-di-oxide gas is passed through the suspension to liberate boric acid.

$Ca_2 B_6 O_{11}. 5 H_2O + 2SO_2 + 4H_2O$

(Colemanite) ↓

$6H_3BO_3 + 2 CaSO_3$

(Calcium Sulphite)

Physical Properties

i. White odourless, crystalline powder, soft to touch.

ii. Slightly acidic to taste.

iii. Freely soluble in boiling water, boiling alcohol and glycerin.

Chemical Properties

i. Boric acid is a weak acid. On heating to 100°C loses one molecule of water to give meta boric acid.

$$H_3BO_3 \xrightarrow{100°C} HBO_2 + H_2O$$

(metaboric acid)

ii. Upon further heating to 160°C, further loss of water from metaboric acid to tetra boric acid.

$$4HBO_2 \xrightarrow{160°C} H_2 B_4O_7 + H_2O$$ (Tetraboric acid)

iii. On heating tetra boric acid produces the boric acid anhydride, boron trioxide B_2O_3

$$H_2 B_4O_7 \xrightarrow{160°C} 2B_2O_3 + H_2O$$

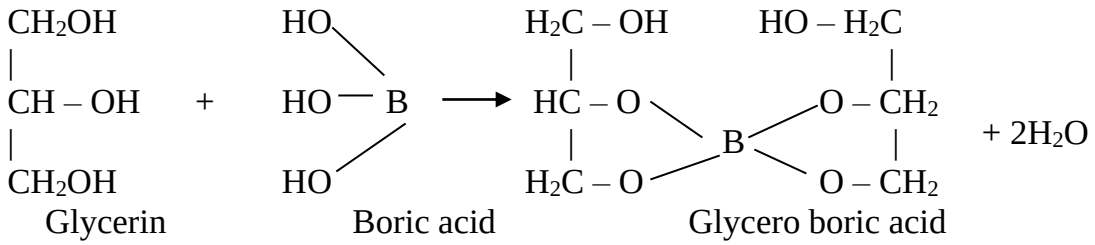
(Boron trioxide)

iv. One molecule of acid reacts with only one mole of sodium hydroxide.

$NaOH + H_3BO_3 \rightarrow NaBO_2 + 2H_2O$

Assay

Boric acid is assayed by **titrimetric method**. It is a very weak acid, hence it cannot be titrated directly with a base to a sharp end point. It is dissolved in a mixture of water and glycerin and it is made as strong acid i.e., Glyceroboric acid and then it can be titratred with sodium hydroxide to phenolphthalein as indicator. The end point is appearance of permanent pale pink colour.



Storage : Well closed container

Use : Anti infective

HYDROCHLORIC ACID

M.F. : HCl

Preparation

(i) It is manufactured by the action of sulphuric acid on sodium chloride (common salt)

$$2NaCl + H_2SO_4 \rightarrow Na_2SO_4 + 2HCl$$

(ii) Hydrogen and chloride gases (obtained from Electrolysis of sodium chloride solution) are combined to give hydrogen chloride gas which is dissolved in water to yield hydrochloric acid.

$$H_2 + Cl_2 \rightarrow 2HCl$$

Properties (Physical & Chemical)

i. It is a colourless, fuming liquid having a pungent odour.

ii. It gives white precipitate with silver nitrate.

$$AgNO_3 + HCl \rightarrow AgCl \downarrow HNO_3$$

Identification Test

i. When it is added to $KMnO_4$, chlorine gas is liberated.

Assay : **Titremetric method (acid-base titration)**

It is assayed by titration with sodium hydroxide using methyl orange as an indicator.

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

Storage It should be stored in well closed non-metallic container.

Use : as solvent, catalyst and also as an acidifier.

STRONG AMMONIA SOLUTION

M.F. : NH_3

Syn : Liquior ammonia fortis

Preparation : Laboratory Method

i. Heating ammonium chloride with calcium hydroxide.

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

Commercial or Industrial Method

i. Haber Synthesis

Hydrogen and nitrogen gases are combined to give ammonia gas.

$$N_2 + 3H_2 \xrightleftharpoons[Mo]{Fe} 2NH_3\uparrow$$

Physical Properties

i. It is clear, colourless, transparent liquid having characteristic strong pungent odour.

ii. Highly soluble in water.

Chemical Properties

i. Ammonia is able to reduce potassium permanganate to MnO_2.

$$2NH_3 + 2KMnO_4 \rightarrow 2KOH + 2MnO_2 + 2H_2O + N_2 \uparrow$$

ii. Ammonia is a strong base. Therefore it reacts with acids to form salts.

$$NH_3 + HCl \rightarrow NH_4Cl$$

Identification

When a glass rod dipped in HCl is brought near the surface of the solution, white fumes will be produced.

Assay : Back Titration Method

Weighed amount of ammonia is added to the excess of sulphuric acid. The excess or unreacted sulphuric acid is back titrated by titration with sodium hydroxide solution using methyl red as indicator.

$$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2\ SO_4$$

$$H_2SO_4 + 2NaOH \rightarrow Na_2\ SO_4 + 2H_2O$$

Storage: It is stored in well closed amber coloured container having a rubber stopper in cool place.

Use : Laboratory reagent, antacid, stimulant, counter irritant.

CALCIUM HYDROXIDE

M.F. : $Ca(OH)_2$

Syn.: : Slaked lime

Preparation Slaking Process

Spraying water on quicklime

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

i. It is a soft white powder, having slightly bitter taste.

ii. It is soluble in water and in alcohol.

iii. On exposure to air, it absorbs atmospheric CO_2 and forms $CaCO_3$.

iv. When it is heated strongly, it loses water and is converted to CaO.

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

A clear saturated solution of calcium hydroxide in water is called **lime water**.

Assay : Complexometric Method

A weighed amount of calcium hydroxide is mixed with sufficient amount of dilute HCl. A known volume of the above solution is mixed with 15 ml of NaOH solution and 3 ml of napthol green are added titrated with disodium ethylene diamine tetra acetate (EDTA) to the deep blue colour end point using murexide as an indicator.

Storage

It should be stored in well closed container, protected from moisture and carbon-di-oxide.

Use :

(i) antacid, (ii) as an astringent (iii) Topically as a protective.

SODIUM HYDROXIDE

M.F : NaOH

Syn : Caustic Soda.

Preparation : Industrial method

Soda Lime Process

1. Sodium carbonate is heated with milk of lime.

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

Properties (Physical & Chemical)

i. It occurs in the form of flakes, sticks and pellets.

ii. It is very deliquescent.

iii. It is strongly alkaline and corrosive.

iv. It is soluble in water, alcohol and in glycerin with the production of heat.

v. It absorbs carbon-di-oxide and gets partially converted into sodium carbonate.

$H_2O + CO_2 \rightarrow H_2CO_3$

$$2NaOH + H_2CO_3 \rightarrow Na_2CO_3 + 2H_2O$$

Assay

As sodium hydroxide absorbs CO_2, it contains a little sodium carbonate. Hence it is assayed by two steps (for the estimation of total alkali and sodium carbonate in the sample).

1st Step

Weighed sample is dissolved in CO_2 free water and titrated with sulphuric acid using phenolphthalein solution as an indicator, until the pink colour of the solution in discharged.

$$2\ NaOH + H_2SO_4 \rightarrow\ Na_2SO_4 + 2H_2O$$

$$2\ Na_2CO_3 + H_2SO_4 \rightarrow Na_2\ SO_4 + 2NaHCO_3$$

As per the above equations, all the NaOH has been neutralized by H_2SO_4 and Na_2CO_3 is converted into $NaHCO_3$. This step is called as half neutralization of sodium carbonate.

IInd Step

To the above solution, methyl orange is added and the titration is continued until a permanent pink colour is produced.

$$2NaHCO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O + CO_2$$

Storage

It must be stored in tightly closed container.

Use : Laboratory reagent

OFFICIAL BUFFERS

Buffer Solutions

Such solutions for which the pH will not be changed when a small amount of acid or base is added. Buffer solutions consists of a mixture of weak acid and salt of its strong base or weak base, and the salt of its strong acid.

Types of buffers:

1. Acidic buffer solutions, (Mixture of weak acid and the salt is called as above. e.g., $CH_3COOH + CH_3COONa$

2.Basic Buffer

Mixture weak base and the salt. eg : NH_4OH and NH_4Cl

Buffer Action

The resistance possessed by buffers to change in pH is defined as buffer action.

Standard Buffer Solutions

Standard buffer solutions are solutions of standard pH.

Official Buffers

The buffer solutions recommended by pharmacopoeia are called as official buffers.

e.g.

1. **Acid phthalate buffer :** It contains potassium hydrogen phthalate and hydro chloric acid.
2. **Alkaline borate buffer :** It contains boric acid, potassium chloride and sodium hydroxide.
3. **Phosphate buffer :** It contains potassium dihydrogen phosphate and sodium hydroxide.
4. **Acetate Buffer : (pH 2.8) :** It contains sodium acetate and glacial acetic acid.

Uses of Buffers

Buffers are used to maintain the pH value.

i. pH of the blood is maintained by buffer system present in our body.

ii. Solubility of the many compounds can be controlled by providing suitable pH.

iii. It provides a particular pH for maximum enzyme activity. Hence it is used in the assay of enzyme activity.

iv. They are very much useful in the estimation of metallic salts by complexometric titrations, since the EDTA – metal complex is more stable at particular pH.

v. Certain pharmaceutical preparations are stabilized by adding suitable buffers.

ANTIOXIDANTS

Definition

Antioxidants are reducing agents which are added to the drugs or other pharmaceutical preparations to prevent their oxidation.

Requirements of an Ideal Antioxidant

i. It should be chemically and pharmacologically inert.

ii. Effective in low concentration.

iii. It should not be toxic.

iv. It should be easily soluble.

HYPO PHOSPHORUS ACID

M.F. : H_3PO_2

Preparation

It is prepared by mixing calcium hypophosphite with sulphuric acid or oxalic acid. The insoluble calcium salt is filtered and collected.

$Ca(H_2PO_2)_2 + H_2SO_4 \rightarrow CaSO_4 + 2H_3PO_2$

Calcium hypophosphite

$$Ca(H_2PO_2)_2 + H_2C_2O_4 \rightarrow CaSO_4 + 2H_3PO_2$$

(Calcium hypophosphite) oxalic acid

Properties (Physical & Chemical)

1. Clear yellowish liquid with slight acidic odour.
2. Soluble in water and alcohol.
3. It acts as monoprotic acid and ionizes to give

   $H_3PO_2 + H_2O \rightleftharpoons H_3O^+ + H_2PO_2^-$
4. It acts as a powerful reducing agent. With iodine it forms iodide.

   $H_3PO_2 + 2I_2 + 2H_2O \rightarrow 4HI + H_3PO_4$ (phosphoric acid)
5. It decolurise the $KMnO_4$ solution.

Identification test

i. Upon heating with copper sulphate solution gives reddish brown precipitate.

Assay (Titremetric method)

Hypophosphorous acid is first diluted with water. Then it is titrated with sodium hydroxide using methyl orange as indicator.

Incompatability

Since it is a reducing agent, it is incomptabale with oxidizing agents.

Storage

It should be stored in well closed container.

Use : As an antioxidant in pharmaceutical preparations.

SULPHUR DIOXIDE

M.F : SO_2

Preparation : Laboratory Method

1. Burning sulphur in presence of air (or) oxgen.

$$2S + 2O_2 \rightarrow 2SO_2$$

2. Decomposition of sodium sulphite with H_2SO_4 acid.

$$NaHSO_3 + H_2SO_4 \rightarrow NaHSO_4 + SO_2 \uparrow + H_2O$$

Industrial Method

Roasting of metallic sulphides such as

$Cu_2S + 2O_2 \rightarrow 2CuO + SO_2 \uparrow$

(Copper sulphide)

$2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2 \uparrow$ etc.

(Zinc sulphide)

Properties (Physical & Chemical)

1. Colourless, non-inflammable gas with pungent odour.
2. Easily liquified.
3. Aqueous solution is acidic to litmus.
4. It is a very good reducing agent.
5. With iodine forms hydroiodic acid.
6. It decolurise the $KMnO_4$ solution

$2KMnO_4 + 2H_2O + 5SO_2 \rightarrow 2MnSO_4 + 2H_2SO_4 + K_2SO_4$

Assay

The method based upon the absorption of SO_2 into NaOH solution to form sodium bisulphite. Then bisulphite so formed is titrated with iodine solution using starch mucilage as an indicator to a blue colour end point.

Storage

Should be stored in well closed container.

Incompatability

Generally incompatible with oxidizing agents (since it is a reducing agent).

Use :

1. It act as an antioxidant.
2. Used for the manufacture of sulphuric acid.

SODIUM META BISULPHITE

M.F : $Na_2S_2O_5$

Preparation : It involves two steps

1st Step

Passing SO_2 gas through a hot strong solution of sodium hydroxide until the solution is saturated. Sodium bisulphite is formed.

$NaOH + SO_2 \rightarrow NaHSO_3$

IInd Step

Sodium bisulphite loses water and gives sodium meta bisulphite on cooling.

$2\ NaHSO_3 \rightarrow Na_2S_2O_5 + H_2O$

Properties:

1. Colourless crystals having sulphurous odour with saline taste.

2. Freely soluble in water.
3. Aqueous solution is acidic.

Assay

Oxidation-reduction reaction. Weighed amount of sample is dissolved in water. Then excess of iodine solution is added. (Which oxidizes the sodium metabisulphite (reducing agent) to sodium meta sulphate.

Excess of iodine is titrated with sodium thiosulphate using starch mucilage as an indicator.

Identification Test

(i) Decolurises the iodine solution.

Incompatibility

Generally incompatible with oxidizing agents.

Storage

It should be stored in well closed container.

Use

1. As an antioxidant in injections.
2. Preservation of food materials.

SODIUM THIOSULPHATE

M.F. $Na_2S_2O_3$

Syn : Sodium hyposulphate or antichlor.

Preparation : Aqueous solution of a sodium sulphite is heated with sulphur. The solution is concentrated, then the crystals are separated.

$Na_2SO_3 + S \rightarrow Na_2S_2O_3$

Properties

1. Colourless crystals or coarse crystalline powder, odourless, with alkaline taste.
2. It melts at 50°C while decomposes on being heated at 100°C.
3. It effloresces in dry air and deliquesces in moist air.
4. Soluble in water.
5. It reduces halogens.

   $2Na_2S_2O_3 + I_2 \rightarrow 2Na\,I + Na_2S_4O_6$ (sodium tetrathionate)
6. Upon treating with HCl
7. It liberates, sulphur, sulphur dioxide

Assay

Weighed amount is dissolved in water and titrated with iodine solution using starch mucilage as an indicator.

$$2Na_2S_2O_2 + I_2 \rightarrow Na_2S_4O_6 + 2NaI \qquad \text{(soda. Tetra thionate)}$$

Storage : Well closed container

Use :

i. With sod. nitrite as an Antidote in the treatment of cyanide poisonings (for mingthiocyanate)

ii. Useful in skin diseases.

NITROGEN

M.F : N_2

Atmospheric air contains nearly 78% of nitrogen. It also occurs as nitrate deposits.

Preparation

1. Distillation of liquid air.
2. Decomposition of NH_3. (Haber Synthesis)

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

3. When burning the phosphorous in a closed container, phosphorous taken up the oxygen and converted in phosphorous pentoxide (P_2O_5), leaving the nitrogen in the container.

Properties

1. Colourless, odourless, tasteless gas.
2. It is soluble in alcohol, slightly in water.
3. It can be liquified.
4. It is inert gas (inactive)

Storage

Stored in metal cylinder under pressure. The cylinder is painted grey with black on the neck and shoulders. The name should be stencilled or painted on the body of the cylinder.

Use :

1. For the packaging of pharmaceuticals (as it is inert gas).
2. Diluent for oxygen
3. Liquid nitrogen is used in surgery to remove some tumours.

SODIUM NITRITE

M.F. : $NaNO_2$

Preparation

Most common suitable method

Absorbing of nitrogen oxide gas (NO) by sodium carbonate solution. The solution is concentrated to crystallize out the product.

$2Na_2CO_3 + 4NO + O_2 \rightarrow 4NaNO_2 + 2CO_2$

Properties

1. Colourless to slightly yellow crystals, odourless, saline taste.
2. It is deliquescent. Absorb moisture and slowly gets oxidized to sodium nitrate.
3. Soluble in water.
4. It is a reducing agent.

Assay

The method is based upon the oxidation of nitrite to nitrate. weighed sample is dissolved in water and mixed with excess volume of potassium permanganate solution. Then 5ml of sulphuric acid was added. Then excess of oxalic acid is added, the mixture is heated to 80° and the excess oxalic acid is back titrated with the std $KMnO_4$ solution.

$NaNO_2 + H_2SO_4 \rightarrow NaHSO_4 + HNO_2$

$HNO_2 + O \rightarrow HNO_3$

Storage

It should be preserved in tightly closed container.

Use

1. Antidote for cyanide poisoning.
2. Food preservative.

GASTRO INTESTINAL AGENTS

ACIDIFYING AGENTS

Definition

These are drugs which are able to increase the acidity in GIT.

Types : Generally four types are there

(i) **Gastric Acidifiers:** (Drugs restoring temporarily the acidity of stomach incase of achlorhydria or hypochlorhydria).

(ii) **Urinary Acidifiers:** (Drugs used to render urine acidic).

(iii) **Systemic Acidifiers:** Drugs which are able to neutralize the alkaline body fluids particularly blood.

(iv) **Acids:** Used as pharmaceutical acids in preparation, laboratory quality control etc.

DILUTE HYDROCHLORIC ACID I.P

Preparation

It is prepared by diluting concentrated hydrochloric acid with water i.e., about 10% W/V of HCl (Limits 9.5 to 10.5%).

Properties

(i) It is a colourless liquid.

(ii) It's specific gravity is 1.045.

(iii) When $KMnO_4$ is added, chlorine is evolved.

Assay

It is assayed by titration with standard sodium hydroxide solution, using methyl orange solution as indicator.

Acidifying agents are used in following conditions.

(i) Hypochlorhydria (decreased acid secretion).

(ii) Achlorhydria (No acid secretion).

ANTACID

These are drugs used for neutralizing excess acid in the stomach.

Classification

(i) Systemic antacids.

(ii) Non-systemic antacids.

(i) Systemic Antacids

They are used to reduce the acidity of blood.

Eg. Sodium bicarbonate injsodium citrate.

(ii) Non-Systemic Antacids

They are used to reduce gastric acidify. (Not absorbed into systemic circulation).

Eg.

Aluminium hydroxide

Magnesium trisilicate

Magnesium hydroxide

Magnesium oxide

Aluminium phosphate

Calcium carbonate

SODIUM BICARBONATE

M.F. $NaHCO_3$

Syn: Baking Soda

PREPARATION

Laboratory Method

It is prepared by passing CO_2 gas through a solution of sodium hydroxide. The solution is concentrated to get the product.

$$2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$$

$$Na_2CO_3 + H_2O + CO_2 \rightarrow 2\ NaHCO_3$$

Industrial Method

Solvay Process

Brine solution (NaCl) is saturated with ammonia (to remove impurities). The solution is filtered, CO_2 is passed through the solution. The precipitate is filtered and dried.

$$H_2O + CO_2 \rightarrow H_2CO_3$$

$$NH_3 + H_2CO_3 \rightarrow NH_4HCO_3$$

$$NaCl + NH_4HCO_3 \rightarrow NaHCO_3 + NH_4Cl$$

Properties

(i) White crystalline or amorphous powder having saline taste.

(ii) It is freely soluble in water.

(iii) Practically insoluble in alcohol.

(iv) It gives an effervescence with acids.

(v) Its solution is alkaline in nature.

(vi) When heated, it gives sodium carbonate, CO_2 and water.

$$2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$$

Assay: Acid-Base Titration Method

Weighed amount is dissolved in water and titrated with sulphuric acid using methyl orange as indicator.

$$2NaHCO_3 + H_2SO_4 \rightarrow Na_2SO_4 + 2CO_2 + 2H_2O$$

Storage

It is stored in well closed container.

Use:

(i) Used in systemic acidosis.

(ii) Local application for burns, insect bites etc.

(iii) Used as a constituent in ear drops to soften and remove wax.

ALUMINIUM HYDROXIDE GEL

It is an aqueous suspension of hydrated aluminium oxide together with varying amounts of basic aluminium carbonate. It contains aluminium oxide, glycerin, sucrose or saccharin as a sweetening agent, peppermint oil as a flavouring agent and sodium benzoate as a preservative.

Preparation

It is prepared by the reaction of an aluminium sulphate or aluminium chloride with sodium carbonate or sodium bicarbonate. The precipitate of aluminium hydroxide is collected, washed and resuspended in water and finally homogenized.

$$3Na_2CO_3 + 3H_2O \rightarrow 3NaHCO_3 + 3\,NaOH$$

$$AlCl_3 + 3NaOH + H_2O \rightarrow 3\,NaCl + Al(OH)_3.\,3H_2O$$

$$2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$$

Properties

1. It is a white viscous suspension.
2. A clear liquid gets separated when it is kept standing for sometime.

Assay: Complexometric Titration

Weighed amount is dissolved in hydrochloric acid by warming. Excess of std EDTA is added. The mixture is neutralized by adding 1 N NaOH. This is warmed on a water bath for half an hour (to ensure complexation between aluminium and EDTA). Then hexamine is added (to maintain alkaline pH) and the excess of EDTA is back titrated with std lead nitrate using xylerol orange as indicator.

Use

1. As an antacid.

2. Since aluminium salts produce constipation, and are therefore generally administered along with magnesium salts to counteract this effect.

ALUMINIUM PHOSPHATE

It consists mainly hydrated aluminium ortho phosphate ($AlPO_4$).

Preparation

It is prepared by interaction between aqueous solutions of aluminium chloride and sodium phosphate. The soluble salt is filtered and dried.

Properties

1. White powder.
2. Insoluble in water, ethanol and alkali hydroxides.
3. Soluble in dilute mineral acids.

Assay: (Complexometric Titration)

Weighed amount is dissolved in HCl, then excess EDTA is added. The solution is made just alkaline. After boiling it for 5 mts, ammonium acetate and glacial acetic acid are added. Then the pH is adjusted to 4.5 and titrate with zinc chloride ($ZnCl_2$).

Use

1. Antacid.
2. Adsorbent for bacterial toxoids.

CALCIUM CARBONATE

M.F. ($CaCO_3$)

Syn: Precipitated chalk

Occurence

In nature, it is found as chalk, marble, limestone, aragonite and calcite (one of the main constituents of corals, pearls and shells).

Preparation (Commercial Method)

It is obtained by mixing the boiling solutions of calcium chloride and sodium carbonate.

$$CaCl_2 + Na_2CO_3 \rightarrow CaCO_3 \downarrow + 2\ NaCl$$

The precipitate is collected, washed with boiling water (until it free from chloride ions) and dried.

Properties

1. It occurs as fine, white, micro-crystalline powder.

2. It is odourless and tasteless.
3. It is almost insoluble in water and alcohol.
4. Calcium carbonate neutralizes acids with effervescence.

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 \uparrow + H_2O$$

5. It produces constipation.

Assay: Complexometric Titration

Weighed amount is dissolved in HCl. Then the pH is adjusted to 12 by NaOH. Then it is titrated with EDTA using murexide and napthol green mixture as indicator to a deep blue color end point.

Use

1. Externally as dentrifice.
2. Internally as an antacid.

   Generally it is administered along with magnesium salts (Laxative).

MAGNESIUM CARBONATE

M.F. $3MgCO_3.Mg(OH)_2.5H_2O$

It occurs in nature as magnesite ($MgCO_3$) and dolomite ($MgCO_3.CaCO_3$).

Preparation

It is obtained by the double decomposition from magnesium sulphate and sodium carbonate. They are dissolved separately in water and the solutions are mixed. The residue is filtered and washed with water until it becomes free from sulphate ions.

$$MgSO_4 + Na_2CO_3 \rightarrow MgCO_3 \downarrow + Na_2SO_4$$

Properties

1. It is a white granular powder.
2. It is odourless and tasteless.
3. When heated to redness, it gets converted to MgO, losing CO_2 and H_2O.

$$3MgCO_3.Mg(OH)_2.4H_2O \rightarrow 4\,MgO + 3CO_2 + 5H_2O$$

Assay

It is assayed by **complexometric titration.**

Weighed sample is dissolved in dilute HCl small amount of NaOH solution is added. Then it is titrated with EDTA using murexide as indicator.

Use:

Antacid

Laxative

MAGNESIUM TRISILICATE

Formula: $2MgO.\ 3SiO_2.\ 3H_2O$

Syn: Hydrated Magnesium silicate

This compound is having magnesium oxide and silicon oxide with varying proportions of water of crystallization.

Preparation

It is obtained from sodium silicate and magnesium sulphate. The magnesium trisilicate is precipitated out by slowly running a solution of magnesium sulphate into a solution of sodium silicate. The precipitate is filtered, washed and dried.

Properties

1. White fine powder.
2. It is odourless and tasteless.
3. It is insoluble in water and alcohol.

Assay

It is assayed for magnesium oxide by conversion to magnesium chloride by complexometric titration and for silicon dioxide by gravimetric method.

For Magnesium Oxide (MgO)

It is done by complexometric titration. Weighed sample is dissolved in hydrochloric acid, small amount of NaOH solution is added. Then it is titrated with 0.05 M disodium edetate using Murexide indicator.

For Silicon dioxide (SiO_2)

To the weighed sample, sulphuric acid is added and filtered. The insoluble SiO_2 is washed until free from sulphate and ignited for 5 minutes, cooled and weighed.

Use:

Antacid, adsorbent

MAGNESIUM OXIDE

M.F. MgO

There are two varieties of magnesium oxide are available.

1. Light MgO
2. Heavy MgO

Heating light or heavy magnesium carbonate, corresponding light or heavy magnesium oxide is obtained.

$$MgCO_3 \xrightarrow[\Delta]{\text{Red heat}} MgO + CO_2 \uparrow$$

Properties

1. It is a white powder.
2. It is odourless.

3. It is insoluble in water and alcohol.
4. It is soluble in dilute acids.

Assay: By Complexometric Titration

Weighed sample is dissolved in dilute hydrochloric acid. Small amount of strong ammonia – ammonium chloride solution is added, then it is titrated with 0.05 m EDTA using mordant black II mixture as indicator.

Use: Antacid and Laxative

Combinations of Antacid

Preparations

Antacid preparations are formulated with one more than one antacid as combinations to counteract the side effect of one by another or to be used for specific conditions.

(i) Aluminium hydroxide gel – Magnesium hydroxide combination.

Preparation: Available as oral suspension and tablets.

Adv: Since aluminium salts causes constipation, this effect is balanced by laxative effect of magnesium.

(ii) Simethicone containing antacids

It is formulated along with aluminium hydroxide gel and magnesium hydroxide.

It is available as oral suspension and tablet.

Advantage: Simethicone relieves flatulence.

(iii) Aluminium hydroxide gel – magnesium trisilicate combination

It is available as oral suspension and tablet.

Advantage:

Magnesium trisilicate has protective effect.

PROTECTIVES AND ADSORBENTS

1. They are generally insoluble.
2. Non-toxic
3. Chemically inert
4. They cover skin or mucous membrane from irritants.

Protectives

Definition : Chemically inert substance used to form a protective layer in GIT.

Adsorbents

Chemically inert substance used for removing toxic substances from GIT.

LIGHT KAOLIN I.P.

M.F : $Al_2O_3. 2SiO_2. 2H_2O$

Preparation :

It is prepared from the native clays, available as deposits in earth.

Procedure

1. Suspension of clay is prepared in water.
2. Larger particles (quartz, mica) are removed by elutriation.
3. Upon successive treatment with sodium pyrophosphate and HCl (to remove acid soluble and basic soluble impurities) and finally subjected to evaporation gives the fine particles of Kaolin.

Properties

1. It is a light white powder, soft to touch.
2. Insoluble in water, mineral acids and organic solvents.

I.P. includes two varieties of kaolin one is heavy kaolin and the other is light kaolin. The light kaolin is purer and smaller in particle size than the heavy variety. Only light kaolin is intended for internal use.

Use : as an adsorbent for toxic substances from G.I.T. tract.

Storage

It should be stored in a well closed container

BISMUTH SUB-CARBONATE

M.F. $[(Bio)_2\ CO_3]_2\ H_2O$).

Preparation

It involves two steps.

1st Step : Bismuth nitrate is prepared by treating metallic bismuth with nitric acid.

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

2nd Step : Adding bismuth nitrate solution to a cold sodium carbonate solution with constant stirring. The white precipitate is washed with water and dried.

$$4\ Bi\ (NO_3)_3 + 6\ Na_2.\ CO_3 + H_2O \rightarrow$$

$$[(Bio)_2\ CO_3]_2\ H_2O \downarrow + 12\ NaNO_3 + 4CO_2 \uparrow$$

Properties (Physical & Chemical)

White or pale yellowish odourless, tasteless powder, affected by light.

1. With acids, it produces effervescence.
2. On heating it yields bimuth oxide (90%)

$$[(BiO_2)\ CO_3]_2\ H_2O \xrightarrow{\Delta} 2\ Bi_2\ O_3 + 2\ CO_2 + H_2O$$

Assay : Gravimetric method

Weighted sample is ignited to constant weight. It is required to yield not less than 90% of Bismuth oxide.

$$[(BiO)_2\ CO_3]_2\ H_2O \xrightarrow{\Delta} 2\ Bi_2\ O_3 + 2\ CO_2 \uparrow + H_2O$$

Use : used in diarrhoea and dysentry.

Storage : It should be stored in well closed air tight container.

SALINE CATHARTICS

These are drugs, when given orally retained in GIT, increases the intestinal bulk by drawing water from circulation by osmosis. They acts as mechanical stimulus, produces increased peristalic movement causing diarrhoea. They are also called as saline purgatives or osmotic laxatives.

SODIUM POTASSIUM TARTRATE

Syn. : Rochelle salt

M.F : $\begin{matrix} CH\ (OH) - COONa \\ | \\ CH(OH) - COOK \end{matrix}$

Preparation

It is obtained by neutralizing a solution of sodium carbonate with potassium bitartrate. The solution is boiled for few mts and then allowed to stand at 60°C for the completion of the reaction. (till the CO_2 ceases). The solution is filtered and evaporated.

2 CH OH – COOH
| + $Na_2 CO_3 \rightarrow$
CH OH – COOK

(Potassium bitartrate)

↓

2 CH OH – COONa
| + $CO_2 \uparrow + H_2O$
CHOH – COOK

Properties

Colourless, crystalline efflorescent powder soluble in water, insoluble in alcohol.

Upon heating at high temperature gives sodium and potassium carbonates.

$2\ KNa\ C_4H_4O_6 + 5O_2 \rightarrow K_2CO_3 + Na_2CO_3 + 6\ CO_2 + 4H_2O$

Assay : Back titration method

An accurately weighted sample is ignited or heated until carbonized. The residue is boiled with excess of standard sulphuric acid and filtered. Excess of acid is back titrated with standard sodium hydroxide using methyl orange as an indicator.

CH (OH) – COONa
| + $5O_2 \rightarrow$ + $K_2CO_3 + Na_2 CO_3 + 6CO_2 + 4H_2O$
CH – (OH) COOK

$K_2CO_3 + Na_2CO_3 + 2H_2SO_4 \rightarrow K_2SO_4 + Na_2SO_4 + 2CO_2 + 2H_2O$

Excess $H_2SO_4 + 2\ NaOH \rightarrow Na_2SO_4 + 2H_2O.$

Identification Test :

When heated the salt emits an odour of burning sugar and leaves a residue which is alkaline to litmus paper.

Storage

It should be stored in air tight container.

MAGNESIUM SULPHATE

M.F. $MgSO_4. 7H_2O$ Syn.: Epsom salt.

It can be prepared by alizing sulphuric acid with magnesium oxide or magnesium carbonate or native dolomite

$MgO + H_2SO_4 \rightarrow MgSO_4 + H_2O$

$MgCO_3\ CaCO_3 + 2H_2SO_4 \rightarrow MgSO_4 + 2H_2O + 2CO_2 + CaSO_4$

(Dolomite)

The impurities are precipitated only mag. Sulphate remains in solution. The solution is filtered, and evaporated.

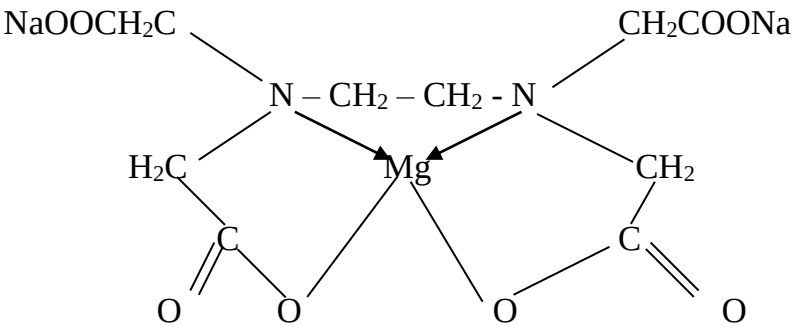
Properties

1. White powder or colourless crystals, odourless with a bitter taste.
2. In warm dry air it may lose water by efflorescence.
3. Freely soluble in water, insoluble in alcohol.

Assay : By complexometric titration

Weighed amount is dissolved in water, strong ammonia-ammonium chloride buffer is added and titrated against 0.05 m EDTA using Mordant Black II mixture as an indicator. The end point is change of wine red to blue colour.

EDTA + Mg^{2+} $\rightarrow$



Use :

1. Used for constipation.
2. Evacuation of gall bladder (in case of chole cystitis)

Storage It should be stored in air tight container.

TOPICAL AGENTS

PROTECTIVES

They are group of insoluble substances, applied to the skin to protect from irritation. They are non toxic and biologically inactive.

TALC I.P

M.F. $Mg_6 (Si_2O_5)_4 (OH)_4$

It is a purified natural hydrated magnesium silicate, and may contain small amounts of aluminum silicate.

Preparation

The native talc is finely powdered and boiled with dilute HCl (to remove impurities like iron, Cao, iron etc.). The insoluble talc is completely washed with water until it becomes free from acid. The residue is then dried.

Properties

i. Very fine, white or grayish white powder.

ii. It is smooth to touch.

iii. Odourless and tasteless.

iv. Its solution is neutral to litmus.

v. Practically insoluble in water, dilute acids and alkalies.

Storage

It should be stored in well closed container.

Use

1. As a base for dusting powders.
2. As a lubricant for tablet making.
3. As a filtering and distributing agent.

]

ZINC OXIDE

M.F: ZnO

Preparation :

1. Large Scale: Heating metallic zinc, in a current of air to a high temperature. The metal vapour burns to form the oxide, collected as a fine white powder.

$$2Zn + O_2 \xrightarrow{\Delta} 2\ ZnO$$

2. Medicinal Grade : Zinc oxide is obtained by adding zinc sulphate to a boiling solution of sodium carbonate. The precipitated zinc carbonate is washed until it becomes free from sulphate. Now it is dried and ignited, loses CO_2 and water, giving the oxide.

$$ZnSO_4 + Na_2\ CO_3 \rightarrow ZnCO_3 + Na_2SO_4$$

$$ZnCO_3 \xrightarrow{\Delta} ZnO + Co_2$$

Properties (Physical & Chemical)

1. White or faintly white very fine powder.
2. It is odourless and tasteless.
3. It is insoluble in water and alcohol.
4. It slowly absorbs CO_2 from the air and forms basic zinc carbonate.
5. It reacts with acids forming zinc salts.

$$ZnO + 2\ NaOH \rightarrow ZnCl_2 + H_2O$$

6. It reacts with base forms zincates.

$$ZnO + 2NaOH \rightarrow Na_2\ ZnO_2 + H_2O$$

Assay : Back Titration Method

Weighed amount of the sample is dissolved in excess of std H_2SO_4 acid, small amount of ammonium chloride is added and heated if necessary. The excess of sulphuric acid is back titrated with std NaOH using methyl orange as an indicator.

(Ammonium chloride prevents the precipitation of zinc hydroxide by the NaOH near the end point).

$ZnO + H_2SO_4 \rightarrow ZnSO_4 + H_2O$

Unreacted $H_2SO_4 + NaOH \rightarrow Na_2SO_4 + H_2O$

Storage

It should be stored in well closed container.

Use :

1. as a mild antiseptic and an astringent.
2. for making dental cement.
3. used in various skin diseases.
4. manufacture of adhesive tapes and bandages.

CALAMINE

Calamine is zinc oxide having a small amount of ferric oxide.

Preparation (Large Scale)

1st Step

Zinc oxide is prepared by heating zinc carbonate.

$$ZnCO_3 \rightarrow ZnO + CO_2$$

2nd Step

The calamine is then prepared by mixing zinc oxide with ferric oxide (up to 1.0 per cent) thoroughly.

Properties

1. It is pink powder.
2. Almost odourless and tasteless.
3. Almost insoluble in water but dissolved completely in mineral acids.

Assay

It is dissolved in excess of std. sulphuric acid and filtered then a small amount of ammonium chloride is added. The excess acid is back titrated with NaOH solution using methyl orange as an indicator.

NH_4Cl is added to prevent the precipitation of zinc hydroxide during titration.

Storage

It should be stored in well closed container.

Use

Astringent, antiseptic and protectant for the skin.

ZINC STEARATE

M.F. $(C_{17}H_{35}COO)_2$ Zn

Zinc stearate contains mainly zinc stearate with variable proportion of zinc palmitate. It also contains 13% of zinc oxide (ZnO).

Preparation

It is prepared by adding zinc sulphate to a solution of sodium stearate.

$2C_{17}H_{35}COONa + ZnSO_4 \rightarrow (C_{17}H_{35}COO)_2 Zn + Na_2SO_4$

The precipitate is washed and dried.

Properties

1. White, amorphous powder free from grittiness.
2. It has faint characteristic odour.
3. It is insoluble in water, alcohol and other.

Assay : By Complexometric Method

Weighed amount of sample is boiled with H_2SO_4 (to convert the zinc present in Zn. Stearate to zinc sulphate). Then the solution is treated with ammonia - ammonium chloride buffer to adjust the pH = 10 an titrated with std EDTA using eriochrome black T as indicator at 40°C.

$(C_{17}H_{35}COO)_2 Zn + H_2SO_4 \rightarrow ZnSO_4 + 2C_{17}H_{35}COOH.$

EDTA + $Zn^{2+} \rightarrow$ (EPTA Zn complex)

Use

Astringent and antimicrobial agent

As a protectant in skin disorder.

Storage

It should be stored in well closed container.

TITANIUM DIOXIDE

M.F. TiO_2

It is an oxide of Titanium (Ti)

Preparation

It is obtained natural samples of ilmenite (ore). The ore is heated with conc. sulphuric acid. The precipitate of titanium dioxide is obtained by hydrolysis.

Properties

1. White powder, odourless and tasteless.
2. Insoluble in water and in dilute mineral acids.
3. It dissolves slowly in hot H_2SO_4 and ammonium sulphate forms double salt.

Assay : By Complexometric Method

Weighed sample is dissolved in a mixture of H_2SO_4 and ammonium sulphate. The solution is filtered and washed several times with water. Then 50 ml of EDTA is added and the pH is adjusted to 5 and the resulting solution is titrated with $ZnCl_2$ (zinc chloride) using xylenol orange solution as indicator.

Use

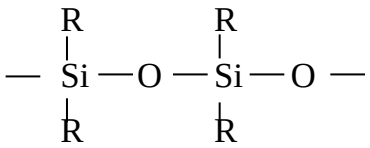
1. Very good topical protective.

Storage

It is stored in well closed container.

Silicon Polymers

They are polymers having the general formula



1. Highly viscous liquids.
2. Viscosity increases with increase in molecular weight.
3. They are stable towards heat and chemical reagents.
4. They can be used as lubricants over a wide range of temperature.

ASTRINGENTS

Astringents are the substances which precipitates the protein.

Alum

Formula $Kal\ (SO_4)_2.\ 2H_2O$. Alum is potassium aluminium sulphate. It is a double salt containing potassium and aluminium sulphate.

Preparation

It is prepared by adding a concentrated solution of potassium sulphate to a hot solution of an equal amount aluminium sulphate.

$$K_2SO_4 + Al_2\ (SO_4)_3 + 24\ H_2O \rightarrow 2KAl\ (SO_4)_2.\ 12H_2O$$

The solution is concentrated, cooled and the crystals are separated.

Properties

1. Colourless transparent crystals having a sweet astringent taste.
2. It is soluble in water but insoluble in alcohol.
3. At 200°C it loses its water at crystallization and becomes anhydrous.

Assay

Complexometric Titration Method

Weighed amount is dissolved in water, treated with known volume of Std EDTA (Aluminium forms complex with EDTA). The unreacted EDTA is back titrated with standard lead nitrate in presence of hexamine buffer using xylenol orange as indicator.

Use

1. Used in the preparation of toxoids.
2. Antiseptic and local styptic (to stop bleeding from cuts).

ZINC SULPHATE

M.F. $ZnSO_4. 7H_2o$

Preparation

It is prepared by two methods.

1st Method

It is prepared by heating zinc sulphide in presence of air. The heated mass is dissolved in hot water, and filtered.

$ZnS + 2O_2 \rightarrow ZnSO_4$

Offecial Method

It is obtained by digesting metallic zinc aranules in dil. H_2SO_4.

$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2 \uparrow$

Properties

1. Granular crystalline powder.
2. It is odourless and metallic taste.
3. It effloresces in dry air.
4. It is very soluble in water and glycerine.
5. Insoluble in alcohol.
6. It forms double salts with potassium and ammonium sulphate.

$ZnSO_4 + (NH_4)_2 SO_4 \rightarrow ZnSO_4 (NH_4)_2. SO_4 6H_2$

Assay:

Complex metric Titration Method

It is titrated with EDTA in presence of ammonia – ammonium chloride buffer using eriochrome black T as an indicator.

Use

1. Internally acts as an emetic.
2. Externally as an astringent.
3. 0.25% solution is used as eye lotion.

SULPHUR AND ITS COMPOUNDS

SUBLIMED SULPHUR

Symbol : S

Syn : Flowers of Sulphur

Preparation

It is prepared by heating any kind of sulphur and condensing the vapour.

Properties

1. Fine crystalline powder.
2. It has faint characteristic odour but tasteless.
3. It is insoluble in water.

Use :

Antiseptic and scabicide.

PRECIPITATED SULPHUR

Symbol : S

Preparation (Small Scale)

It is prepared by acidifying sodium thiosulphate solution with hydrochloric acid. The unstable thiosulphuric acid is liberated, gets rapidly decomposed to give precipitated sulphur.

$Na_2 S_2O_3 + 2 HCl \rightarrow H_2S_2O_3 + 2 NaCl$

$H_2S_2O_3 \rightarrow S + SO_2 + H_2O$

Industrial Method

It is prepared by heating together sublimed sulphur and milk of lime for an hour.

$2 Ca(OH)_2 + 12S \rightarrow 2 CaS_5 + CaS_2O$

(cal. Penta sulphide)

$CaS_5 + 2\ HCl \rightarrow CaCl_2 + H_2S + 4S$

(Calciumpenta
Sulphide)

Properties

1. Pale greenish yellow soft powder.
2. Odourless and tasteless.
3. Upon heating it burns with a blue flame.

   $S + O_2 \xrightarrow{\Delta} SO_2$
4. It is insoluble in water and alcohol.

Use:

1. Good scabicide.
2. Antiseptic
3. Used in treatment of acne.
4. Parasiticide.

SELENIUM SULPHIDE

M.F. SeS_2

Preparation

It is prepared by passing hydrogen sulphide gas into selenious acid. The precipitate is filtered and dried.

$H_2SeO_3 + 2H_2S \rightarrow SeS_2 \downarrow + 5H_2O$

Selenious acid

Properties

1. It is orange powder having faint sulphide odour.
2. Insoluble in water, alcohol and organic solvents.
3. It dissolves in nitric acid and form selenious and sulphuric acid.

   $SeS_2 + 16\ HNO_3 \rightarrow H_2SeO_3 + 2H_2SO_4 + 16NO_2 \uparrow + S\ H_2O$

Use:.

1. Anti dandruff

DENTAL PRODUCTS

Dental Caries (Tooth decay)

It is a disease of the teeth caused by acids produced by the action of micro organisms on food materials. This is disease is characterized by decalcification of tooth accompanied by foul mouth odour. To prevent dental caries and to maintain clean and

healthy teeth it becomes necessary to use dentrifices. Main function of dentrifices is to clean the surface of the teeth.

Role of Fluoride

Small quantity of fluoride is necessary to prevent dental caries. The fluoride which are deposited on the surface of teeth does not allow the action of acids or enzymes in producing lesions. The anticaries agents used are dentrifices and fluoride salts.

SODIUM FLUORIDE

M.F. : NaF

Preparation

It may be prepared by neutralization of hydro fluoric acid with (NaOH) sodium carbonate.

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

Another Method

It is prepared by double decomposition of calcium fluoride with sodium carbonate.

$CaF_2 + Na_2CO_3 \rightarrow 2\ NaF + CaCO_3 \downarrow$

Properties

1. It is a white powder.
2. Colorless and odourless.
3. It is soluble in water.
4. Insoluble in alcohol.
5. Upon acidification ; hydrofluoric acid is produced.

$NaF + HCl \rightarrow HF + NaCl$

Assay

It is assayed by **complexometric titration**.

Weighed quantity is dissolved in water, sodium chloride and alcohol is added. Then the solution is treated with excess of lead nitrate.

$2\ NaF + pb\ (NO_3)_2 \rightarrow pbF_2 + 2NaNO_3$

The precipitate is filtered. The filtrate and the washings are titrated with disodium edetate using xylerol orange as indicator.

Use

To prevent dental caries.

Storage

Should be stored in well closed container.

STANNOUS FLUORIDE

M.F. : SnF_2

Preparation

It is prepared by dissolving stannous hydroxide in hydro fluoric acid.

$Sn(OH)_2 + 2HF \rightarrow SnF_2 + 2H_2O$

Properties

1. it is a white crystalline powder having salty taste.
2. It is soluble in water.
3. Insoluble in alcohol and organic solvents.
4. Aqueous solution of stannous fluoride decomposes rapidly because of its oxidation from stannous to stannic form causing turbidity.
5. It must be freshly made.

Use:

To prevent dental caries.

Assay

Iodimetry method weighed amount is dissolved in hot recently boiled dilute hydrochloric acid. The flask is cooled, potassium iodide is added, then it is titrated with potassium iodide using starch as an indicator.

Dentrifice is a material used for cleaning of teeth and adjacent gums.

CALCIUM CARBONATE

Calcium carbonate is a fine powder used as dentrifices in tooth powders and in toothpastes. For other details please refer antacids.

SODIUM METAPHOSPHATE

It is the sodium salt of polymeta phosphoric acid.

M.F. ($NaPO_3$)

It occurs as a white powder soluble in water. It is used in dentrifices as an abrasive. Also used as an anti-rusting agent (for surgical instruments). Also as a stabilizing, emulsifying and chelating agent in food industry.

DICALCIUM PHOSPHATE

M.F. $Ca\ HPO_4.\ 2H_2O$

Syn : Dibasic calcium phosphate.

Preparation

It is obtained by mixing neutral calcium chloride with disodium hydrogen phosphate solution.

$CaCl_2 + Na_2 HPO_4 \rightarrow CaHPO_4 \downarrow + 2\ NaCl$

The precipitate is filtered, washed and dried.

Properties

1. Very fine powder.
2. Odourless and tasteless.
3. When exposed to air, it effloresces losing waters (forms anhydrous form).

Assay

Complexometric Titration

Weighed amount is dissolved in hydrochloric acid and titrated with EDTA using hydroxy naphthol blue as indicator.

Use:

Externally as a dentrifice, orally as an electrolyte replenisher.

STRONTINUM CHLORIDE

$SrCl_2$. 6 H_2O

Preparation

It is prepared by treating HCl with strontium oxide.

$SrO + 2HCl \rightarrow SrCl_2 + H_2O$

Properties

1. Grayish – white powder.
2. Odourless and tasteless.
3. It is insoluble in water.

Use:

To relieve dental hypersensitivity (reduce the sensitivity of teeth to heat and cold).

ZINC CHLORIDE

M.F. $ZnCl_2$

Preparation

It is prepared by reaction of hydrochloric acid, on zinc oxide or metallic zinc or zinc carbonate.

$Zn + 2\ HCl \rightarrow ZnCl_2 + H_2\uparrow$

Properties

1. White crystalline odourless powder.
2. It is very deliquescent.
3. It is soluble in water, alcohol, acetone and glycerin.
4. It is incompatible with soluble carbonates, phosphates, tannic acid.

Assay:

Complexometric Titration Method

Weighed amount is dissolved in water, and ammonia-ammonium chloride buffer is added, titrated with std EDTA using eriochrome black as an indicator.

Use

1. It act as desensitizing agent in dental remedies.
2. Used as antiseptic lotion for foul – smelling wounds.

INHALANTS

These are the drugs in the vapour form are inhaled or administered through the respiratory system in our body.

OXYGEN

M.F. O_2

Preparation

It occurs free in air up to 21%.

Preparation: By two methods

1. Fractional distillation of liquified air yields oxygen at - 183°C (90°K).
2. Electrolysis of slightly alkaline water (pure water is bad conductor of electricity).

$$2H_2O \rightarrow 2H_2 + O_2$$

Properties

1. Colourless, odourless and tasteless gas.
2. It supports combustion but is not inflammable.
3. When mixed with equal volumes of nitric oxide, red fumes of nitrogen dioxide is formed.

   $$2NO + O_2 \rightarrow 2NO_2$$

4. It is soluble 1 in 32 parts by volume of water.

Assay:

Assay is based on its complete absorption by alkaline pyrogallol solution using specific apparatus for determination of medicinal gases.

Storage

Oxygen is usually stored in metal cylinders under compression, should be painted black. The shoulders of the cylinder should be painted white. The name of the gas or the symbol "O_2" properly stenciled on it. The cylinders are recommended to be stored in cool room free from other inflammable materials.

Uses

1. as inhalant for supporting respiration during anaesthesia or post operative conditions.
2. inhalant for poisoning due to other gases.
3. Diluent for volatile and gaseous anaesthetics.

CARBON DIOXIDE

M.F. CO_2

Syn : Carbonic acid gas, carbonic anhydride.

Preparation

It is obtained from calcium carbonate (lime stone) either by direct strong heating or by treatment with dilute mineral acids.

$$CaCO_3 \longrightarrow CaO + CO_2 \ (g)$$

$$CaCO_3 + 2HCl \xrightarrow[Heat]{} CaCl_2 + H_2O + CO_2 \ (g)$$

Commercial Method

Large quantities of the gas are obtained as by – products of fermentation industries or fertilizer factories.

Properties

1. Colourless, odourless gas.
2. Does not support combustion.
3. It is heavies than air, soluble in water.
4. The solution is slightly acidic due to the formation of carbonic acid.

   $CO_2 + H_2O \rightarrow H_2CO_3$
5. It can be liquified under compression.
6. It can be solidified called as dry ice.
7. It extinguishes fire.

Storage

It is stored in metal cylinders painted qrey. The name of the gas or the formula CO_2 should be stenciled on the shoulder of the cylinder.

Assay

Assay is based on its absorption by 50% KOH solution. The un absorbed gas is measured.

Uses

1. It is essential for regulating acid base balance in the body.
2. Respiratory stimulant.
3. To give relief in hick-up.
4. For rapid excretion of inhalation anaesthetics.
5. Liquid orals treated with CO_2 gas are used to mask the taste.
6. It can also be used as an inert gas in the containers containing easily oxidization substances.

NITROUS OXIDE

M.F. N_2O

Syn : Laughing gas

Preparation

1. It is obtained by heating ammonium nitrate to about 170°C.

   $NH_4NO_{3\,(S)} \rightarrow N_2O_{(g)} + 2H_2O$

2. It can also be prepared by heating a mixture of sodium nitrate and ammonium sulphate.

   $2NaNO_3 + (NH_4)SO_4 \rightarrow Na_2SO_4 + 2N_2O + 4H_2O$

Properties

1. Colourless, odourless and tasteless gas.
2. Soluble in water, alcohol, chloroform ether and in oils.
3. It supports combustion.
4. It is not absorbed by alkaline pyrogallol solution (differ from oxygen).
5. It is heavier than air and can be compressed to a liquid.

Assay

It is assayed by determining uncondensible gas in a particular apparatus (gaseometric set up) using liquid nitrogen for condensation of N_2O. The uncondensible part should not exceed 5% V/V.

Use

Used as general anaesthetic along with oxygen (20 to 50%) indental practice.

RESPIRATORY STIMULANTS

These are drugs used to increase the activities of various functions of the CNS, mainly to stimulate respiration.

Ammonium Carbonate N.F.

It contains variable proportion of ammonium bicarbonate and ammonium carbonate.

Preparation

1. Ammonium carbonate is manufactured by subliming a mixture of ammonium sulphae and calcium carbonate.

   $2(NH_4)_2\ SO_4 + 2CaCO_3 \rightarrow NH_4\ HCO_3 + NH_2\ COONH_4$

   (Ammonium carbonate)

2. It is also prepared by the reaction of CO_2 and ammonia in presence of stream.

   $3NH_3 + 2CO_2 + H_2O + NH_4HCO_3 + NH_2\ COONH_4$

Properties

1. White powder, alkaline to litmus.
2. Soluble in water.
3. On exposure to air, it decomposes into ammonia and carbon dioxide.

Assay: Back Titration Method

Weighed amount is dissolved in excess of sulphuric acid. Excess of sulphuric acid is back titrated with standard sodium hydroxide using methyl orange as indicator.

Storage

It should be stored in air tight container.

Use: As expectorant

EXPECTORANTS AND EMETICS

These are drugs, eliminate the secretions of respiratory tract by inducing cough.

Ammonium Chloride

M.F. NH_4Cl

Preparation

It is prepared by neutralizing hydrochloric acid with ammonium hydroxide.

Properties

1. White crystalline, odourless powder with saline taste.
2. It is hygroscopic.
3. Freely soluble in water.

Assay

Weighed amount is dissolved in water and treated with pre-neutralised formaldelyde solution. The ammonium chloride is decomposed to methyleneimine and an equivalent amount of hydrochloric acid. The liberated acid is titrated with standard NaOH using phenolphthalein indicator.

Use:

1. Expectorant
2. Diuretic
3. Systemic acidifier

POTASSIUM IODIDE

M.F.: KI

Preparation

It is prepared by the action of potassium hydroxide on iodine, potassium. Iodate is converted to Iodide.

$$6\ KOH + 3I_2 \rightarrow KIO_3 + 5KI + 3H_2O$$

$$KIO_3 + 3C \rightarrow KI + 3CO$$

Properties

Colourless, crystalline or white powder.

Odourless with slight bitter taste, soluble in water, glycerin and in alcohol. On standing becomes yellow particularly exposed to light due to the liberation of free iodine.

Assay

It is assayed by titration with potassium iodate. It is dissolved in water, conc. HCl is added into it and is then titrated with a standard potassium Iodate solution.

$$KIO_3 + 5KI + 6\ HCl \rightarrow 6\ KCl + 3I_2 + 3H_2O$$

$KIO_3 + 2I_2 + 6\ HCl \rightarrow \quad KCl + 5I\ Cl + 3H_2O$

Use

1. For thyroid deficiency
2. Expect or ant

Emetics

Emetics are drugs used to produce vomiting.

ANTIMONY POTASSIUM TARTRATE

M.F. $C_4H_4KO_7\ Sb$

Syn : Taster emetic

Preparation

It is prepared by mixing antimony trioxide with potassium acid tartrate. It is then boiled for few mts. Then the liquid is filtered and dried.

$2\ KHC_4H_4O_6 + Sb_2O_3 \rightarrow 2K\ (SbO)\ C_4H_4O_6 + H_2O$

Properties

1. Colourless, odourless crystals having sweet taste.
2. It is soluble in water but insoluble in alcohol.
3. On exposure to air, crystals effloresces.

Assay: Iodometric Method

Weighed amount is dissolved in water, small amount (about 2g) of sodium bicarbonate is added. Then it is titrated with iodine using starch mucilage as indicator.

$2\ C_4H_4O_7\ Sb\ K + 3H_2O + I_2 \rightarrow 2k\ H\ C_4H_4O_6 + Sb_2\ O_5 + 4\ HI$

Storage

It is stored in air tight container.

Use

1. to treat schistosomiosis.
2. It is acting as an emetic.

ANTIDOTES

These are drugs or remedies which neutralize the poison or converting them to non-toxic.

Sodium Nitrite ($NaNO_2$)

Refer under Antioxidants.

MAJOR INTRA AND EXTRA CELLULAR ELECTROLYTES

The body fluids are solutions of inorganic and organic solutes. The concentration balances of the various components are maintained in order for the cells and tissues to have a constant environment. To maintain the electrolyte balance, there are regulatory mechanisms which controls pH, ionic balances, osmotic balances, etc.

Electrolytes used in replacement therapy

The electrolytic concentration will vary with a particular fluid compartment.

1. Intracelluar fluid – (45 – 50% of body weight and present with in the cell).
2. Extracellular fluid – (12 – 15% of body weight and present outside the cell).
    a. Interstitial fluid – (12 – 15% of body weight and
    b. Plasma or vascular fluid (4 – 5% of body weight)

The electrolytes are necessary for maintaining osmotic pressure and electro neutrality (equal number of cations and anions). The electrolytes also essential to transmit impulses.

In case of loss of electrolytes in the body due to water imbalance like diarrhoea, vomiting, excessive use of diuretics etc. the above functions of electrolytes will be affected. During this condition, the patient should be given with suitable electrolyte in the form of injection or oral solutions to maintain the normal level of electrolyte.

The electrolytes used for replacement therapy

1. Sodium chloride
2. Potassium chloride
3. Calcium chloride
4. Calcium gluconate
5. Potassium gluconate
6. Calcium lactate
7. Dibasic calcium phosphate
8. Tribasic calcium phosphate
9. Magnesium sulfate.

SODIUM CHLORIDE (NaCl)

Preparation

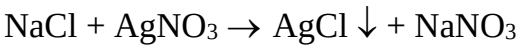
It can be prepared from sea-water, under ground rock-salt deposits and by chemical means. Sea water contains about 3% of sodium chloride. Purest form of analytical grade sodium chloride is prepared by passing hydrogen chloride gas into a standard solution of the salt. Very pure sodium chloride precipitates out. The crystals are then centrifuged and dried.

Physical Properties

It occurs in the form of colourless, transparent cubical crystals, or as a white crystalline powder. It is odourless and slight saline test. It is slightly hygroscopic due to the presence of small amount of magnesium or calcium chloride. It is freely soluble in water and slightly soluble in alcohol.

Chemical Properties

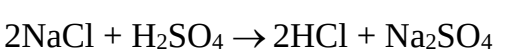
1. Sodium chloride gives white precipitate of silver chloride with solution of silver nitrate.



$$NaCl + AgNO_3 \rightarrow AgCl \downarrow + NaNO_3$$

The precipitate is light sensitive (affected by light) and it is soluble in dilute ammonia and in soluble in nitric acid.

2. It reacts with sulphuric acid or phosphoric acid to give hydrochloric acid.



$$2NaCl + H_2SO_4 \rightarrow 2HCl + Na_2SO_4$$

3. Sodium chloride is easily oxidized to liberate free chlorine.

Heating with Manganese dioxide and concentrated sulphuric acid produces chlorine.

$$2NaCl + MnO_2 + 2H_2SO_4 \rightarrow MnSO_4 + Na_2SO_4 + 2H_2O + Cl_2 \uparrow$$

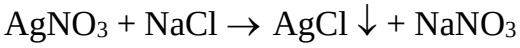
Oxidation of solution of sodium chloride is used to prepare sodium hydroxide and chlorine.

Assay :

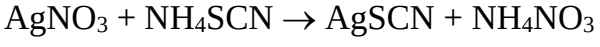
Modified Volhard's Method :

An accurately weighed quantity is dissolved in water and a known excess of N / 10 silver nitrate solution, concentrated nitric acid and nitrobenzene are added. It is titrated against N/10 ammonium thiocyanate solution using cerric ammonium sulphate as indicator.

Sodium chloride is precipitated as silver chloride by the addition of silver nitrate. Nitrobenzene is added to coagulate the silver chloride so that it will not interfere with the titration of the excess of silver nitrate with N/10 ammonium thiocyanate, since silver chloride reacts slowly with ammonium thiocyante.



$$AgNO_3 + NaCl \rightarrow AgCl \downarrow + NaNO_3$$



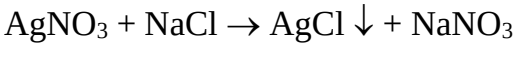
$$AgNO_3 + NH_4SCN \rightarrow AgSCN + NH_4NO_3$$

Storage

It should be stored in a well closed container.

Chemical Incompatibility

When sodium chloride is treated with soluble salt of silver, mercurous or lead, the corresponding metallic chloride is precipitated.



$$AgNO_3 + NaCl \rightarrow AgCl \downarrow + NaNO_3$$

Uses

It produces effect of both chloride ion and sodium ion. Deficiency of sodium chloride leads to "salt Hunger" as indicated by metabolic disturbances etc.

1. It is used as fluid and electrolyte replenisher.
2. It maintains normal osmotic pressure of blood.
3. It is used as saline diuretics.
4. It is used in the formulations of I.V. fluids to maintain the iso-osmotic with blood serum.

Official Preparations of Sodium Chloride

1. Sodium chloride injection, U.S.P.

   Contains 0.9% NaCl.

   Use : Fluid and Electrolyte replenisher, irrigation solution.

   Dose : I.V. infusion 1 Litre.

2. Bacteriostatic sodium chloride injection, U.S.P

   Contains 0.9% NaCl.

   Use : Sterile vehicle

3. Sodium chloride solution, U.S. P

   Contains 0.9% NaCl.

   Use : Isotonic vehicle.

4. Sodium chloride tablets, U.S.P

   Usually 600mg, 1 and 2.25 g tablets are available.

   Use : Electrolyte replenisher.

5. Dextrose and sodium chloride injection U.S.P.

   Available in different strengths and different volumes.

% Dextrose	% NaCl	m. eq/lit	Available volume (ml)
5	0.11	18.8	250, 500 & 1000
5	0.20	34.2	250, 500 & 1000
5	0.225	38.5	250, 500 & 1000

Use : Fluid, nutrient & electrolyte replenisher.

6. Sodium chloride and dextrose tablets N.F.

   Usually 200 mg of sodium chloride and 450 mg of dextrose tablets are available.

7. Mannitol and sodium chloride injection, USP

   Different strengths and different volume are available.

% Mannitol	% NaCl	m. Eq/lit	Available volume (ml)
5	0.3	51.3	500 & 1000
10	0.3	51.3	500 & 1000
15	0.45	76.9	150 & 500
20	0.45	76.9	250 & 500

POTASSIUM CHLORIDE (KCl)

Preparation

It may be obtained by separation and purification from its minerals like carnalite (KCl, $MgCl_2$. $6H_2O$). On laboratory scale it may be prepared by reacting potassium carbonate and hydrochloric acid.

$$K_2CO_3 + 2HCl \rightarrow 2KCl + H_2O + CO_2$$

Physical Properties

It occurs as colourless elongated, or cubical crystals, or as a white granular powder. It is odourless, has a saline taste. It is freely soluble in water, that is neutral to litmus. It is insoluble in alcohol.

Chemical Properties

Potassium chloride reacts with silver nitrate to give silver chloride as precipitate and potassium nitrate. This property is used to estimate the amount of potassium chloride in the pharmaceutical preparations.

Assay

A weighed quantity of substance is dissolved in water and titrated against standardized silver nitrate using potassium chromate as indicator. The end point is formation of brick red colour.

$$AgNO_3 + KCl \rightarrow AgCl\downarrow + KNO_3$$

Uses

1. Potassium chloride is used as an electrolyte replenisher, along with sodium chloride and calcium chloride.
2. It is administered orally as solution, elixer or tablets in the case of potassium deficiency.
3. It is also used in the digitalis poisoning

Official preparations of potassium chloride

1. Potassium chloride injection, BP, USP

Available as 1.5g in 10 ml

3 g in 12.5 ml & 20 ml

4.5 & 6g in 30 ml

2. Potassium chloride tablets, USP

Available as enteric-coated tablets containing 300 mg or 1g.

3. Ringers injection, USP

Contains 0.03% KCl

Use : Fluid and electrolyte replenisher

Usual dose : Intravenous infusion, 1 litre

4. Lactated Ringer's Injection USP

Contains 0.03% KCl.

Use : Systemic alkaliserdose : 1.V. 1 litre

18. PHYSIOLOGICAL ACID – BASE BALANCE

Acids are produced during metabolism, since most metablic reactions occurs only with in a very narrow pH range (7.35 – 7.42). The body utilizes several efficient buffer systems.

Three of the major buffer systems.

1. Bicarbonate / carbonic acid (HCO_3^- / H_2CO_3) found in plasma and kidneys.
2. Mono Hydrogen Phosphate and Dihydrogen Phosphate (HPO_4^{2-}/ $H_2PO_4^-$) found in cells and kidneys.
3. Red blood cells in the Haemoglobin (Hb) buffer system.

Therefore it is necessary to maintain the pH of the system respectively. If there is any change in pH due to the diseased condition or physiological change, we must provide official Acid-or base to balance the required pH.

Electrolytes used in Acid-base-balance

Metabolic acidosis is treated with sodium salt of bicarbonate, lactate, acetate and rarely citrate. Administration of bicarbonate increases the HCO_3^- / H_2CO_3 ratio when there is a bicarbonate deficit. Lactate, acetate and citrate ions are normal components of metabolism and will be degrade to carbon dioxide and water by the tricarboxylic acid cycle.

Metabolic acidosis has been treated with ammonium salt. Its action is in the kidneys where it prevents the Na^+ - H^+ exchange.

Official compounds used in Acid-base therapy.

1. Sodium acetate, N.F.

2. Potassium acetate N.F.
3. Sodium bicarbonate USP
4. Sodium Citrate, USP
5. Potassium Citrate, NF
6. Sodium Lactate Injection USP
7. Ammonium Chloride USP.

ELECTROLYTES USED TO BALANCE PHYSIOLOGICAL ACIDS AND BASES

SODIUM ACETATE (CH_3 COO Na, $3H_2O$)

Preparation

It is prepared by neutralization of acetic acid with sodium carbonate, (or) sodium hydroxide.

$2CH_3COOH + Na_2CO_3 \rightarrow 2CH_3COONa + CO_2 + H_2O$

$CH_3COOH + NaOH \rightarrow CH_3 COONa + H_2O$

Physical Properties

It occurs as colourles, transparent crystals, as granular crystalline powder or as white flakes. It is odourless or has a faint, acetous odour. It is efflorescent in warm dry air. It is very soluble in water and is soluble in alcohol.

Buffer Mechanism

It is metabolized to carbon dioxide and then to bicarbonate, can be used as an effective buffer in metabolic acidosis.

$$CH_3COO\ Na \xrightarrow[\text{Metabolized}]{(O)} HCO_3^-$$

When acid is added, the pH does not change much because H^+ ion of acid, is captured by bicarbonate ion and to form carbon dioxide and water.

$$HCO_3^- + H^+ \longrightarrow H_2O + CO_2 \uparrow$$

Chemical Properties (from acid)

1. It converts in to sodium carbonate when it is ignited.

   $2CH_3COONa.\ 3H_2O + 4O_2 \rightarrow Na_2CO_3 + 6H_2O + 3CO_2\uparrow$

2. It gives deep red colour with ferric chloride due to the formation of ferric acetate.

   $FeCl_3 + 3CH_3\ COONa \rightleftharpoons (CH_3COO)_3\ Fe + 3\ NaCl.$

3. It is oxidized to sodium bicarbonate.

   $$CH_3COONa \xrightarrow{4(O)} NaHCO_3 + H_2O + CO_2\uparrow$$

Assay: Non-Aqueous Titration

During the assay no water should be contacted. Accurately weighed quantity is dissolved in glacial acetic acid; a small amount of acetic anhydride is added and allowed

to stand for half an hour. It is titrated against standard perchloric acid using 1-naphthol benzein solution as indicator. The end point is change of colour from blue to dark green.

$$CH_3COONa + HClO_4 \rightarrow NaClO_4$$

Perchloric acid — Sodium Perchlorate

Storage

It should be stored in well closed container.

Dose: 1.5 g

Uses: 1. Acidic urine is corrected by infusion of sodium acetate.

2. Used as antacid

POTASSIUM ACETATE (CH_3COOK)

Preparation

Potassium acetate is prepared by neutralization of potassium carbonate or potassium bicarbonate by an acetic acid.

$$2CH_3COOH + K_2CO_3 \rightarrow 2CH_3COOK + CO_2 + H_2O$$

$$CH_3COOH + KHCO_3 \rightarrow CH_3COOK + CO_2 + H_2O$$

Physical Properties

It occurs as colourless, mono clinic crystals, or as white crystalline powder. It has saline and slightly alkaline taste. It is deliquescent on exposure to moist air.

It is very soluble in water and is freely soluble in alcohol.

Chemical Properties

On heating with high temperature, it decomposes in to potassium carbonate, carbon dioxide and water.

$$2CH_3COOK + 4O_2 \xrightarrow{\Delta} K_2CO_3 + 3H_2O + 3CO_2 \uparrow$$

Incompatibility: It is incompatible with acids, silver, mercury and iron salts.

Assays

An accurately weigh the potassium acetate and heat until it carbonizes and produces potassium carbonate. Dissolve the residue in excess of standard sulphuric acid. Some amount of acid neutralizes the potassium carbonate and back titrate remaining unreacted acid with standard sodium hydroxide using methyl orange indicator until the colour changes from pink to straw yellow.

$$2CH_3COOK + 4O_2 \rightarrow K_2CO_3 + 3H_2O + 3CO_2 \uparrow$$

$$K_2CO_3 + H_2SO_4 \rightarrow K_2SO_4 + CO_2 + H_2O$$

Storage

It should be stored in air tight container since the potassium acetate salt is deliquescent.

Use:

1. It is used as alkaliser.
2. Haemodialysis and peritoneal dialysis.
3. Used in potassium deficiency.

SODIUM BICARBONATE INJECTION

It is official in 1P 1966 and USP XVIII sodium bicarbonate injection USP XVIII is a sterile solution available in different strengths and volumes. For intravenous infusion, 500 ml of a 1.4% w/v solution is available. It is also available as 1% in 20 ml; 5% in 500 ml; 1.4% in 500 ml, 7.5% in 50 ml; and 8.4% in 30ml.

Sodium bicarbonate injection 1P 1966 is a sterile solution of 1.4% w/v of sodium bicarbonate in water for injection.

Uses

1. Drug of choice for systemic acidosis.
2. Used in the treatment of methyl alcohol poisoning.

SODIUM CITRATE

This is prepared by mixing hot solution of citric acid and sodium carbonate in the calculated proportions and crystallizing the product.

$$2\ \begin{matrix} CH_2-COOH \\ | \\ CH_2(OH)COOH \\ | \\ CH_2-COOH \end{matrix} + 3\ Na_2CO_3 \rightarrow 2\ \begin{matrix} CH_2-COONa \\ | \\ CH(OH)-COONa \\ | \\ CH_2\ COONa \end{matrix} + 3\ CO_2 + 3H_2O$$

Physical Properties

It occurs as colourless crystals, or as white crystalline powder. It may be either anhydrous or contain, two moles of water of hydration. It is freely soluble in water and very soluble in boiling water, it is insoluble in alcohol. The salt should be neutral to phenolphthalein.

Chemical Properties

On heating it is decomposes to sodium carbonate carbon dioxide and water.

$$2\ \begin{matrix} CH_2-COONa \\ | \\ CH(OH)-COONa \\ | \\ CH_2-COONa \end{matrix} \rightarrow 3Na_2CO_3 + 3CO_2 + 3H_2O$$

Assay

A weighed quantity of substance is heated to get charred residue. Dissolve and heat the residue in water and measured volume of hydrochloric acid, filter the residue, excess of acid in the combined filtrate is treated with standard sodium hydroxide using methyl orange as indicator.

$$\begin{array}{l} CH_2COONa \\ | \\ CH\ (OH)\ COONa.\ 2H_2O \rightarrow\ 3Na_2CO_3 + 3CO_2 + 3H_2O \\ | \\ CH_2\ COONa \end{array}$$

3 Na_2CO_3 is equivalent to 6 HCl.

Uses

1. Used as an anticoagulant for whole blood.
2. Used for chelation of cations. (e.g.) Ferrous ions.
3. Used as buffering agent.
4. Systemic alkaliser.

POTASSIUM CITRATE

Preparation

This is prepared in a similar way to sodium citrate from potassium carbonate and citric acid.

$$\begin{array}{lcl} CH_2-COOH & & CH_2-COOK \\ | & & | \\ CH\ (OH)COOH\ + 3\ K_2CO_3 \rightarrow & & 2\ CH(OH).\ COOK + 3CO_2 + 3H_2O \\ | & & | \\ CH_2-COOH & & CH_2\text{-}\ COOK \end{array}$$

Physical Properties

It occurs as transparent crystals or as a white granular powder, it is odourless, has a cooling saline taste and is deliquescent when exposed to moist air. It is freely soluble in water and almost insoluble in alcohol.

Incompatibility

It is incompatible with calcium and strontium salts.

Assay

Ignition and titration of the alkaline residue, as described under sodium citrate.

$$\begin{array}{l} CH_2\ COOK \\ | \\ 2\ \ CH\ (OH).\ COOK,\ H_2O \rightarrow\ 3K_2CO_3 \\ | \\ CH_2\ COOK \end{array}$$

Uses

1. Used as systemic alkaliser
2. Expectonent

SODIUM LACTATE INJECTION

Sodium lactate injection USP is a sterile solution of lactic acid in water for injection which has been neutralized with sodium hydroxide. It must be between pH 6.0 and 7.3. It is available as 1/6 molar solution in 1, 50, 250 and 1000-ml containers as fluid and electrolyte replenisher used in the treatment of metabolic acidosis.

Sodium lactate injection BP is administered by intravenous route and it is a sterile solution containing 1.85% w/v of sodium lactate in water for injection. It may be prepared from sodium lactate solution or from lactic acid. Content of sodium lactate, $C_3H_5NaO_3$ 1.75 to 1.95% w/v.

The label states that

1. Solution containing visible particles should not be used.
2. The intravenous infusion is one sixth molar and contains, in one litre, approximately 167 millimoles of sodium ions and bicarbonate ions (as lactate).

Uses

1. Fluid and electrolyte replenisher.
2. For the treatment of metabolic acidosis.

AMMONIUM CHLORIDE (NH_4Cl)

Preparation

It is easily prepared by neutralizing hydrochloric acid with ammonia solution and evaporating the solution to dryness. Unreacted excess of either ammonia or hydrogen chloride will voltalize.

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

It can be purified by crystallization or by sublimation.

Physical Properties

It occurs as colourless crystals or as a white fine or coarse crystalline powder which has a cool saline taste and is some what hygroscopic. It is freely soluble in water and in glycerin and even more soluble in boiling water it is sparingly soluble in alcohol.

Chemical Properties

Ammonium chloride volatilizes on heating and the vapour dissociates into ammonia and hydrogen chloride.

$$NH_4Cl \underset{\Delta}{\rightleftharpoons} HCl + NH_3$$

Assay

An accurately weighed amount of the ammonium chloride is dissolved in water and treated with formaldehyde solution. So that entire ammonium chloride liberates equivalent amount of hydrogen chloride, which is then titrated with standard sodium hydroxide solution.

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

$4NH_4OH + 6\ HCHO \rightarrow C_6H_{12}N_4 + 10H_2O$

Hexamine

$HCl + NaOH \rightarrow NaCl + H_2O$

Previously it was assayed by Volhard's method as described under sodium chloride.

Uses :

1. It is used as expectorent in cough mixture.
2. It is also used as a substitute for sodium chloride as an electrolyte replanisher.
3. Used as systemic acidifier.

AMMONIUM CHLORIDE INJECTION

Ammonium chloride injection USP is a sterile solution of ammonium chloride in water for injection. It contains not less than 95% and not more than 105% of labeled amount of NH_4Cl, Hydrochloric acid is added to adjust the pH.

Storage

Preserve in single dose – or in multi dose containers, preferably of Type I or Type II glass.

COMBINATION OF ORAL ELECTROLYTE POWDERS AND SOLUTIONS

(FOR INJECTION)

These combination products can be divided into two groups: 1) Fluid maintenance and 2) Electrolyte replacement. Maintenance therapy with intravenous fluids is intended to supply normal requirements of water and electrolytes to patients who can not take them orally. All maintenance solutions must contain at least 5% dextrose.

Replacement therapy is needed when there is heavy loss of water and electrolytes as in prolonged fever, severe vomiting and diarrhoea. Usually there are two types of solutions used in replacement therapy : a solution for rapid initial replacement and a solution for subsequent replacement.

Official combination of electrolyte infusions.

Ringer's Injection, U.S.P.

Sodium Chloride 8.6 g

Potassium chloride 0.3 g

Calcium chloride (as dihydrate) 0.33 g

Water for injection q.s. to 1000 ml

It is usually available in 500 ml and 1000 ml injections.

Lactated Ringer's Injection, USP

Sodium chloride	-	600 mg
Sodium lactate	-	600 mg
Sodium lactate	-	310 mg
Potassium chloride	-	30 mg
Calcium chloride (as dihydrate)	-	20mg

Water for injection q.s. to 100 ml

It is usually available as 150, 250, 500 and 1000 ml injections.

Oral Rehydration Salts I.P.

Oral rehydration salts are dry, homogeneously mixed powder containing dextrose, sodium chloride, potassium chloride and either sodium bicarbonate or sodium citrate for use in oral rehydration therapy after being dissolved in requisite amount of water.

Oral rehydration salts-A (ORS-A) commonly used in India for treatment of non-choleraic diarrhoea oral-rehydration salts-citrates (ORS-citrate) recommended by the Diarrhoeal disease control programme of the World Health Organization (WHO) and the United Nations Children's Funds (UNICEF), in amounts to be dissolved in the stated amounts of water.

The composition of the two formulations are described below in terms of the amounting, to be dissolved in sufficient water to produce 1000 ml.

	Formula g / litre	
	ORS-A	**ORS-Citrate**
Sodium Chloride	1.25	3.5
Potassium Chloride	1.5	1.5
Sodium citrate	2.9	2.9
Anhydrous Dextrose	27.0	20.0
Dextrose Monohydrate	29.7	22.0

INORGANIC OFFICIAL COMPOUNDS OF IRON, IODINE AND CALCIUM:

FERROUS SULPHATE AND CALCIUM GLUCONATE.

Official Compounds

Official compounds are the drugs or a dosage forms of a drug for which a monograph (systematic informations) is given in the pharmacopoeia published by the respective governments. (In India-Indian Pharmacopoeia).

Official Compounds of Iron

1. Ferrous fumarate I.P.
2. Ferrous gluconate I.P.
3. Ferrous Sulphate I.P.
4. Dried Ferrous Sulphate I.P.
5. Iron and Ammonium Citrate I.P.
6. Iron Dextran Injection, U.S.P.

7. Iron Sorbitex Injection, USP.

Ferrous Sulphate (Fe SO_4. $7H_2O$)

Preparation

It is prepared by dissolving a slight excess of scrap iron in dilute sulphuric acid and concentrating to get green crystals of ferrous sulphate

$$Fe + H_2So_4 \rightarrow FeSO_4 + H_2 \uparrow$$

Physical Properties

This is crystalline ferrous sulphate containing seven molecules of water of hydration. It occurs in the form of transparent, green crystals or as a pale bluish – green crystalline powder. It is odourless and has a metallic, astringent taste. It effloresces in dry air. When exposed to moist air, it is slowly oxidized and is coated with a brown, basic ferric sulphate. When this takes place, the sample should not be used.

Solubility

It is soluble in water and practically in soluble in alcohol.

Chemical Properties

Ferrous sulphates combine with alkali sulphates to form double salts. One such products is ferrous ammonium sulphate, $FeSO_4$ $(NH_4)_2$ $SO_4.6H_2O$, it is used in analytical chemistry.

Assay

An accurately weighed quantity is dissolved in dilute sulphuric acid and titrated against N/10 ceric ammonium sulphate using ferroin sulphate as indicator.

Ferrous sulphate is reducing agent, which is oxidized to ferric sulphate by the ceric ammonium sulphate. The indicator ferroin sulphate solution is ortho-phenanthroline ferrous complex. The end point is the appearance of a light blue colour.

Storage

Stored in a well-closed container.

Use

1. Haematinic
2. Used for Anaemia due to iron deficiency.

Official Compounds of Calcium

1. Calcium amino salicylate
2. Calcium carbonate
3. Calcium chloride
4. Calcium gluconate
5. Calcium hydroxide
6. Calcium lactate
7. Calcium levulinate
8. Calcium pantothenate
9. Dibasic Calcium Phosphate
10. Tribasic calcium phosphate

Calcium gluconate $(OHCH_2\ [CHOH]_4\ COO)_2\ Ca.\ H_2O$

Physical Properties

It occurs as a white, crystalline or granular powder. It is tasteless and odourless it is stable in air. It loses its water of crystallization with decomposition above 100°C. It is soluble in 1 in 30 in cold water and 1 in 50 in boiling water and insoluble in ethyl alcohol, chloroform and solvent ether.

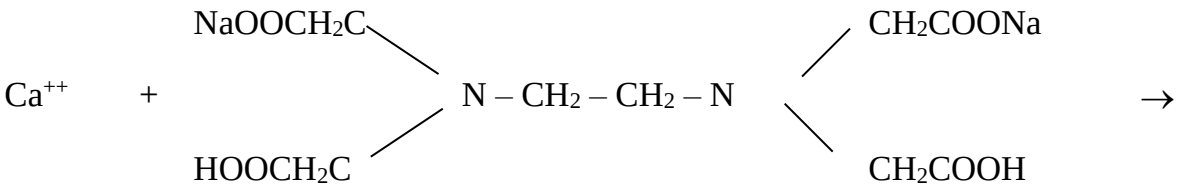
Chemical Properties

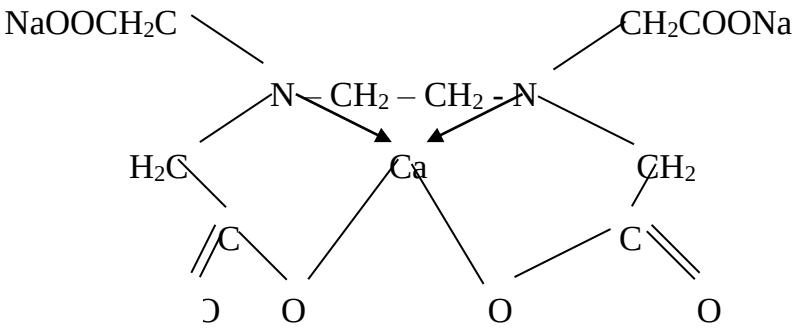
To the aqueous solution of calcium gloconate, ferric chloride solution is added, A yellow colour is produced.

Assay

This is a complexometric assay. A known quantity is dissolved in warm water and a definite quantity of 0.05 M magnesium sulphate solution and strong Ammonia – Ammonium chloride solution are added. The mixture is titrated against M/20 disodium ethylene diamine tetra acetate (EDTA) using Moderant black mixture as indicator. The end point is change of colour from red to blue. A blank determination should be done omitting the sample.

The buffer of strong ammonia-ammonium chloride solution is added to raise and maintain the pH at 10, because at this pH only complexation takes place. The magnesium salts are added to get sharp end point.





Storage :

Store in a well closed container.

Use

1. Used as electrolyte replenisher
2. It is administered in the form of tablets or injections incase of calcium deficiency.

Official compounds of Iodine

1. Iodine I.P.
2. Potassium Iodide I.P.
3. Sodium Iodide I.P.
4. Sodium Iodide I 125 USP
5. Sodium Iodide I 131 USP.

RADIO PHARMACEUTICALS AND CONTRAST MEDIA

Atomic Structure:

All the matters are made up of atoms. Bonding of atoms of same or different elements forms the molecule. An atom consist of nucleus and electrons revolving around the nucleus in different orbitals. The electrons have negative charge. The nucleus contains positively charged protons and neutral neutrons. The protons and neutrons have definite mass. An atom consist of an equal number of protons and electrons, then the atom is electrically neutral, for that atom the total electrical charge is zero.

Atomic Number:

Number of protons (Z) which is equal to the number of electrons in a neutral atom.

Mass Number (A):

Total number of protons (Z) and neutrons (N).

$\therefore$ Mass number (A) = Z + N

To represent an atom with all the above details it is written as below:

$^{A}_{Z}X$ where, X = Symbol of element
A = Mass number
Z = Atomic number

Examples: $^{12}_{6}C$ $^{59}_{27}CO$ $^{7}_{3}Li$ $^{14}_{7}N$

Isotopes

Atoms having the same atomic number but different mass numbers.

Examples: $^{12}_{6}C$ $^{13}_{6}C$; $^{16}_{8}O$ $^{17}_{8}O$ $^{18}_{8}O$; $^{54}_{26}Fe$ and $^{56}_{26}Fe$

Ferrous 54 and Ferrous 56 both have the same atomic number of 26, but the mass number is different 54 and 56. This is due to the difference in the number of neutrons.

^{54}Fe contains (54-26) 28 neutrons

^{56}Fe contains (56-26) 26 neutrons.

Therefore, ^{56}Fe is isotope of ^{54}Fe.

Isobars:

Atoms having the same mass number but different atomic number are called isobars.

Examples: $^{197}_{80}Hg$ $^{197}_{79}Au$; $^{60}_{27}Co$ $^{60}_{28}Ni$

Radio Activity:

Some elements are able to emit certain invisible rays which affect a photographic plate in the dark. These rays are also able to penetrate solid matter, ionise gases and produce luminescence in substance like zinc sulphate and barium salts. Such substances are called radio-active and the property is called radio-activity. Naturally, radio-active elements are uranium, radium, thorium etc.

A nucleus of an atom having same number of neutrons and protons are stable that is neutron to proton ratio is 1:1 and these atoms does not emit any type of radiation. A nucleus in which the number of neutron is different than the number of protons that is neutron to proton ratio is not equal and these atoms emits radiation. While emitting radiation the parent atom undergoes transformation and produces another daughter atom, and emitted radiation may be alpha rays (α-particle) Beeta rays (β-particles) and gamma radiation.

The Properties of radiations

Radiations emitted by atoms are of two types. They are particulate and electromagnetic. The most important particulate radiations are the alpha (α) and beta (β) radiations emitted by disintegrating atoms of radio nuclides.

Alpha Particles (α)

1. The alpha particles are positively charged.
2. When radio active element emits alpha particles the resulting nucleus of the atom will have two positive charges less than the original nucleus. It can be illustrated by the decay of Radium nucleus to give randon nucleus.

$$^{226}_{88}Ra \rightarrow {}^{222}_{86}Rn + {}^{4}_{2}He$$

3. They are very much heavier than β - particles.
4. They have less penetrating power.
5. They have very great ionising powers (high specific ionisation).

Beta Particles (β)

1. Beta particles are negatively charged.
2. They are heavier than α - particles.
3. They have more penetrating power than α - particles as it can penetrate tissues.
4. They are relatively less ionizing powers than α - particles.
5. β - particles sometimes referred as negatrons which are emitted by unstable nuclei in which the neutron / proton ratio exceeds the stability limit and in such case neutrons are transformed protons with beta emission.

$$\begin{matrix} 1 & & 1 \\ & N \rightarrow & P + \beta^- \\ 0 & & 1 \end{matrix}$$

Gamma Radiations

1. Gamma radiations are electromagnetic radiation similar to light and X-rays but of higher energy.
2. These radiations do not have any charge and thus are not affected by electric or magnetic field.
3. They are very short wave length resembling X-rays and travel with the velocity of light.
4. They have poor ionizing power and very high penetrating power.
5. They can interact with molecules and atoms in specific media and can produce ions and free radicals.

Biological Effects of Radiations

1. These chemical species can alter the local pH resulting in the production of other toxic compounds.
2. Life period may be shortening if a person is exposed to a smaller dose of radiation.
3. It may cause sterility and it also may induce cancer.
4. These radiations may alter the DNA leading to destruction of tissues or organs.
5. Radiation may cause anaemia and decreases the blood cells.

Measurement of Radioactivity

The different kinds of particles and rays produced during the disintegration of a radioactive material leave number of ions along their paths. These ions are normally detected and measured. Measurement of radioactivity is based on the following properties of radiation.

1. Radiation to cause ionization of gases.
2. Radiation to cause flash of light.
3. Radiation to cause chemical change.

The different devices used to measure the radiations are

1. Ionization chamber
2. Proportional counters
3. The Geiger Muller counter
4. Scintillation counters
5. Semi conductor detectors
6. Photographic plate method

Geiger-Muller Counter

This is the most popular radiation detector because, it does not need a well-stabilized high voltage supply. It is most frequently used for detecting β - particles.

It contains a central wire anode, usually made of tungsten, and a cathode, silver, is coated in the innerside of the cylinder. The space between the electrodes (anode and cathode) contains a gas, which is usually an argon at a pressure of a few mm of mercury. The chamber is filled with argon gas and if the radiation is passed through the mica window of the chamber, the gas is ionized and there is a flow of current each particles of radiation causes a brief flow or pulses of current which is recorded by a device known as scalar which shows the total number of pulses.

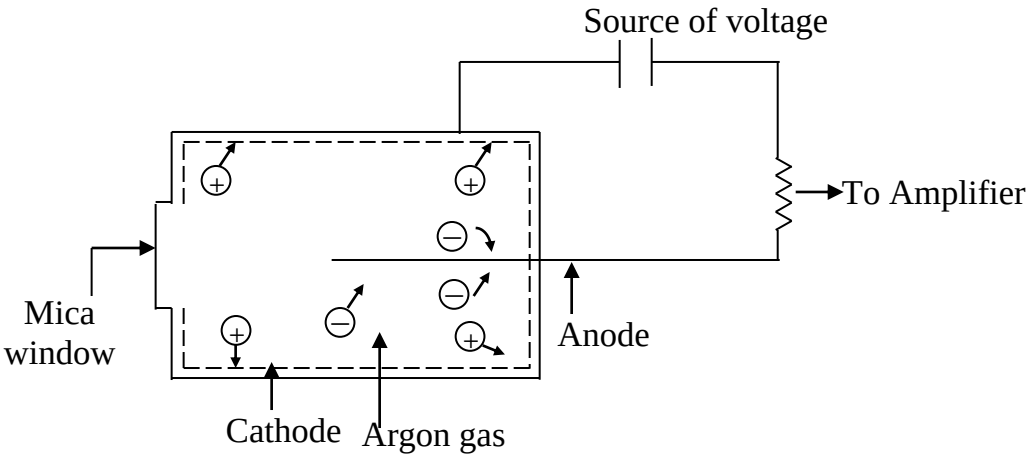


Fig.1. Geiger – Muller Counter

Radio Isotopes

The isotopes which limits radiations are called radio isotopes. There are several radio isotopes have medicinal values.

Biological Half Life ($t_{½}$)

It is defined as the time in which the amount of radio nuclide decays (decomposes) to half of its initial value. It is related to decay constant λ.

$$t\,½ = \frac{0.693}{\lambda}$$

General Storage and Precautions of Radio Active Compounds

1. Great care must be taken in the use and storage of radio active materials.
2. Special shielding is necessary for protecting α, β and γ radiations.
3. For protecting α and β radiations, requires thick glass containers or Perspex containers are necessary.
4. For protection γ radiations requires havier lead shielding or containers are necessary.
5. Areas where radioactive materials are stored or used should be monitored, that is tested for radioactivity regularly.
6. Radioactive materials should never be touched with hand, it should be handled by means of forceps or suitable instruments.
7. Smoking, drinking or eating activities are to be avoided in the laboratory where the radioactive materials are handled.
8. Sufficient protective clothing or shielding must be used while handling the materials.
9. Radioactive materials should be kept in suitable labeled containers and kept preferably in a remote corner.
10. There should be proper disposal of radioactive materials.

Official preparations of Radio Pharmaceuticals and their Applications

Radioisotopes are used in medicines in two different ways. They are 1) sources of radiation in therapy 2) Radioactive tracers are used for diagnostic purposes.

The therapeutic uses of radioisotope depend mainly on their ability to ionize atoms. Radioactive tracers are used to find out the diseased portion of the organ and the parts of the system.

Sodium Chromate (Cr^{51}) Solution
24

It is radioactive chromium^{51} ion in the form of $Na_2Cr^{51}O_4$. It has a half life of 26.5 days. It is used to study red cell mass, volume and its survival time and for scanning the spleen.

Sodium Iodide (I^{131}) Capsules and Solution
54

It is a radioactive isotope of iodine 131 in the form of sodium iodide 131. It emits β and γ rays. It has a biological half life of 8 days. It is used as a diagnostic and therapeutic agent in thyroid conditions and Myxedema. It is also used to determine the plasma volume and simultaneous use with sodium chromate Cr-51 and Ferrous citrate Fe-59 to determine total blood volumes is also possible.

Cobalt 57 and 60

Cyanocobalamin Co 57 capsules and solutions.

Cyano cobalamin Co 60 capsules and solutions.

Biological half life of Co 57 is 270 days and Co 60 is 5.27 years, emitting both beta and gamma radiation. Cobalt 60 is used in therapy where X-rays are used. It is also used for the sterilization of surgical materials and dressings by its gamma radiation. Cobalt 57 is used in the diagnosis of pernicious anaemia.

Sodium Phosphate P 32 Solution

It emits beta radiations, its half life is 14.3 days, it is used in both diagnosis and treatment of various neoplastic diseases. Phosphate is utilized in cell metabolism. Primary diagnostic use of phosphate p-32 is in the localization of intra ocular tumors and cerebral tumors.

Gold Au 198 Injection

It produces both β and γ radiation, its half life is 2.7 days. It is used for therapeutic purpose. It is administered intracavitary injection in to the pleural and peritoneal cavities as an acid in the management of plural effusion and accumulation of serous fluid in the peritoneal cavity.

Sodium Iodide I 125 Solution

It produces both X-rays (K-capture) and γ-rays, its half life is 60 days. It is used in the treatment of Hyper thyroidism.

Calcium (Ca 44 and Ca 45)

Radioactive calcium is used to study bone structure and in the treatment of carcinoma of bone.

Carbon 14 (C 14)

It is most widely used in various studies for eg. in metabolism of carbohydrate and fats, drug excretion, decomposition of pharmaceutical products.

Iron 59, 55 (Fe 59 and Fe 55)

It emits both beta particles and high energy gamma rays. The half life of Iron 59 is 45 days. It is used in research studies about utilization and absorption of iron salts, it is also used to measure red blood cell life span.

Hydrogen (H_2 and H_3)

The deuterium (H^2) and tritium (H^3) are useful to determine total body water.

Sodium (Na 22 and Na 24)

It is used in estimation of extra cellular fluid, blood circulation rate, studies in cell permeability, excretion and distribution of water.

RADIO OPAQUE CONTRAST MEDIA

Radio opaque substances are those compounds (both inorganic and organic) that have the property of casing a shadow on X-ray films. These substances have the ability to stop the passage of X-rays and these are the elements of high atomic numbers.

Inorganic compounds like barium sulphate and some bismuth compounds thus are useful as radio-opaque contrast media for diagnostic uses. A large number of organic iodinated compounds are also used as radio opaque contrast media.

These compounds are useful for examination of gasterointestinal tract, kidney, liver, gallbladder and blood vessels of heart, brancheal tract and that of urethra, vagina etc.

Barium Sulphate ($BaSO_4$)

Preparation

It is prepared by precipitating barium ions from cold dilute solutions of barium salt with dilute sulphuric acid.

$Ba(OH)_2 + H_2SO_4 \rightarrow BaSO_4 \downarrow + 2H_2O$

$BaCl_2 + H_2SO_4 \rightarrow BaSO_4 \downarrow + 2HCl$

Physical Properties

It is a fine, white, odourless, tasteless and bulky powder that is free from grittiness. The salt is insoluble in water, organic solvents, and dilute acids and alkalies it is soluble in concentrated sulphuric acid.

Assay

It is assayed by gravimetrically. First step involves conversion of barium sulphate into barium carbonate by adding sodium or potassium carbonate and heating to 1000°C. Then the residue is extracted with hydrochloric acid. The barium in the extract is precipitated as barium chromate by treating with potassium dichromate in alkaline medium. The precipitate is washed, dried to get constant weight and weighed.

Uses

It is used as a contrast medium for X-ray examination of the alimentary tract.

It is administered orally by enema for examination of the colon.

Dose : 200-400 g oral

QUALITY CONTROL OF DRUGS AND PHARMACEUTICALS

Quality assurance plays a central role in determining the safety and efficacy of medicines. Highly specific and sensitive analytical method holds the key to the design, development, standardization and quality control of medicinal products.

Total quality control will include all those aspects starting with the procurement of raw materials to the finished products available at the drug stores and till it is consumed by the patient. Thus it will include not only the parameters of Good Manufacturing Practice (GMP) but also to the storage, handling and preserving the sample till ultimate use.

The major areas of quality control include:

1. Good quality and nature
2. Physically and chemically pure
3. It contains the amount of ingredients as stated in the label.
4. It is to be effective after administration
5. It retains quality in terms of shelf-life (or) stability.

The importance of quality control is to test a drug for stated quality and quantity. In order to maintain both the above parameters of qualitative identification and quantitative determinations. The procedures and standards are prescribed in the pharmacopoeias published by the respective government of most of all countries.

Methods used for Quality Control

Various tests and procedures for analysis including finding and determining impurities are given in official pharmacopoeias.

In the quantitative analysis, depending upon the characteristics of drugs and its formulation various analytical methods are followed. These includes,

Physiochemical methods, includes determination of specific gravity, density, viscosity, surface tension, refractive index, optical rotation, and all the types of volumetric analysis.

For determining physiochemical properties, use of instruments like potentiometer, conductometer, polarography, colourimeter, spectrophotometer, fluorimeter, flame photometer, are necessary.

Other methods for quantitative determination will include the separation technique like chromatographic, (HPLC, HPTLC, TLC etc), determination by weight like gravimetric and precipitation method.

Apart from the routine qualitative and quantitative analysis, pharmaceutical products also evaluated for their quality. They are tests like disintegration, dissolution, hardness, friability, weight variation, content uniformity, for unit solid dosage forms like tablets and capsules. Bio availability studies, pharmacokinetic studies biological assays (bio assays) and microbiological studies are also carried out.

Errors in Pharmaceutical Analysis

In pharmaceutical analysis, ultimate result of analysis is important from accuracy and reliability point of view. The term accuracy refer to the agreement of experimental result with the true value and it is usually expressed in terms of errors.

Precision is defined as the degree of agreement between various results of the same quantity that is the reproducibility of a result.

Sources of Errors

There are two main classes of errors which affect the accuracy and precision of a measured quantity.

1. **Determinate Errors:** These are determinable, and can be either avoided or corrected. The error may be constant as in the case of
   - ❖ Weighing with uncalibrated weights,
   - ❖ Measuring a volume using uncalibrated burette or pipette.

   These are also called as systematic errors. They arise due to

a) Instrumental errors - by using uncalibrated equipment

b) Operative errors - by person operating or doing analysis (personal error)

c) Chemical error - due to impurities in chemicals solvents and reagents.

d) Errors in methodology: error due to unvalidated method:

e) Errors of above categories are usually detectable and can be eliminated to the large extent.

2. **Indeterminate Errors**

These are often called accidental or random errors. They are found by small differences in series of measurements made by the same analyst under identical conditions. They can not be predicted and hence cannot be eliminated.

Sources of Impurities in Pharmaceuticals

The substances used in pharmaceutical field should be almost pure. The purity of the substances varies with different factors such as, their methods of manufacture, types of their purification etc. Impurity means presence of other materials than drug or presence of unwanted foreign particle other than active drugs. The impurities may be toxic or non-toxic even if it is non-toxic it may be used intentionally as adulterant to increase the weight of the active ingredient. Non toxic impurities also reduce the activity of the drug, so that one must avoid impurities in pharmaceuticals, cannot eliminate all the impurities. The official pharmacopoeias prescribe limits for particular impurities like sulphate, chloride, iron, heavy metals and arsenic.

Some factors which are responsible for pharmaceutical impurities are discussed below:

1. Raw Material Employed in Manufacture

The raw materials, from which these are prepared, often contain impurities. It is therefore necessary to employ pure chemicals and substances as raw materials.

E.g.

1. Presence of tin, lead, silver, copper, cobalt and gold in bismuth salts.

2. Rock salt contains small amounts of calcium sulphate and magnesium chloride. So sodium chloride prepared from rock salt will almost contains trace of calcium and magnesium compounds as impurity.

2. Method used in Manufacture

Some impurities get incorporated into the materials during the manufacturing process.

a) Intermediates

For certain drugs a multiple-step-synthesis procedure is involved, which produces intermediate compounds. The purification of the intermediates is essential, otherwise impurities present in the intermediates will get into the final product.

(e.g.) Potassium iodide is prepared by treating potassium hydroxide with iodine. The intermediate potassium iodate formed is reduced to iodide. If the iodide is not reduced completely, the final product potassium iodide, will contain traces of potassium iodate as impurity.

b) Reagents used in the Process

The final product may contain unreacted reagents as impurities, if it is not washed properly.

e.g.,

1. Lead as an impurity may result from the sulphuric acid used as reagent.
2. Soluble alkali may be an impurity in calcium carbonate if the calcium carbonate is made by reacting calcium chloride and sodium carbonate and not properly washed.

c) Solvents

Water is a common solvent in large scale manufacturing of pharmaceuticals. This can give rise to trace impurities such as sodium, calcium, magnesium, carbonate, chloride and sulphate ions. These impurities can be avoided by using purified water.

d) Catalyst

Generally, catalysts are used to induce the reaction. There may be possibility of incorporation of traces of catalyst in the final products.

e.g.,

1. Presence of palladium catalyst in phenanthrene.
2. Presence of copper chloride in the synthesis of phenol.

e) The Reaction Vessels

The vessels used in manufacturing process are made of metals like copper, iron, aluminium, zinc, tin though these days many of these metals are replaced by stainless steel. Traces of these metal ions may contaminate the final products.

Glass vessels may give rise to traces of alkali to the product.

Metal particles of aluminium containers may contaminate the products like ointments and pastes stored in it.

f) Atmospheric Contaminants

Dust, sulphur dioxide, hydrogen sulphide, arsenic and water vapour from atmosphere may affect a drug. Presence of carbon dioxide, carbon monoxide and hydrogen cyanide from environment also affect the drug products if it is not manufactured under controlled conditions.

g) Decomposition of the Product during Storage

Many drugs undergo changes due to improper storage conditions. If the drugs are not stored properly, they will expire before the date of expiry. These decomposition may be due to light, water vapour, air, carbon dioxide and metallic ions.

e.g,

1. Ferrous sulphate slowly changed into insoluble ferric oxide by air and moisture.
2. Solutions of potassium hydroxide absorbs carbon dioxide on exposure to air.
3. Bismuth carbonate turns black on exposure to sunlight for a long period.

Therefore, the products which are prove to decompose due to environmental factors should be stored in well-closed containers. If the products are prone to decompose due to light should be stored in light-resistant containers like amber colour bottles for liquids and opaque packaging for solid dosage forms.

Deliberate Adultration

A drug may be deliberately adulterated with cheaper and inert materials for the sake of more profit. This will reduce the potency of the active ingredient present in the formulation quantitatively. These practices are prevented by central and state drug control departments.

LIMIT TESTS

Limit tests are quantitative tests which are designed to detect and limit small quantities of impurities present in the substance. All the limit tests that are prescribed in the pharmacopoeias are based on the comparison of standard turbidity or colour with that of the sample under test. For the preparation of standard turbidity or colour the pharmacopoeias prescribe the limit of particular impurities for particular substances and it varies for different compounds. Usually the limits are prescribed in parts per million (PPM). The amount of test samples to be taken is mentioned in the individual monograph of the pharmacopoeias.

Limit Test for Chlorides

A solution of the substance is acidified with nitric acid, diluted to definite volume and treated with silver nitrate and the opalescence so produced is compared with that of standard opalescence containing known amount of sodium chloride solution.

$$Cl^- + AgNO_3 \rightarrow AgCl\downarrow + NO_3^-$$

Presence of nitric acid prevents the precipitation caused by silver carbonate or silver hydroxide which may result due to alkaline impurities in the solution.

2. Limit Test for Sulphate

It depends upon the precipitation of the sulphate with barium chloride in the presence of hydrochloric acid, ethyl alcohol and traces of potassium sulphate.

The turbidity produced is compared with that of turbidity produced by addition of the above reagents to a standard solution containing a definite quantity of potassium sulphate.

$$SO_4^{--} + BaCl_2 \rightarrow BaSO_4 \downarrow + 2Cl^-$$

The potassium sulphate increases the sensitivity of the test by giving ionic concentrations in the reagent which just exceed the solubility product of barium sulphate. Presence of alcohol helps to prevent super saturation. Hydrochloric acid is added to prevent precipitation due to barium carbonate which is also sparingly soluble in water.

3) Limit Test for Iron

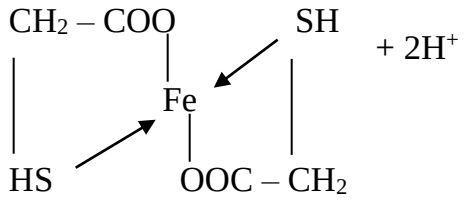
Specified amount of the drug is dissolved in water and treated with citric acid and thioglycollic acid. It is made alkaline with dilute ammonia solution. The purple colour produced is compared with that of standard ferric ammonium sulphate treated in the same way as the test solution.

$$2\,Fe^{+++} + 2HS - CH_2COOH \rightarrow \begin{array}{l} S - CH_2 - COOH \\ | \\ S - CH_2 - COOH \end{array} + 2Fe^{++} + 2H^+$$

Ferric ion Thioglycollic acid

$$Fe^{++} + 2HS - CH_2COOH \rightarrow$$

Ferrous ion Thioglycollic acid



$+ 2H^+$

Ferrous Thioglycollate complex
(purple colour)

Ferric ion is reduced to ferrous ion by the thioglycolic acid. Citric acid is added to prevent precipitation of the iron by the ammonia (citric acid forms a soluble complex). Ammonia is added to make alkaline the solution, and the purple colour is stable in alkaline medium. Purple colour is due to the formation of co-ordination compound, ferrous thioglycollate.

4. Limit Test for Heavy Metals

All metals like Copper, Bismuth, Lead, Mercury, Arsenic, Antimony, Silver, etc (except alkali metals and alkaline earth metals) are coloured by sulphide ions (H_2S or Na_2S) under specified conditions. Depends upon the quantity of the metal the colour varies from brown to black.

There are three methods are prescribed in I.P to determine the presence of heavy metals.

Method A and B are carried out in acid conditions with hydrogen sulphide reagent and method C involves alkaline medium with the use of sodium sulphide reagent.

Method A

A solution of substance is adjusted to a pH 3 to 4 (by adding ammonia (or) acetic acid) and hydrogen sulphide reagent is mixed with this and comparison of black colour produced with a standard colour containing a known amount of lead.

Method B (For Organic Compounds)

The substance is ignited well in presence of conc. sulphuric acid and treated with mixture of nitric and sulphuric acids. The resulting solution is digested with dilute hydrochloric acid. Then extracted with hot water and proceeded as in method A.

$$Pb^{++} + H_2S \rightarrow PbS + 2\,H^+$$

Method C

The solution of the substance is treated with sodium hydroxide solution and sodium sulphide reagent. Then it is compared with that a standard colour.

$$Pb^{++} + Na_2S \rightarrow PbS + 2Na^+$$

5. Limit Test for Arsenic

In this test arsenic impurities if at all present is converted in to arsine gas (ASH_3) which when contact with a mercuric chloride paper produces yellow stain. The intensity of the stain is proportional to the amount of arsenic present. A standard stain produced from a definite amount of arsenic is used for comparison.

Apparatus used for arsenic limit test is called Gutzeit apparatus.

A drug solution is prepared and placed in wide monthed bottle, potassium iodide, zinc dust, hydrochloric acid, stannous chloride are added into it and the apparatus is set up as given in the figure 2.

Hydrogen gas is generated in the solution by the presence of stannous chloride, hydrochloric acid (stannated hydrochloride) and potassium iodide on arsenic free granulated zinc. Stannous chloride and potassium iodide are acts as a reducing agents so that any pentavalent arsenic is reduced to the trivalent state. The presence of stannous chloride and hydrochloric acid ensures rapid reaction between acid and potassium iodide and produces nascent hydrogen gas.

The reactions are:

$$Zn + 2HCl \rightarrow ZnCl_2 + 2\,[H]^+$$

$$H_3ASO_4 + 2\,[H] \rightarrow H_3ASO_3 + H_2O$$

$$H_3ASO_3 + 6\,[H] \rightarrow ASH_3 + 3H_2O$$

$$2ASH_3 + HgCl_2 \rightarrow Hg\,(ASH_3)_2 + 2HCl$$

The arsine gas produced in the bottle escapes through the tube and the lead acetate impregnated cotton wool kept in the centre of the tube entraps the hydrogen sulphide if any from the arsine gas. The gas escapes through glass tube and reacts with mercuric chloride paper kept in the clips and produces yellow stain. The reaction is allowed to proceed for forty minutes maintained at 40°C.

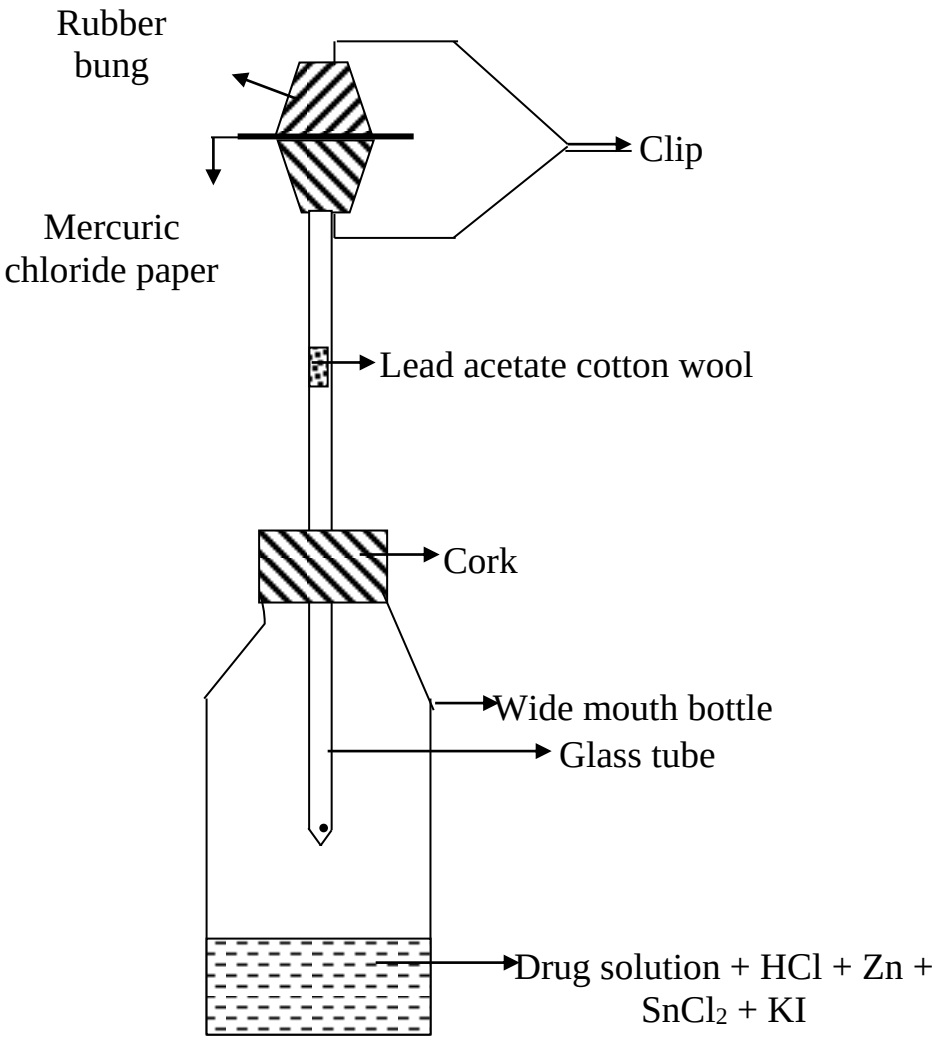


Figure 2 : Gutzeit apparatus for limit test for Arsenic

ANTIMICROBIALS AND ASTRINGENT

Anti microbial is a broad terminology describing activity against microbes. Specific terminology gives exact mode of action.

1. **Antiseptics** are substances that kill or prevent the growth of micro organism. This is specific for preparation intended to be used for living tissues.
2. **Disinfectant** is prevent infection by the destruction of pathogenic micro organism. It is generally used to inanimate objects.
3. **Germicide** is an agent which kills micro organisms. More specific terminologies like 'bactericide' (against bacteria), 'fungicide' (against fungi), virucide (against virus) denotes exact action.
4. **Bacteriostatics** is an agent which function by inhibiting the growth of bacteria. Thus bacteriostatic agents do not kill but stops the growth of bacteria.

Mechanism of Action

Inorganic compounds generally exhibit antimicrobial action by three different mechanism.

They are 1) Oxidation mechanism

2) Halogenation mechanism

3) Protein precipitation

1. **Oxidation Mechanism:** This belongs to class of peroxides, peroxy acids, oxygen liberating like permangante. They act on proteins containing sulph hydryl group and oxidises free sulphydryl to disulphide bridge and inactivate its function.
2. **Halogenation Mechanisms:** Compounds which liberates chlorine or hypochlorite or iodine act by this mechanism. They act on peptide linkages and alter it's property. The destruction of specific function of protein results in death of micro organism.
3. **Protein Precipitation:** Many cations exhibit protein binding or protein precipitation. The interaction with protein occurs through polar group of protein which acts as ligands and metal cation as lewis acid. The complex formed may be strong chelate leading to inactivation of proteins.

HYDROGEN PEROXIDE (H_2O_2)

Preparation

It is prepared by adding a paste of barium peroxide in ice cold water to a calculated quantity of ice cold dilute sulphuric acid. The insoluble barium sulphate is filtered off.

$$BaO_2 + H_2SO_4 \rightarrow BaSO_4\downarrow + H_2O_2$$

It is also manufactured by electrolysis process. Electrolysis of sulphuric acid to peroxy sulphuric acid which is hydrolyzed to give the product. Sulphuric acid is oxidized to give peroxydisulphuric acid ($H_2S_2O_8$)

Oxidation

$$2H_2SO_4 \xrightarrow{(O)} H_2S_2O_8 + H_2 \uparrow$$

Hydrolysis

$$H_2S_2O_8 \xrightarrow{(H_2O)} H_2SO_5 + H_2SO_4$$

Peroxy sulphuric acid

$$H_2SO_5 + H_2O \xrightarrow[\Delta]{} H_2O_2 + H_2SO_4$$

Properties

Hydrogen peroxide solution is a colourless liquid with slightly acidic taste. The solution is decompases in contact with oxidisable matter, reducing agent, when made alkaline or even on standing.

$$2H_2O_2 \rightarrow 2H_2O + O_2 \uparrow$$

The solution is stabilized by the addition of small amount of acid and adjusting the pH between 2 and 3. Polyvalent metal ions catalyse decomposition of hydrogen peroxide and complexing agent prevent it by acting as stabilizer.

Hydrogen peroxide acts as oxidizing or reducing agent depending upon the chemical environment.

In oxidation reaction (in acidic medium) it accepts two electrons.

$$H_2O_2 + 2H^+ + 2e^- \rightarrow 2H_2O$$

In reduction – release of two electrons.

Decolourisation of permanganate solution.

$$5H_2O_2 + 2KMnO_4 + 3H_2SO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 8H_2O + 5O_2 \uparrow$$

Assay

It is estimated by titration with potassium permanganate in presence of 4 N sulphuric acid. Potassium permanganate is reduced to manganese sulphate. This determination depends on mutual oxidation – reduction as expressed by following equations.

$$2KMnO_4 + 3H_2SO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5(O)$$

$$H_2O_2 + (O) \rightarrow H_2O + O_2$$

Hydrogen peroxide is oxidized to oxygen by nascent oxygen produced from the reaction between potassium permanganate and dilute sulphuric acid. The appearance of permanent pale pink colour indicates the end point.

Storage

It should be stored in light resistant container in a cool place.

Use

1. Used as an Antiseptic and topical Anti-infective.

2. It arrests the bleeding of wounds.
3. It is used to clean the wounds and ears.

2. POTASSIUM PERMANGANATE ($KMnO_4$)

Preparation

Manganese dioxide is fused with solid potassium hydroxide along with potassium chlorate, a green mass potassium manganate is obtained. The mass is cooled is extracted with water and filtered.

$3MnO_2 + 6KOH + KClO_3 \xrightarrow{\Delta} 3K_2MnO_4 + KCl + 3H_2O$

The filtrate is treated with carbon dioxide followed by chlorine. By this potassium manganate is converted into potassium permanganate.

$3K_2MnO_4 + 2\ CO_2 \rightarrow 2KMnO_4 + MnO_2 + 2K_2CO_3$

$2K_2MnO_4 + Cl_2 \rightarrow 2KMnO_4 + 2KCl$

Potassium permanganate can also be prepared by electrically, by electrolysing warm solution of the manganate.

$2K_2MnO_4 + 2\ H_2O \rightarrow 2KMnO_4 + H_2 \uparrow + 2KOH$

Physical Properties

It occurs in the form of deep, dark purple, monoclinic prismatic crystals and moderately soluble in water. The taste is sweet and astringent.

Chemical Properties

It is very powerful oxidizing agent both in dry state and in solution. Explosions may occur when it comes in contact with organic or other readily oxidisable materials.

It act as an oxidizing agent because it produces nascent oxygen in solution.

$2KMnO_4 + 3H_2SO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5(O)$ (acid solution)

$2KMnO_4 + H_2O \rightarrow 2MnO_2 + 2KOH + 3(O)$ (Alkaline (or) neutral solution)

Potassium permangante oxidizes iodides, bromides, chlorides, ferrous salts, nitrites, sulphites, thio sulphates peroxides and oxalates. Organic materials such as ethyl alcohol and charcoal are readily oxidized.

Assay

It is assayed by titrating it with N/10 oxalic acid in presence of disulphuric acid at 70°C. If the temperature is not maintained at 70°C, the reaction will become slow.

$2KMnO_4 + 3H_2SO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5(O)$

$$5 \begin{array}{l} COOH \\ | \\ COOH \end{array} + 5(O) \rightarrow 10CO_2 + 5H_2O$$

Storage:

It should be stored in well closed container.

Use

1. It is used as local anti infective.
2. It is used as mouthwash and gargle (more than 1 in 1000 solution).
3. It is also used as stomach wash in the treatment of Narcotic drug poisoning.

CHLORINATED LIME [Ca(OCl) Cl]

Syn: Bleaching powder

Calcium chloro hypochlorite.

Preparation

It is obtained by the action of chlorine on calcium hydroxide. Slaked lime is spread on stable shelves in a container and chlorine gas is introduced at the top of the chamber and passed through the contents of the shelves. This is done at 25°C to minimize the formation of calcium chloride.

$Ca(OH)_2 + Cl_2 \rightarrow Ca(OCl)\,Cl + H_2O$

Properties

It is dull white powder with characteristic odour, on exposure to air it absorbs moisture and decomposes by liberating chlorine. It is sparingly soluble in water and insoluble in alcohol.

When bleaching powder is added to water hypochlorite goes into solution and oxygen is liberated. The oxidizing and bleaching properties are shown.

Bleaching powder is incompatible with ammonium salts sulphur and many organic compounds.

Assay

For the estimation, an aqueous suspension of chlorinated lime is mixed with acetic acid in the presence of potassium iodide and the liberated chlorine displaces an equivalent amount of iodine from potassium iodide. The liberated iodine is titrated with standardized solution of sodium thiosulphate using starch as an indicator.

$Ca(OCl)Cl + 2CH_3COOH \rightarrow (CH_3\,COO)_2\,Ca + Cl_2 + H_2O$

$Cl_2 + 2\,KI \rightarrow I_2 + 2\,KCl$

$I_2 + 2Na_2S_2O_3 \rightarrow Na_2S_4O_6 + 2NaI$

Storage:

It is slowly decomposing with loss of chlorine due to atmospheric carbon dioxide and moisture and for this reason, it should be stored in air tight containers.

Use:

1. It is used as disinfectant, deodorant.

2. Commonly used in chlorination of water and in treatment of swimming tank.

IODINE (I_2)

Preparation

Iodine is manufactured by extracting kelp (sea weed ash) with water and the solution is concentrated. The sulphate and chloride of sodium and potassium are crystallized out, leaving soluble sodium and potassium iodides in the mother liquor. Sulphuric acid is added to the mother liquor and sulphur which is liberated from small amount of thiosulphate and sulphide is allowed to settle. The mother liquor is decanted and to this MnO_2 is then added and the Iodine is distilled out.

$$2NaI + 3H_2SO_4 + MnO_2 \rightarrow MnSO_4 + 2\ NaHSO_4 + I_2 + 2H_2O$$

Impurities like I Cl, I Br and I CN are removed by heating crude iodine with potassium iodide.

$$ICl + KI \rightarrow KCl + I_2$$

Physical Properties

It occurs as heavy, bluish-black rhombic plates with metallic luster. It has peculiar odour and volatilizes at ordinary temperature. It melts at higher temperature. It is practically insoluble in water but soluble in alcohol. It is freely soluble in chloroform and ether.

Chemical Properties

1. It combines directly with some non-metals and with many metals.

$$2P + 3\ I_2 \rightarrow 2PI_3$$

$$Fe + I_2 \rightarrow FeI_2$$

Reducing agent reacts with aqueous iodine solution and gets oxidized.

$$H_3ASO_3 + I_2 + H_2O \rightarrow 2HI + H_3ASO_4$$

$$H_2S + I_2 \rightarrow 2HI + S$$

Iodine reacts with alkali to form an iodide and iodate when heated.

$$3I_2 + 6NaOH \xrightarrow[\Delta]{} 2NaI + NaIO_3 + 3H_2O$$

Potassium iodide dissolves large quantity of iodine in water, because of the formation of poly iodide. (I_3^-)

$$KI + I_2 \rightarrow KI_3$$

Assay

It is estimated by addition of potassium iodide solution, and acidified with acetic acid and titrated with sodium thiosulphate using starch mucillage as indicator. The end point is appearance of blue colour.

$2Na_2S_2O_3 + I_2 \rightarrow 2NaI + Na_2S_4O_6$

Sodium Tetrathionate

Incompatiability

It oxidizes hypophosphite, sulphite, some metals and reducing agents and iodine itself gets reduced to iodide. It reacts with ammonia or ammoniated mercury to form explosive iodide or nitrogen.

Storage

It is volatile at room temperature and reacts with rubber and corks. So it should be stored in amber colour bottles with tight glass stopper and kept in a cool place.

SOLUTIONS OF IODINE

Iodine is insoluble in water but it is soluble in water in presence of potassium or sodium iodide due to the formation of poly iodides. The following are the solution preparations containing iodine.

1. Strong iodine solution (10% W/V solution of iodine)
2. Weak iodine solution (2% W/V solution of iodine)
3. Aqueous iodine solution (5% W/V solution of iodine)
4. Iodine tincture USP.
5. Mandl's paint.

1. **Strong Iodine Solution (strong tincture of iodine):** Contains 10% W/V solution of iodine and 6% W/V solution of potassium iodide in alcohol.
2. **Weak solution of Iodine (weak tincture of iodine):** Contains 2.5% W/V solution of Iodine and 2.5% W/V solution of potassium iodide in alcohol.
3. **Aqueous solution of Iodine (Lugal's Solution):** Contains 5% W/V solution of iodine and 10% W/V solution of potassium iodide in water.
4. **Iodine Tincture USP:** Contains 2% W/V solution of iodine and 2.4% W/V solution of potassium iodide and alcohol 50 ml and water up to 100 ml. It is used for external use only.
5. **Mandl's Paint:** Contains 1.25% W/V solution of iodine in glycerin. Glycerin is used to hold the iodine in the applied area (throat).

Use: All the above solutions are used as antiseptics and disinfectants.

POVIDONE – IODINE (PVP – IODINE)

(Polyvinyl Pyrrolidone – Iodine Complex)

It is a complex of polyvinyl pyrrolidone and iodine containing not less than 9% and not more than 12% W/V of available I_2 (iodine).

The complex is yellowish brown amorphous powder and has slight characteristic odour, its aqueous solution is acid to litmus. It is soluble in alcohol, but insoluble in organic solvents.

It is available as Aerosol and solution. The solution is a transparent liquid having reddish brown colour and a pH of not more than 6.0.

Uses

Major advantages over other iodine preparation is lack of tissue irritation. Solutions are used for surgical scrubs and for pre operative antisepsis for the skin.

It is also used in gargles and mouth washes for the treatment of infections in the oral cavity.

BORIC ACID

Refer under 'Acids and Bases'

BORAX ($Na_2 B_4O_7. 10 H_2O$)

It is known as sodium borate.

Preparation

1. The mineral colemanate is mixed with sodium sulphate and heated to redness but not to fusion in a rotary furnace. This mass has cooled, borax is dissolved in water and allowed to crystallize, after removing insoluble calcium sulphate.

$$2Ca_2B_6O_{11} + 3Na_2SO_4 \rightarrow 3CaSO_4 \downarrow + CaO + 3Na_2B_4O_7$$

2. The mineral borocalcite is also converted into borax by this method.

$$Ca_2B_2O_7. 4H_2O + Na_2SO_4 \rightarrow Na_2B_4O_7 + CaSO_4 \downarrow + 4H_2O$$

Properties

Borax occurs as colourless, odourless crystals or as a white crystalline powder that has sweetish, alkaline taste. It effloresces in warm dry air. It is soluble in water and more in boiling water and in glycerine. It is soluble in alcohol.

On heating it losses part of water of hydration. It is hydrolyzed partially to sodium metaborate and boric acid.

$$Na_2B_4O_7 + 3H_2O \rightleftarrows 2NaBO_2 + 2H_3BO_3$$

The metaborate is largely hydrolysed on dilution with water.

$$NaBO_2 + 2H_2O \rightleftarrows NaOH + H_3BO_3$$

Use

1. It is germicide and used as bacteriostatic.
2. It is used in preparations of eye wash (1-2%).

3. It is used as mouth wash and gargles.
4. Borax is used as food preservative. It is used in cosmetic preparations as emulsifier and also in lotions.

SILVER NITRATE ($AgNO_3$)

Preparation

It is prepared by action of dilute nitric acid on pure silver. 3 parts of silver are added to the solution of 25% nitric acid (10 parts) and warmed. Then it is heated to expel the nitrous fumes, filtered and evaporated until it is dry.

$$3\ Ag + 4\ HNO_3 \rightarrow 3\ Ag\ NO_3 + NO\uparrow + 2H_2O$$

Properties

It occurs as colourless crystalline compound odourless, bitter in taste. When it is exposed to light or organic matter it turns grey or greyish black. It is more soluble in water and in alcohol.

When it is heated, it melts at 212°C to yellowish liquid and when heated further it decomposes in to metallic silver with evolution of NO_2 and O_2.

$$2AgNO_3 \xrightarrow[\Delta]{} 2Ag + 2NO_2\uparrow + O_2\uparrow$$

It gives white yellow-white precipitate with hydrochloric acid and other halogen salts.

Silver Mirror Test

Ammonium hydroxide with silver nitrate forms silver-ammonium complex. To this solution, if reducing agent like glucose is added the silver ions are reduced to metallic silver and silver mirror is formed.

Incompatibilities

It is incompatible with reducing agents, tartrates, sugars and tannins. In neutral and alkaline conditions precipitation results with halides, borax, hydroxide, phosphate sulphate etc.

Assay

It is estimated by dissolving in water, nitric acid is added to it and titrated against standard ammonium thiocyanate using ferric alum as indicator. The end point is the formation of reddish-brown colour.

$$AgNO_3 + NH_4\ SCN \rightarrow AgSCN\downarrow + NH_4\ NO_3$$

Storage

It is decomposed (reduction) by light so it should be stored in well closed, glass container and protected from light.

Uses

1. It is used as antibacterial (0.01 – 0.5%).
2. At higher concentration it is used as Astringent (1% and above).
3. At very low concentration acts as bacteriostatic (0.0025 to 0.0050%).
4. Silver nitrate ophthalmic solution in 1% strength is used as eye wash.

MILD SILVER PROTEIN

It is a preparation with silver available in colloidal form by the presence of proteins or in combination with it. It contains not less than 19% and not more than 23.0% of silver.

Preparation

It is prepared by using silver salt with an excess of denatured protein (serum albumin, casein, or gelatin). The product is dried in vacuum and stored in amber coloured bottles.

Properties

It is a dark brown – blackish shining scales or granules, odourless and is hygroscopic, it is soluble in water but insoluble in alcohol, ether and chloroform.

Assay:

Same as that of silver nitrate.

Storage

It is stored in tightly closed amber-coloured glass containers, in dry and dark place. Disodium edetate (EDTA) in 10 mg/ml is used as stabilizer for aqueous solution.

Uses

1. Aqueous solution of 1-2% are used as antibacterial.
2. For rhinitis, tonsilities it is used in 0.5 – 10% of concentration.

Only freshly prepared solutions are to be used. Since it has less free silver ions, it is effective antimicrobial and show less irritation and astringent effect.

MERCURY (Hg)

Preparation

It occurs naturally as a sulphide called cinnabar.

It is obtained by roasting cinnabar in a current of air.

$$HgS + O_2 \rightarrow Hg + SO_2$$

Properties

It is shining silvery white heavy liquid and extremely mobile. Practically insoluble in water, alcohol and hydrochloric acid but completely soluble in nitric acid and boiling sulphuric acid. It boils at 350°C.

Assay

An accurately weighed quantity is dissolved in equal volume of nitric acid and water by heating to form mercuric nitrate. It is titrated against ammonium thiocyanate using ferric ammonium sulphate as an indicator.

Storage

Since it is volatile, it should be stored in tightly closed container in a cool place.

Uses

1. In general mercury being toxic, is not used medicinally.
2. There are number of other pharmaceutical uses of mercury like preparation of mercury compounds, amalgams etc.
3. A preparation known as mercury with chalk acts as purgative because of irritant action of mercury ion.

YELLOW MERCURIC OXIDE (HgO)

Preparation

It is prepared by pouring concentrated solution of mercuric chloride into a dilute solution of sodium hydroxide with constant agitation. This is then allowed to stand at room temperature for about an hour. Then the supernated liquid is decanted off and the precipitate is washed with water until the washings are free from alkali. The yellow precipitate is collected and dried on absorbent paper at 30°C. The above steps are carried out in dark place to get bright orange-yellow product.

$$HgCl_2 + 2NaOH \rightarrow Hg(OH)_2 + 2NaCl$$

$$Hg(OH)_2 \rightarrow HgO + H_2O$$

Properties

It is an orange-yellow heavy amorphous powder, odourless and gets decolourized on exposure to light. It is practically insoluble in water and alcohol but readily soluble in dilute hydrochloric acid and dilute nitric acid.

On heating to red hot it decomposes into oxygen and vapour of metallic mercury.

$$2HgO \rightarrow O_2\uparrow + 2\,Hg$$

Assay

It is estimated by volumetric thiocyanate method. An accurately weighed quantity is dissolved in nitric acid and water. The solution is titrated against ammonium thiocyanate solution using ferric ammonium sulphate as an indicator.

Storage

It should be stored in tightly closed containers and protected from light.

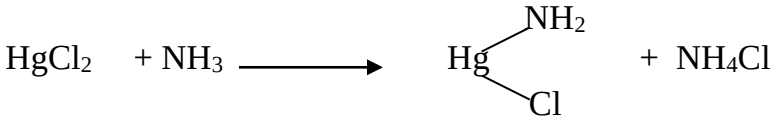
Uses

1. It is used as mild antiseptic.
2. It is used as 1% solution for ophthalmic purpose to treat inflammation and conjunctivitis.

AMMONIATED MERCURY (NH_2 (Hg) Cl)

Preparation

It is prepared by adding 5% mercuric chloride solution to a mixture of 4 parts of dilute ammonia and 20 parts of water with constant stirring. The precipitate is collected, washed with cold water and dried below 30°.



Properties

It is white amorphous powder and is odourless, darkens on exposure to light. It is practically insoluble in water alcohol and ether.

Assay

It is treated with potassium iodide solution with stirring. The mercuric iodide formed in the reaction is converted into potassium mercuric iodide (K_2HgI_4) by potassium iodide. The liberated (alkali) ammonia and potassium hydroxide is titrated with hydrochloric acid using methyl orange as an indicator.

$$NH_2\,HgCl + 2KI + H_2O \rightarrow HgI_2 + NH_3 + KOH + KCl$$

$$HgI_2 + 2KI \rightarrow K_2HgI_4$$

Uses

1. It is acting as mild antiseptic.
2. It is used in various skin infections caused by fungi, lice and other infestation.
3. It is used as an ointment and dusting powder in the strength of 5%.

Pharmaceutical Preparations of Mercuric Compound

1. Mercuric oxide eye ointment.

   Preparation contains 0.9 to 1.1% of HgO in simple ointment.

   Ointment is used to reduce inflammation and as antiseptic in conjuctivitis.

2. Ammoniated mercuric ointment

   It contains 2.25 to 2.75% of NH_2 HgCl. The preparation is used as mild antiseptics.

A. IDENTIFICATION TEST OF SOME ANIONS

1. BENZOATES : a) To 1 ml of a 10 percent w/v neutral solution add 0.5 ml of ferric chloride solution, a dull-yellow precipitate, soluble in solvent ether is formed.

b) Moisten 0.2 g of the substance being examined with 0.2 ml of sulphuric acid and gently warm the bottom of the tube, a white sublimate is deposited on the inner walls of the tube and no charring occurs.

c) Dissolve 0.5 g of the substance being examined in 10 ml of water add 0.5 ml of hydrochloric acid. The precipitate obtained, after crystallisation from water and drying under reduced pressure melts at about 122°C.

2. BICARBONATES :

a) Solutions of bicarbontates, when boiled liberates carbon dioxide.

b) Treat a solution of the substance being examined with a solution of magnesium sulphate, no precipitate is formed (distinction from carbonates). Boil, a white precipitate is formed.

c) Introduce into a test-tube 0.1 g of the substance being examined suspended in 2 ml of water. Add 2 ml of 2M acetic acid. Close the tube immediately using a stopper fitted with a glass tube bent at two right-angles. Heat gently and collect the gas in 5 ml of barium hydroxide solution, a white precipitate forms that dissolves on addition of an excess of dilute hydrochloric acid.

3. BROMIDES : a) Dissolve 10 mg of the substance being examined in 2 ml of water. Acidify with 2 M nitric acid and add 1 ml of 0.1 M silver nitrate. Shake and allow to stand, a curdy, pale-yellow precipitate forms. Centrifuge and wash the precipitate rapidly with three quantities, each of 1 ml, of water in subdued light. Suspend the precipitate in 2 ml of water and add 1.5 ml of 10M ammonia; the precipitate dissolves with difficulty.

b) Dissolve about 10 mg in 2 ml of water and add 1 ml of chlorine solution, bromine is evolved, which is soluble in two or three drops of chloroform, forming a reddish solution. The addition of phenol solution to the aqueous solution containing liberated bromine yields a white precipitate.

NOTE : In testing for bromides in the presence of iodides, all iodine must first be removed by boiling the aqueous solution with an excess of lead dioxide.

4. CARBONATES : a) Suspend 0.1 g of the substance being examined in a test-tube in 2 ml of water. Add 3 ml of 2 M acetic acid. Close the tube immediately using a stopper fitted with a glass tube bent at two right angles. Heat gently and collect the gas in 5 ml of 0.1 M barium hydroxide, a white precipitate is formed that dissolves on addition of an excess of dilute hydrochloric acid.

b) Treat a solution of substance being examined with a solution of magnesium sulphate, a white precipitate is formed (distinction from bicarbonates).

5. CHLORIDE : a) Dissolve 10 mg of the substance being examined in 2 ml of water. Acidify with dilute nitric acid and add 0.5 ml of silver nitrate solution. Shake and

allow to stand, a curdy, white precipitate is formed, which is insoluble in nitric acid, but soluble, after being well washed with water, in dilute ammonia solution, from which it is reprecipitated by the addition of nitric acid.

b) Introduce into a test-tube 0.1g of the substance being examined, add 0.2 g of potassium dichromate and 1 ml of sulphuric acid. Place a filter-paper strip moistened with 0.1 ml of dipnenylcarbazide solution over the opening of the test-tube, the paper turns to violet-red. (Do not bring the moistened paper into contact with the potassium dichromate solution).

6. CITRATES : a) To a neutral solution of the substance being examined add a solution of calcium chloride, no precipitate is produced. Boil the solution, a white precipitate, soluble in 6 M acetic acid, forms.

b) Dissolve 0.1 g of the substance being examined in 5 ml water. Add 0.5 ml of sulphuric acid and 3 ml of potassium permanganate solution. Warm until the colour of the permanganate is discharged and add 0.5 ml of a 10 per cent solution of sodium nitroprusside in 1 M sulphuric acid and 4 g of sulphamic acid. Make alkaline with strong ammonia solution, added dropwise, until all the sulphamic acid has dissolved, further addition of strong ammonia solution produces a violet colour, turning to violet blue.

7. IODIDE: a) Dissolve 0.1 g of the substance being examined in 2 ml of water. Acidify with dilute nitric acid and add 0.5 ml of silver nitrate solution. Shake and allow to stand, a curdy, pale-yellow precipitate forms. Centrifuge and wash the precipitate rapidly with three quantities, each of I ml of water in subdued light. Suspend the precipitate in 2 ml of water and add 1.5 ml of 10 M ammonia, the precipitate does not dissolve.

b) To 0.2 ml of a solution of the substance being examined add 0.5 ml of 1 M sulphuric acid, 0.15 ml of potassium dichromate solution, 2 ml of water and 2 ml of chloroform. Shake for a few seconds and allow to stand ; the chloroform layer is violet or violet-red.

c) To 1 ml of a solution of the substance being examined add 0.5 ml of mercuric chloride solution, a dark red precipitate is formed which is slightly soluble in an excess of this reagent and very soluble in an excess of potassium iodide solution.

8. SULPHATE : a) Dissolve about 50 mg of the substance being examined in 5 ml of water Add 1 ml of dilute hydrochloric acid and 1 ml of barium chloride solution a white precipitate forms.

b) Dissolve about 50 mg of the substance being examined in 5 ml of water and add 2 ml of lead acetate solution, a white precipitate is formed which is soluble in ammonium acetate solution and in sodium hydroxide solution.

9. THIOSULPHATES: a) Dissolve 0.1 g of the substance being examined in 5 ml of water, add 2 ml of hydrochloric acid, a white precipitate is formed which soon turns yellow and sulphur dioxide is evolved recognizable by its odour.

b) Dissolve 0.1 g of the substance being examined in 5 ml of water, add 2 ml of ferric chloride test solution, a dark violet colour is produced which quickly disappears.

c) Solutions of thiosulphatcs decolorises iodine solution, the decolorised solutions do not give the reactions of sulphates.

d) Solutions of thiosulphates decolorise bromine solution, the decolorised solutions give the reactions of sulphates.

IDENTIFICATION TEST OF SOME CATIONS

1. ALUMINIUM : a) Dissolve about 20 mg of the substance being examined in 2 ml of water. Add about 0.5 ml of 2 M hydrochloric acid and about 0.5 ml of thiacetamide reagent, no precipitate forms. Add dropwise 2M sodium hydroxide solution, a gelatinous white precipitate appears that redissolves on addition of further sodium hydroxide solution. Gradually add ammonium chloride solution, the gelatinous white precipitate reapperars.

b) Dissolve about 20 mg of the substance being examined in 5 ml of water add five drops of ammonium acetate solution and five drops of a 0.1% w/v solution of mordant blue 3, an intense purple colour is produced.

c) To a solution of the substance being examined in water add dilute ammonia solution until a faint precipitate is produced and then add 0.25 ml of freshly prepared O.05% w/v solution of quinalizarin in a 1% w/v solution of sodium hydroxide. Heat to boiling, cool and acidify with an excess of acetic acid, a reddish-violet colour is produced.

2. AMMONIUM SALTS : a) Heat a few mg of the substance being examined with sodium hydroxide solution, ammonia is evolved, which is recognisable by its odour and by its action on moist red litmus paper (colour changes to blue).

b) To the prescribed solution add 0.2 g of light Magneisum oxide. Pass a current of air through the mixture and direct the gas that is evolved to just beneath the surface of a mixture of 1 ml of 0.1 M HCl and 0.05 ml of methyl red solution, the colour of the solution changes to yellow. On addition of 1 ml of a freshly prepared 10% w/v solution of sodium cobaltinitrite, a yellow precipitate forms.

3. ANTIMONY : Dissolve with gentle healing about 10 mg of the substance being examined in a solution of 0.5 g of sodium potassium tartrate in 10 ml of water and allow to cool. To 2 ml of this solution add sodium sulphide solution drop wise, gives a reddish orange precipitate which dissolves on adding sodium hydroxide solution.

4. ARSENIC : Heat 5 ml of the prescribed solution on a water-bath with an equal volume of hypophosphorus reagent, a brown precipitate is formed.

5. BARIUM : a) Barium salts impart a yellowish-green colour to a nonluminous flame, appearing blue when viewed through green glass.

b) Dissolve about 20 mg of the substance being examined in 5 ml of dil HCl, add 2 ml of dil. sulphuric acid a white precipitate forms which is insoluble in nitric acid.

6. BISMUTH : a) To 0.5 g of the substance being examined add 10 ml of dil. HCl. Heat to boiling for one minute, cool and filter if necessary. To 1 ml of the solution obtained add 20 ml of water, a white or slightly yellow precipitate appears which on addition of 0.05 to 0.1 ml of sodium sulphide solution turns brown,

b) To about 50 mg of the substance being examined add 10 ml dil. nitric acid. Heat to boiling for one minute, allow to cool and filter if necessary. To 5 ml of the solution obtained add 2 ml of a 10% w/v solution of thiourea, an orange yellow colour or an orange

precipitate is produced. Add 4 ml of a 2.5% w/v solution of sodium flouride, the solution is not decolourised within 30 minutes,

7. CALCIUM: a) Dissolve 20 mg of the substance being examined in 5 ml of 5M acetic acid. Add 0.5 ml of potassium ferrocyanide solution, the solution remains clear. Add about 50 mg of ammonium chloride, a white, crystalline precipitate is formed.

b) To a solution of the substance being examined add a few drops of a solution of ammonium oxalate, a white precipitate is obtained that is, only sparingly soluble in dilute acetic acid but is soluble in HCI.

c) Dissolve 20 mg of the substance being examined in 2 ml of HCI and dilute with NaOH solution, add 5 ml of ammonium carbonate solution, a white precipitate is formed which after boiling and cooling the mixture, is only sparingly soluble in ammonium chloride solution.

8. FERRIC SALTS : a) Dissolve 0.1 g of the substance in 1 ml of water. Add 1 ml of a 5% w/v solution of potassium ferrocyanide, an intense blue precipitate is formed that is Insoluble in dil HCI.

b) To 3 ml of a solution containing 0.1 mg of iron add 1 ml of 2N.HC1 add 1 ml of ammonium thiocyanate solution, the solution becomes blood-red in colour. Take two portions, each of I ml, of the mixture. To one portion add 5 ml of solvent ether, shake and allow to stand, the ether layer is pink. To the other portion add 3 ml of 0.2 M mercuric chloride, the red colour disappears.

c) To 2 ml of a solution containing about 0.1 mg of iron add 3 ml acetic acid until the solution is strongly acidic and add 2 ml of a 0.2% w/v solution of 8 hydroxy-7-iodoquinoline-5-sulphonic acid. A stable green colour is produced.

9.FERROUS SALTS : a) About 10 mg of iron in 2 ml of water, add 2 ml of dil. sulphuric acid and 1 ml of a 0.1 % w/v solution of 1,10 phenanthroline. An intense red colour is produced, the colour is discharged by addition of a slight excess of 0.1 M ceric ammonium sulphate.

b) To 1 ml of a solution not less than 1 mg of iron, add 1 ml of potassium ferricyanide solution, a dark blue precipitate is formed that is insoluble in dil.HCI and is decomposed by sodium hydroxide solution.

c) To 1 ml of a solution containing not less than 1 mg of iron add 1 ml of potassium ferrocyanide solution, a white precipitate is formed which rapidly becomes blue and is insoluble in dil.HCI.

10. LEAD: a) Dissolve 0.1g of the substance being examined in 1 ml of dil. acetic acid, add 2 ml of potassium chromate solution, a yellow precipitate forms that is insoluble in 2 ml of sodium hydroxide solution.

b) Dissolve 50 mg of the substance being examined in 1 ml of dil. aceticacid add 10 ml of water and 0.2 ml of 1M potassium iodide, a yellow precipitate forms. Heat to boiling for one or two minutes, and allow to cool, the precipitate is reformed as glistening yellow plates (Golden spangles).

11. MAGNESIUM: a) Dissolve about 15 mg of the substance being examined in 2 ml of water, add 1 ml of dil. ammonia solution, a white precipitate forms that is

redissolved by adding 1 ml of ammonium chloride. Add 1 ml of 0.25 M disodium hydrogen phosphate a white crystalline precipitate form.

b) To 0.5 ml of a neutral or slightly acidic solution of the substance being examined add 0.2 ml of a 0.1% w/v solution of titan yellow and 0.5 ml of 0.1 m sodium hydroxide, a bright red turbididy develops which gradually settles to give a bright red precipitate.

12. POTASSIUM: a) Dissolve about 50 mg of the substance being examined in 1 ml of water, add 1 ml of dil. acetic acid and 1 ml of a freshly prepared 10% w/v solution of sodium cobalt nitrite, a yellow or orange yellow precipitate forms immediately.

b) Dissolve 0.1 g of the substance being examined in 2 ml of water. Heat the solution with 1 ml of sodium carbonate solution, no precipitate forms. Add 0.05 ml of sodium sulphide solution, no precipitate forms. Cool in ice water and add 2 ml of a 15% w/v solution of tartaric acid and allow to stand, a white, crystalline precipitate forms.

c) Ignite a few mg of the substance being examined and dissolve in the minimum quantity of water. To this solution add 1 ml of platinic chloride solution in the presence of 1 ml of HCI a yellow, crystalline precipitate forms, which on ignition leaves a residue of potassium chloride and platinum.

13. SILVER: a) Dissolve 10 mg of the substance being examined in 10 ml of water, add 0.3 ml of dilute HCI, a curdy white preciptitate is formed that is soluble in dil.ammonia solution. Add potassium iodide solution, a yellow precipitate is formed.

b) Dissolve 10 mg of the substance being examined in 20 ml of water, add 2 ml of potassium chromate solution, a red precipitate is formed which is soluble in nitric acid.

14. SODIUM: a) Dissolve 0.1g of the substance being examined in 2 ml of water, add 2 ml of a 15% w/v solution of potassium carbonate and heat to boiling, no precipitate forms. Add 4 ml of freshly prepared potassium antimonate solution and heat to boiling. Allow to cool in ice water and if necessary, rub the inside of the test-tube with a glass rod, a dense white precipitate is formed.

b) Acidify a solution of the substance being examined with 1M acetic acid and add a large excess of magnesium uranyl acetate solution, a yellow, crystalline precipitate is formed.

15. ZINC: a) Dissolve 0.1 g of the substance being examined in 5 ml of water, add 0.2 ml of sodium hydroxide solution, a white precipitate form. Add a further 2 ml of sodium hydroxide solution, the precipitate dissolves. Add 10 ml of ammonium chloride solution, the solution remains clear but a flocculent, white precipitate forms on addition of 0.1 ml of sodium sulphide solution.

b) Dissolve 0.1 g of the substance being examined in 5 ml of water, acidify with dil.sulphuric acid and add one drop of a 0.1% w/v solution of copper sulphate and 2 ml of ammonium mercuri-thio-cyanate solution, a violet precipitate is formed.

c) Dissolve 0.1 g of the substance being examined in 5 ml of water, add 2 ml of potassium ferrocyanide solution, a white precipitate is formed which is insoluble in dil. HCl.

MODEL QUESTION PAPERS

D. PHARM. EXAMINATION

(PART – I)

12. PHARMACEUTICAL CHEMISTRY – I

[Time: 3 Hours]

Maximum : 80 Marks

Answer FIVE Questions

All questions carry EQUAL marks

Write chemical equations wherever necessary

1. (a) List the official compounds of calcium and mention their use. Give the preparation, properties, use and assay of Iodine. (4+6) = 10

   (b) Give an account on Biological effects of radiation and storage of Radio Pharmaceuticals. (6)

2. Describe the principle of the limit tests of

   (a) Lead (Dithizone method)

   (b) Sulphate

   (c) Iron (8 + 4 + 4)

3. Give the identification tests for the following radicals.

   (a) Iodide

   (b) Nitrate

   (c) Carbonate

   (d) Potassium

   (e) Copper

   (f) Aluminium

   (g) Barium

   (h) Zinc (8 × 2 = 16)

4. (a) Give an account on the sources of impurities in the Pharmacopoeial compounds.

   (b) Discuss the methods used for the quality control. (10 + 6)

5. Write notes on :

   (a) Pharmaceutical Buffers

   (b) Antacids

   (c) Saline Cathartics (5 + 6 + 5)

6. Give the principle of assay of the following:

   (a) Borax

   (b) Sodium Chloride

   (c) Magnesium Sulphate

   (d) Potassium Iodide

7. Outline the preparation of the following compounds.

   (a) Chlorinated Lime

   (b) Ammonium chloride

   (c) Antimony Potassium tartrate

   (d) Ferrous Sulphate (4×4 = 16)

8. Write briefly on :

   (a) Oral electrolyte powder.

   (b) Official mercury compounds

   (c) Protective and adsorbent (5 + 6 + 5)

D. PHARM. EXAMINATION

(PART – I)

12. PHARMACEUTICAL CHEMISTRY – I

[Time : 3 Hours]

Maximum : 80 Marks

Answer FIVE Questions

All questions carry EQUAL marks

Write chemical equations wherever necessary

1. (a) Give the preparation and chemical properties of 'Boric Acid'..

   (b) Explain the electrolytic process of manufacturing 'Sodium Hydroxide'.

   (c) Give the storage condition for

      (i) Strong solution of ammonia.

      (ii) Sodium hydroxide.

   (d) Write a note on "Official buffers". $4 \times 4 = 16$

2. (a) What are 'Anti-Oxidants'? Give the preparation, properties and use of 'Sodium Meta bisulphite'.

   (b) What are Antacids? Outline the preparation of 'Aluminium Hydroxide Gel'.

   (c) Explain the principle of assay of 'Magnesium Tri Silicate'. (6 + 5 + 5)

3. Write notes on the following:

   (a) Light Kaolin

   (b) Talc

   (c) Magnesium Sulphate

   (d) Zinc Stearate $4 \times 4 = 16$

4. Explain the preparation, assay, storage condition and use of the following:

   (a) Hydrogen peroxide

   (b) Chlorinade lime $2 \times 8 = 16$

5. Explain the principle of assay of

   (a) Iodine

   (b) Ammoniated Mercury

   (c) Zinc Sulphate

(d) Sodium Chloride $4 \times 4 = 16$

6. Give an account on :

(a) Precipitated Sulphur

(b) Dicalcium Phosphate

(c) Nitrous Oxide

(d) Antimony Potassium Tartrate $4 \times 4 = 16$

7. Write notes on :

(a) Storage of Radio-active pharmaceuticals

(b) Oral Rehydration Salts

(c) Radio-opaque contrast media

(d) Limit test for 'Chloride' $(4 \times 4 = 16)$

8. (a) Outline the important sources of impurities in inorganic drugs.

(b) Describe the principle of limit test for heavy metals.

(c) Write down the tests for identification of following ions:

(i) Iron

(ii) Calcium $(8 + 4 + 4)$

D. PHARM. EXAMINATION

(PART – I)

12. PHARMACEUTICAL CHEMISTRY – I

[Time : 3 Hours]

Maximum : 80 Marks

Answer FIVE Questions

All questions carry EQUAL marks

Write chemical equations wherever necessary

1. (a) Explain the term Radio activity and Radio Isotopes. (4)

   (b) Discuss the methods for measurement of Radio activity. (6)

   (c) Write the applications of Radio isotopes. (6)

2. Describe the method of preparation and medicinal uses of (4×4 = 16)

   (a) Yellow Mercuric Oxide

   (b) Sodium bicarbonate

   (c) Calcium hydroxide

   (d) Potassium Iodide

3. Give the principle involved in the assay of (4×4 = 16)

   (a) Ferrous Sulphate

   (b) Ammonium Chloride

   (c) Calcium Gluconate

   (d) Iodine

4. (a) Give the reason for the following (4×2 = 8)

      (i) Ammonia is used in the limit test for Iron.

      (ii) Polyhydric alcohol is used in the assay of Boric acid.

      (iii) The use of Lead acetate cotton wool in the limit test for Arsenic.

      (iv) Thioglycollic Acid is added to the Ferric sulphate solution.

(b) Write the properties, storage conditions and medicinal uses of $4 \times 2 = 8$

(i) Oxygen

(ii) Ammonia

(iii) Bentonite

(iv) Epsom salt

5. What are dental products?

Write method of preparation and properties of (16)

(a) Calcium Carbonate

(b) Sodium Fluoride

(c) Zinc Chloride

(d) Dicalcium phosphate

6. Write notes on : $(2 \times 8 = 16)$

(a) Sulphur and its compound.

(b) Protectives and adsorbent.

7. Give the method of preparation, properties and uses of $(4 \times 4 = 16)$

(a) Silver nitrate

(b) Chlorinated lime

(c) Boric Acid

(d) Hydrogen Peroxide

8. (a) Explain the importance of quality control for drugs and pharmaceutical substances. (10)

(b) Give the important test for the identification of $(3 \times 2 = 6)$

(i) Chloride

(ii) Lead

(iii) Calcium