

## Model question and answer

Subject- Pharmaceutical inorganic chemistry      Subject Code- BP104T

B.Pharm First year Sem I

### UNIT I

#### Impurities in pharmaceutical substances

**1. Define 'Pharmacopoeia' and write a brief note on IP. (10 marks)**

- Pharmacopoeia derived from Greek word 'Pharmakon' means drug and 'Poiea' means to make.
- Pharmacopoeia is a book containing directions for the identification of samples and the preparation of compound medicines, and published by the authority of a government or a medical or pharmaceutical society.
- For this reason Pharmacopoeia is a legislation of a nation which sets standards and mandatory quality indices for drugs, raw materials used to prepare them and various pharmaceutical preparations.

#### **Indian Pharmacopoeia**

- First official Pharmacopoeia of India appeared in 1868 which was edited by Edward John Waring.
- In preindependence days, British Pharmacopoeia was used in India.
- In 1946 Government of India issued one list known as 'The Indian Pharmacopoeial list' Committee under chairmanship of Sir R. N. Chopra alongwith other nine members prepared „The Indian Pharmacopoeial list“.
- It was prepared by Dept. of Health, Govt. of India, Delhi in 1946. In 1948 Government of India appointed an Indian Pharmacopoeia committee for preparing „Pharmacopoeia of India.
- Indian Pharmacopoeia committee under chairmanship of Dr. B. N. Ghosh Published first edition of IP in 1955.
- It is written in English & official titles of monographs given in Latin. It covers 986 monographs. Supplement to this edition was published in 1960.
- Second edition of IP was published in 1966 under the chairmanship of Dr. B. Mukkerji.
- Third edition of IP was published in 1985 with two volumes & nine appendices.
- Fourth edition of IP was published in 1996 under the chairmanship of Dr. Nityanand.
- Fifth edition of IP was published in 2007 & addendum to this edition was published in 2008.
- 6th edition of IP is published in 2010. The 6th edition of the Indian Pharmacopoeia 2010 is published by the Indian Pharmacopoeia Commission (IPC) Ghaziabad in accordance with a plan and completed through the untiring efforts of its members, Secretariat and Laboratory over a period of about two years.
- The seventh edition of the Indian Pharmacopoeia (IP 2014) is published by the Indian Pharmacopoeia Commission (IPC) on behalf of the Government of India, Ministry of Health & Family Welfare.

- The Eighth edition of Indian Pharmacopoeia (IP- 2018) is published by the Indian Pharmacopoeia Commission (IPC) on behalf of the Ministry of Health & Family Welfare, Government of India in fulfilment of the requirements of the Drugs and Cosmetics Act, 1940 and the Rules there under.
  - **Union Minister for Health and Family Welfare and Chemicals and Fertilisers, Dr. Mansukh Mandaviya chaired IPC Conference 2022 and released 9th edition of Indian Pharmacopoeia on 1st July at Vigyan Bhawan, New Delhi.**
- 2. What is a Pharmacopoeial Monograph? (2 marks)**
- A pharmacopoeial monograph usually contains basic chemical information for the ingredient, as well as its description and function (for food ingredients).
  - Furthermore, a monograph contains detailed instructions for identification, purity tests and other specific tests to limit the amount of undesirable impurities, all of which may be used to verify common requirements by manufacturers and formulators concerned with the quality of their ingredients and products.
- 3. What is a Pharmacopoeia? (2 marks)**
- Pharmacopoeia derived from Greek word 'Pharmakon' means drug and 'Poiea' means to make.
  - Pharmacopoeia is a book containing directions for the identification of samples and the preparation of compound medicines, and published by the authority of a government or a medical or pharmaceutical society.
- 4. Classify impurities according to ICH guideline and write down the sources of impurities. (10 marks)**
- The sources of impurities in pharmaceutical drug products and drug substances can be assigned to the drug substance or inert ingredients which are used for the formulation of a drug product.
  - Sources of impurities can also be brought into the drug product during formulation process or through contact with the packaging.
  - The impurities formation may take place either in drug substances, drug products, or during the formulation of the products. The sources of impurities may be from the intermediate step or from the route of synthesis.

According to the ICH guideline impurities are classified as:

- **Organic impurities** – Impurities that occur due to starting materials, by-products, intermediates, degradation products, reagents, ligands, and catalysts.
- **Inorganic impurities** – Inorganic impurities may be derived from the manufacturing process and are normally known and identified as reagents,

- **Residual solvents** – Residual solvents are the impurities introduced with solvents i.e. Class 1- Solvents To Be Avoided, Class 2 – Solvents To Be Limited, Class 3 – Solvents with Low Toxic Potential.
- In the above three types, the number of inorganic impurities and residual solvents is limited. These are easily identified and their physiological effects and toxicity are well known. For this reason, the limits set by the pharmacopeias and the ICH guidelines guarantee that the harmful effects of these impurities do not contribute to the toxicity or the side effects of the drug substances.

### Source of impurities:

- **Impurities in starting materials and Intermediates:** Starting materials and intermediates are the chemical building blocks used to construct the final form of a drug substance. Unreacted starting materials and intermediates, particularly those involved in the last steps of the synthesis, can potentially survive the synthetic and purification process and appear in the final product as impurities. For example in the synthesis of the Tipranavir drug substance, aniline is the intermediate in the last step of the synthesis. Due to the similarity between the structures of aniline and the final product, it is difficult to totally eliminate it in the subsequent purification step. Consequently, it appears in the drug substance at around 0.1%.
- **By-products of the synthesis:** All chemical reactions are not 100% selective; the side reactions are common during the synthesis of drug substances. By-products from the side reactions are among the most common process impurities in drugs. By-products can be formed through a variety of side reactions, such as incomplete reaction, overreaction, isomerization, dimerization, rearrangement, or unwanted reactions of starting materials or intermediates with chemical reagents or catalysts.
- **Products of over-reaction:** In many cases, the previous steps of the synthesis are not selective enough and the reagents attack the intermediate not only at the desired site. For example in the synthesis of nandrolone decanoate, the last step of the synthesis is the decannulation of the 17-OH group. In the course of overreaction, the reagents also attack the 4-ene-3 oxo group leading to an enol ester-type impurity (3, 17 $\beta$ - dihydroxyestra-3, 5- diene disdecanoate).
- **Products of side reactions:** Some of the frequently occurring side reactions (which are unavoidable in drug synthesis) are well-known to synthetic chemists; other side reactions that lead to trace-level impurities have to be detected and elucidated during impurity profiling. The formation of a diketopiperazine derivative is a typical side reaction in peptide synthesis.
- **Impurities originating from degradation of the drug substance:** Impurities can also be formed by degradation of the end product during the manufacturing of bulk drugs. Degradation products resulting from storage or formulation of different dosage forms or aging are common impurities in medicines. The definition of degradation product in the

- ICH guidelines is a molecule resulting from a chemical change in the substance brought about by overtime or due to the action of light, temperature, pH, or water or by reaction with the excipient and/or the intermediate container closure system.
- **Enantiomeric impurities:** The majority of therapeutic chiral drugs used as pure enantiomers are natural products. The high level of enantioselectivity of their biosynthesis excludes the possibility of the presence of enantiomeric impurities. In the case of synthetic chiral drugs, the racemates which are usually marketed, if the pure enantiomer is administered, the antipode is considered an impurity. The reason for its presence can be either the incomplete enantioselectivity of the syntheses or the incomplete resolution of the enantiomers of the racemate. Although the ICH guidelines exclude enantiomeric impurities, pharmacopeias consider them as ordinary impurities.
- **Reagents, ligands, and catalysts:** These chemicals are less commonly found in APIs; however, in some cases, they may pose a problem as impurities. Chemical reagents, ligands, and catalysts used in the synthesis of a drug substance can be carried over to the final products as trace-level impurities.

**5. Write about factors affecting types and amount of impurities present in the chemicals or pharmaceutical substances. (5marks)**

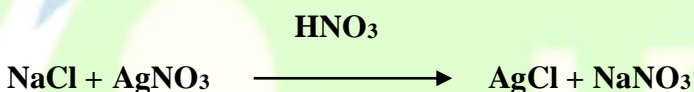
- Several factors affect the types and amount of impurities present in the chemicals or pharmaceutical substances, such as:
  1. **Raw materials used in the manufacture** – Impurities known to be associated with these chemicals may be carried through the manufacturing process and contaminate the final product.
  2. **Reagents used in the manufacturing process** – If reagents used in the manufacturing process are not completely removed by washing, these may find entry into the final product.
  3. **Method/Process used during manufacturing** – Drugs and chemicals are manufactured from different raw materials, using different methods or processes. The impurities are incorporated into the material during the manufacturing process. The type and amount of impurity present vary in the drugs/chemicals.
  4. **Chemical processes used in manufacturing**
  5. **Atmospheric contamination during the manufacturing process**
  6. **Intermediate products in the manufacturing process**
  7. **Defects during manufacturing**
  8. **Manufacturing hazards**
    - Particulate contamination – The presence of unwanted impurities can arise from dirt, dust, glass, porcelain, or plastic fragments or from product containers.
    - Process errors – A number of active ingredients in the product & its pharmacopeial limits may affect the manufacturing process and may create process errors.
    - Cross-contamination – The handling of powders, granules, and tablets in bulk creates airborne dust, which can lead to cross-contamination of the product.
    - Microbial contamination – Many liquid preparations and creams are susceptible to bacterial and fungal contamination.
    - Packing errors – Improper labeling or destruction of stock of unused labels may constitute a packing hazard.

6. **Inadequate storage conditions** – Reactions with the content material or the occurrence of changes in the physical form of the drug due to temperature.
7. **Decomposition of the product during storage** – Substances may decompose in storage due to the presence of air, light, and oxygen leading to the final product being contaminated. Decomposition products appear as impurities in the substances.
8. **Accidental substitution or deliberate adulteration with spurious or useless materials** – many pharmaceutical chemicals are adulterated with cheaper substances.
  - The control of pharmaceutical impurities is currently a critical issue for the pharmaceutical industry. ICH has created guidelines regarding control impurities. The other various regulatory authorities also emphasize the identification of impurities and purity in the APIs. Thus, impurities testing for pharmaceuticals is necessary for creating a quality product for the market.
9. **Describe the principle, apparatus and procedure for the limit test of chloride.**

**Apparatus required:** Nessler's cylinder, Nessler's stand and glass rod

**Chemical required:** Dilute nitric acid, 0.0584 % w/v solution of NaCl, 0.1N silver nitrate

**Principle:** Limit test of chloride is based on the reaction of soluble chloride with silver nitrate in presence of dilute nitric acid to form silver chloride, which appears as solid particles (Opalescence) in the solution.



| Test sample  | Standard compound   |
|--|---|
| Specific weight of compound is dissolved in water or solution is prepared as directed in the pharmacopoeia and transferred in Nessler cylinder | Take 1ml of 0.05845 % W/V solution of sodium chloride in Nessler cylinder |
| Add 1ml of nitric acid   | Add 1ml of nitric acid  |
| Dilute to 50ml in Nessler cylinder   | Dilute to 50ml in Nessler cylinder  |
| Add 1ml of AgNO <sub>3</sub> solution  | Add 1ml of AgNO <sub>3</sub> solution                                     |
| Keep aside for 5 min   | Keep aside for 5 min  |
| Observe the Opalescence/Turbidity  | Observe the Opalescence/Turbidity   |

**Observation:** The opalescence produce in sample solution should not be greater than standard solution. If opalescence produces in sample solution is less than the standard solution, the sample will pass the limit test of chloride and vise versa.

- ❖ Nitric acid is added in the limit test of chloride to make solution acidic and helps silver chloride precipitate to make solution turbid at the end of process.

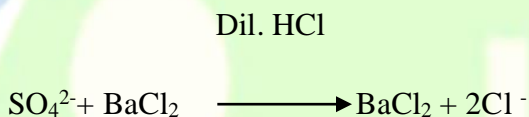
## 10. Describe the principle, apparatus and procedure for the limit test of sulphate.

### Requirements

**Apparatus-** Nessler's cylinder 50 ml, beaker, stirrer etc.

**Chemical's-** sodium chloride, HCl, sulfuric acid, barium chloride, alcohol.

**Theory –** The limit test for sulfate is mainly designed to control sulfate impurity in inorganic substance. It depends upon the precipitation of the sulfate ion with BaSO<sub>4</sub> reagent in the presence of dil. HCl. The turbidity so obtained is compared with std turbidity containing a known amount of sulfate ion.



### Procedure

**Sample:** Dissolve the specified qty of NaCl in 10 ml of Distilled water and transfer to a nessler cylinder. Add 2 ml of dil HCl. Dilute to 45 ml with DW. Add 5 ml of BaSO<sub>4</sub> soln. Stir immediately with a glass rod, and set aside for 5 min. The turbidity produced is not greater than the std turbidity

**Standard solution:** Take 2.5 ml of 0.01 N H<sub>2</sub>SO<sub>4</sub> in a nessler cylinder. Add 2 ml of dil HCl and dilute to 45 ml with distilled water. Add 5 ml of BaSO<sub>4</sub> soln. stir immediately with a glass rod and set aside for 5 min. **Observation:** Inference: the given sample passes/ fails the limit test for sulfate.

**Observation:** The opalescence produce in sample solution should not be greater than standard solution. If opalescence produces in sample solution is less than the standard solution, the sample will pass the limit test of chloride and vise versa.

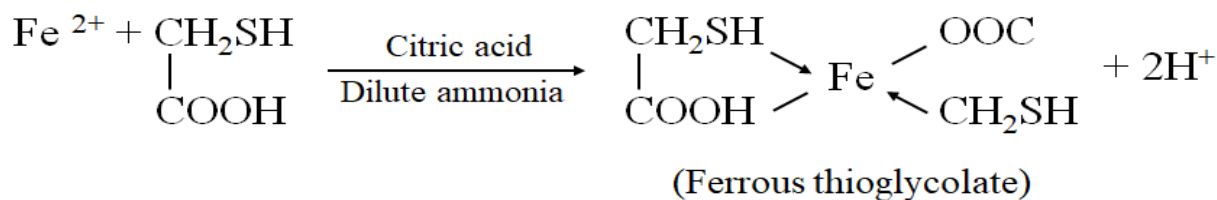
## 11. Describe the principle, apparatus and procedure for the limit test of iron.

**Apparatus required:** Nessler's cylinder, Nessler's cylinder stand, glass rod

**Chemicals required:** 90% iron free citric acid solution, standard iron solution, thioglycolic acid

### Principle:

Limit test of Iron is based on the reaction of iron in ammoniacal solution with thioglycolic acid in presence of citric acid to form iron thioglycolate which is pale pink to deep reddish purple in color.



(Thioglycolic acid)

| Test sample   | Standard compound  |
|---|--|
| Sample is dissolved in specific amount of water and then volume is made up to 40 ml | 2 ml of standard solution of iron diluted with water upto 40ml           |
| Add 2 ml of 20 % w/v of citric acid (iron free)                                     | Add 2 ml of 20 % w/v of citric acid (iron free)                          |
| Add 2 drops of thioglycolic acid  | Add 2 drops of thioglycolic acid   |
| Add ammonia to make the solution alkaline and adjust the volume to 50 ml            | Add ammonia to make the solution alkaline and adjust the volume to 50 ml |
| Keep aside for 5 min  | Keep aside for 5 min   |

Earlier ammonium thiocyanate reagent was used for the limit test of iron. Since thioglycolic acid is more sensitive reagent, it has replaced ammonium thiocyanate in the test.

**Observation:** The purple color produce in sample solution should not be greater than standard solution. If purple color produces in sample solution is less than the standard solution, the sample will pass the limit test of iron and vice versa.

**Reasons:** Citric acid helps precipitation of iron by ammonia by forming a complex with it. Thioglycolic acid helps to oxidize iron (II) to iron (III). Ammonia to make solution alkaline.

## 12. Describe the principle, apparatus and procedure for the limit test of heavy metal.

### Principle:

Limit test of Heavy metals is based on the reaction of metallic impurities with Hydrogen sulfide (H<sub>2</sub>S) or Sodium Sulfide in an acidic medium to produce metal sulphides which gives Brown color. Here lead is used to make standard solution. Heavy metal like: Cobalt, tin, Manganese, Bismuth, Antimony, Silver, Arsenic, lead etc.

**Procedure:** Method A & B: Method A is used for substance gives clear colorless solution under specific condition given in monograph, while Method B is for those substance which does not give clear colorless solution. **Procedure for method A:**

| Test sample  | Standard sample  |
|--|--|
| Place 25 ml of the solution of the test sample prepared according to direction of I.P. in a Nessler cylinder labelled as 'Test'. | Place 2 ml of standard lead solution (0.02mg lead) in a Nessler cylinder labelled as 'Standard' and dilute with distill water to 25ml. |
| Adjust with dil. Acetic acid or ammonia to a pH b/t 3 to 4 and dilute with water to 35 ml.                                       | Adjust with dil. Acetic acid or ammonia to a pH b/t 3 to 4 and dilute with water to 35 m   |
| Add 10 ml of freshly prepared saturated solution of hydrogen sulphide  | Add 10 ml of freshly prepared saturated solution of hydrogen sulphide  |
| Make the volume to 50 ml with distilled water and mix  | Make the volume to 50 ml with distilled water and mix  |
| Keep aside for 5 min   | Keep aside for 5 min   |



## Procedure for Method B:

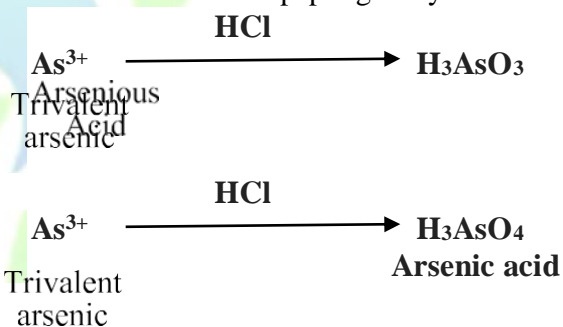
It is similar to method A except in this case the coloured substance (Test sample) is given special treatment (Sulphuric acid, ignition, nitric acid, ignition, HCl and finally digestion with water) to make it colourless before preparing its solution.

**Observation:** The turbidity/ color produce in sample solution should not be greater than standard solution. If turbidity/color produces in sample solution is less than the standard solution, the sample will pass the limit test of heavy metals and vice versa.

## 13. Describe the principle, apparatus and procedure for the limit test of arsenic.

### Limit test of Arsenic (Gutzeit Test)

Limit Test for Arsenic (As) is based on the fact that Arsenic is easily reduced into Arsine gas ( $\text{AsH}_3$ ), which on mercuric chloride paper gives yellow stain.

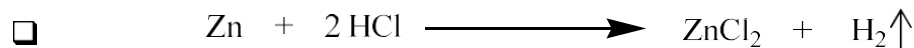


- The solution is treated with a reducing agent (Stannous Chloride) to convert the pentavalent arsenic acid into trivalent arsenious acid.

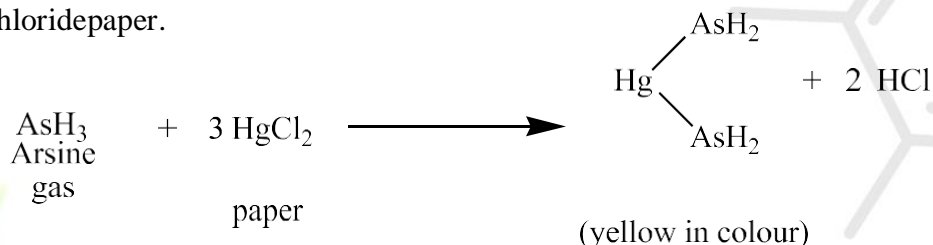


- The arsenious acid is then converted into gaseous arsenious hydride (arsine gas) with the help of nascent hydrogen, which is produced by  $\text{Zn} + \text{HCl}$ .





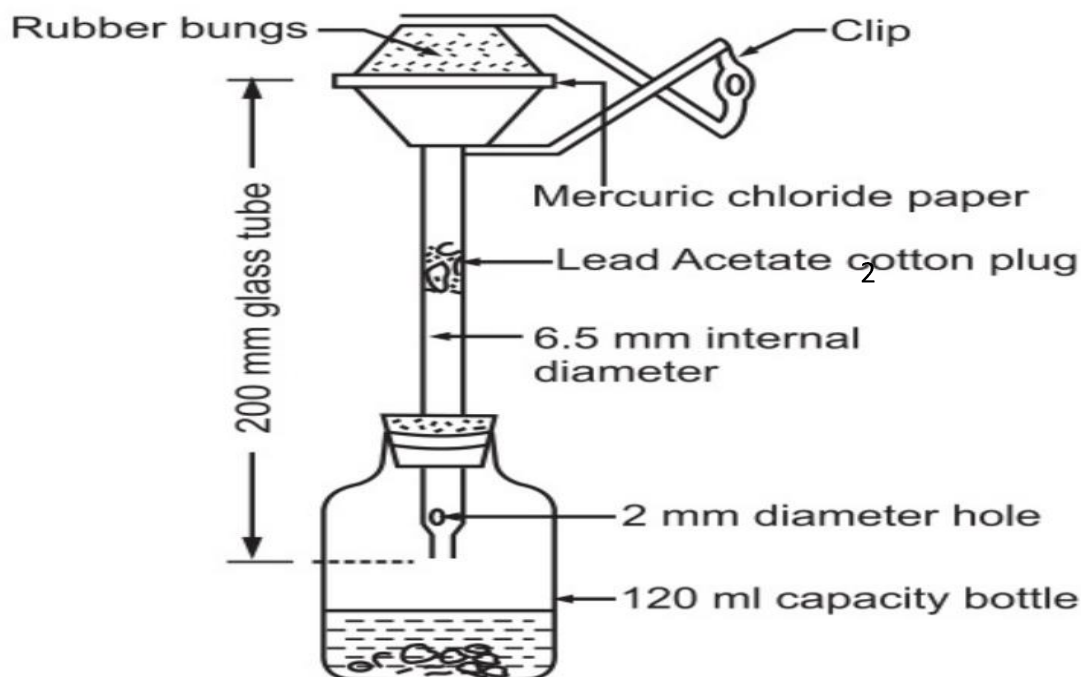
Arsine gas is carried through the tube by the stream of hydrogen and out through the mercuric chloride paper.



This results in the formation of yellow or brown stain on the mercuric chloride paper. The intensity of the colour is proportional to the quantity of arsenic.

- In the same manner a standard stain is separately produced for the permissible limit of arsenic.

The intensity of the two stains is compared. If the intensity of stain in the case of 'Test' (sample) is more than that of the 'standard' then the sample contains more arsenic than the limit.



## Procedure:

- The solution of Test (sample) is prepared in the acid (HCl) and stannous chloride as specified in I.P. and displaced in a wide-mouthed bottle.
- To this is added 1 gm of potassium iodide AsT and 10 gm of Granulated Zinc AsT. The glass tube with its outer fitting is placed quickly, keep the solution aside for 40 minutes.
- The yellow stain is produced on the mercuric chloride paper if arsenic is present.
- It is compared in day light with the standard stain produced by doing the test separately in a similar manner with known quantity of dilute arsenic solution. The solution contains 1.32 mg of arsenic trioxide in 100 ml water.

## Notes:

- All reagent used must be completely free from arsenic impurity. Marked as 'AsT'.

Potassium iodide is used because it helps in the reduction of pentavalent arsenic acid into trivalent arsenic acid.

### **14. Which ICH guidelines refer to impurities? (2 marks)**

According to the ICH (International Conference of Harmonization), impurities are classified as organic, inorganic, and residual solvents. The Q3A (R2) refers to the impurities in the New Drug substance. The guidelines address the impurities, chemistry, listing of impurities in their threshold, qualification, and identification. Further, Q3B (R2) refers to Impurities in New drug products, and it defines those impurities which might arise from the drug substances as degradation products or the interaction between excipient and drug substances or the primary packing materials (components).

### **15. What are impurities in pharmaceuticals? (2 marks)**

The Impurities are classified as inorganic impurities, organic impurities, or residual solvents. Organic impurities may arise from starting materials, by-products, synthetic intermediates, and degradation products. Inorganic impurities may be derived from the manufacturing process and are commonly known and identified as reagents, ligands, inorganic salts, heavy metals, catalysts, filter aids, charcoal, etc. Finally, residual solvents are the

impurities introduced with solvents. The number of inorganic impurities and residual solvents of the above three types is limited.

### 16. What are the common sources of Impurities? (2 marks)

The sources of impurities may arise from inorganic impurities, organic impurities, and residual solvents. Organic impurities may be from the starting materials, as a by-product, stages of intermediates, and also degradation products. Inorganic impurities may be through manufacturing processes which are normally identified as reagents, inorganic salts, ligands, heavy metals, charcoal, catalysts, etc. Residual solvents impurities are residual solvents present in the manufacturing process.

### 17. What are the factors affecting impurities in pharmaceuticals? (2 marks)

The factors affecting the impurities in the drug substances or drug products may be due to the synthesis process or manufacturing processes, degradation, storage conditions, excipients, container, or contamination.

## Unit – 2

### Acids, Bases and Buffers

#### 1. Define buffer. Write down its application.

A buffer is a solution that can resist pH change upon the addition of an acidic or basic components. It is able to neutralize small amounts of added acid or base, thus maintaining the pH of the solution relatively stable.

Application of buffers:

- Purify specific components, such as insulin, by separating them and purifying them.
- Make sure the drug is solubilized: Some ingredients are only dissolved at specific pH levels.
- Stabilize the drug's components: Prevent the gastrointestinal environment from destroying or altering the pH value of essential components, such as aspirin.
- Make sure ingredients are biologically active: Certain ingredients, such as pepsin, cannot maintain their activity below a specific pH level.

- A drug's ability to be injected into the human body: Injections closely match blood pH values; eye drops closely match conditions around the eye.
- It inhibits gastric acid production by acting as a buffer by reducing the stomach's acid content.
- In biological systems - Two buffer systems keep the pH of the blood at 7.4. First is plasma - A primary buffer is found in plasma. There are two kinds of acids/alkalis present in plasma: carbonic acid and sodium carbonate. In erythrocytes, secondary buffers are oxyhemoglobin, hemoglobin, and potassium salts of acid and alkali phosphoric acid.
- In pharmaceutical systems - Pharmacy utilizes buffers to ensure maximum stability for products by adjusting their pH levels. If you are going to use parenteral preparations (i.e. injections), you should be careful about pH as large deviations are potentially harmful. Parenteral products should have a pH of 7.4, which is the pH of the blood. As part of parenteral products (injections), acetate, phosphate, citrate, and glutamate are often used as buffers.

## 2. Discuss in detail about buffer equation and buffer capacity.

Buffer equation

Henderson-Hasselbalch Equation is also known to be a buffer equation.

**For acid buffers** - The pH can be calculated by comparing the dissociation constant K of the weak acid with the concentrations of acid and salt.

Here is how dissociation expressions of weak acids look.



$$K_a = \frac{[\text{H}^+][\text{A}^-]}{[\text{HA}]}$$

$$\text{Or } [\text{H}^+] = K_a \frac{[\text{HA}]}{[\text{A}^-]} \text{----- (1)}$$

Weak acids are only marginally dissociated, and their dissociation is further depressed by the addition of A-ion (common ion effect), resulting in an equilibrium concentration of the unionized acid that is nearly the same as its initial concentration after unionization. We assume that the equilibrium concentration of A- is equal to the concentration of salt added at the start, due to its complete dissociation. The concentration of A- is represented by the salt concentration in equation (1) above.

$$[\text{H}^+] = K_a \cdot \frac{[\text{Acid}]}{[\text{Salt}]} \text{----- (2)}$$

If you take the logs on both sides, we attain:  $\log[H^+] = \log K_a + \log [Acid] / [Salt]$  when both sides are multiplied by  $-ve$ ,

$$-\log[H^+] = -\log K_a - \log [Acid] / [Salt] \text{ As}$$

$$-\log[H^+] = pH \ \& \ -\log K_a = pK_a \ \text{pH} = pK_a - \log[Acid] / [Salt] \text{ OR}$$

$$pH = pK_a + \log[Salt] / [Acid] \text{ ----- (3)}$$

Equation (3) is known as the Henderson-Hasselbalch equation.

By knowing the acid and salt concentrations, it assists in calculating a buffer solution's pH value.

**For basic buffers** - Based on the same principle as for acidic buffers, we can calculate the buffer equation for basic buffers. Suppose a basic buffer is made up of a mixture of weak organic acids (BOH) and their salts (BA). We can write the dissociation constant for the base as follows:

$$BOH \leftrightarrow B^+ + OH^- \quad K_b = [B^+] [OH^-] / [BOH] \text{ OR } [OH^-] = K_b [BOH] / [B^+] \text{ ----- (1)}$$

In other words, the balance between equilibrium concentrations of the unionized base and its initial concentrations is close. This is because a weak base is only slightly dissociated by the salt, BA, providing the  $B^+$  ion (common ion effect). Since the salt has been completely dissociated by the time it reaches equilibrium,  $B^+$  is assumed to have the same equilibrium concentration as the initially added salt. Accordingly, in equation (1), the salt concentration is used as a measure of  $B^+$  concentration.

$$[OH^-] = K_b \cdot [Base] / [Salt] \text{ ----- (2)}$$

By adding the two logs together, we get:

$$\log[OH^-] = \log K_b + \log [Base] / [Salt]$$

Adding the  $-ve$  sign to both sides,

$$-\log[OH^-] = -\log K_b - \log [Base] / [Salt] \text{ As } -\log[OH^-] = pOH \ \& \ -\log K_b = pK_b \ \text{pOH} = pK_b - \log [Base] / [Salt]$$

$$\text{Or } pOH = pK_b + \log[Salt] / [Base] \text{ -----(3)}$$

**Buffer capacity:**

Adding acid or base to a buffer solution will change its buffer capacity, which measures its resistance to pH changes. Besides buffer capacity, buffer value, buffer efficiency, and buffer coefficient are other terms for buffer capacity.

The buffer capacity for which the symbol ' $\beta$ ' stands may also be defined as follows:

The ratio between a small increase in acidity or alkalinity (amount added) and the small change in pH ( $\Delta\text{pH}$ ) that results from its addition.

$$\beta = \Delta A \text{ or } \Delta B / \Delta\text{pH}$$

You can change the pH of a buffer by mixing gradations of strong acid or base (in gram equivalents or liters) with it. It is necessary to add one gram of a strong acid or base to one liter of a solution to adjust its pH by one unit. Therefore, if the pH level of a solution changes less when acid or base is added, the buffer capacity is higher and vice versa.

### 3. What is buffer capacity, mention the formula?

**Ans:**

Buffer capacity is defined as the number of moles of an acid or base that has to be added to 1 liter of a buffer to cause its pH to change by 1 unit.

Therefore, to calculate buffer capacity, we use the following formula:

$$\beta = \frac{n}{\Delta\text{pH}}$$

- $\beta$  is buffer capacity (it is unitless)
- $n$  is the number of moles of an acid or base (added to the buffer) per liter of the buffer
- $\Delta\text{pH}$  is the difference between the initial pH of the buffer and the pH of the buffer after the addition.

### Major extra and intracellular electrolytes

#### 1. Mention the composition of ORS (Oral Rehydration Salts) and explain briefly?

The composition of the new, reduced osmolarity ORS, as recommended by WHO, is as follows:

- Sodium chloride—2.6 g
- Glucose (anhydrous)/dextrose—13.5 g
- Potassium chloride—1.5 g
- Trisodium citrate dehydrate—2.9 g

(Total weight of a packet = 20.5 g)

The new ORS was launched by WHO in January 2004 and in India in June 2004.

2. **How is the ORS reconstituted?**

The contents of the packet are dissolved in 1 L of drinking water.

3. **What is the role of each of the constituents?**

- Glucose facilitates absorption of sodium and hence water.
- Sodium and potassium replace the loss of these essential elements in diarrhea and vomiting.
- Citrate corrects the acidosis that occurs due to diarrhea and dehydration. Selection of fluids.

4. **How is the new ORS different from the older formulation?**

The new ORS contains lesser amount of sodium and glucose thereby resulting in a lower osmolarity solution after reconstitution.

5. **What benefit does trisodium citrate offer over the use of sodium bicarbonate in ORS?**

Trisodium citrate has the following advantages over sodium bicarbonate:

- It improves the shelf life of ORS.
- It helps in reducing the stool output probably through a direct action on the intestinal mucosa, enhancing the absorption of sodium and water.

6. **Write a notes on 'Electrolytes used in the replacement therapy'.**

**Electrolyte replacement therapy** To achieve normal body fluid volume and composition, a replacement of body fluids must be performed. Volume contraction is life-threatening because it compromises the circulatory system, causes blood volumes to drop, heart output to decrease, and microcirculation to become impaired. An infusion of sodium chloride solution is indicated when volume depletion leads to life-threatening conditions. Cholera has been successfully treated with intravenous administration at a rate of 100 ml per minute for the first 1000 ml of blood.

**Sodium chloride replacement**

Sodium chloride: NaCl (molecular weight – 58.44)

It does not contain any added substances. It appears to be in a white crystalline powder or a colorless cubic form while having a saline taste. Along with this, it is slightly soluble in boiling water while fully soluble in water at room temperature. It is slightly soluble in alcohol and fully soluble in glycerine.

Use: it is widely used as a flavor enhancer, fluid and electrolyte replenisher, and manufacturer of isotonic solutions. Typically, isotonic solutions are used in moist dressings to irrigate cavities in the body or tissues. The administration of hypotonic solutions is used when patients are incapable of taking fluids or nutrients orally for a period of one to three days. There is excess sodium loss when using hypertonic solutions/injections.

**Potassium chloride replacement**

Potassium chloride: KCl (Molecular weight – 74.56)



Calculated using the dried substance, the potassium chloride content is not less than 99%. Crystals of it are white crystalline solids, cubic. In water, it is less soluble than sodium chloride, and in boiling water, it is slightly more soluble. It is also soluble in glycerine, although it is insoluble in alcohol.

Use: In potassium deficiency, fibromyalgia, myasthenia gravis, electrolyte replenisher is prescribed.

Contraindication: renal impairment.

### **Calcium replacement Calcium:**

Ca<sup>2+</sup> (Molecular weight 308.30) At least 97% and at least 103% of Calcium Chloride dihydrate are contained within Calcium Chloride. In its powder form, it is a white, odorless substance that is soluble in water but nearly insoluble in alcohol.

Use: Calcium supplementation for calcium deficiency is an excellent method.

### **Oral rehydration salt (ORS)**

The oral rehydration solution (ORS) contains potassium chloride and sodium citrate along with glucose sodium chloride and sodium chloride. The tablets are to be dissolved in the requisite volume of water and to be used to prevent and treat dehydration associated with diarrhea, including to maintain hydration levels. To effectively treat diarrhea, WHO and UNICEF recommend using ORS and zinc together. 1,2 ORS replaces the essential fluids and salts lost through diarrhea. This means zinc reduces the length and severity of episodes and shortens the time to recurrence. Children with diarrhea can be treated with ORS and zinc, which is highly effective and inexpensive, and could prevent deaths in 93% of cases.

**Packaging and labeling:** Aluminum foil sachets with multiple layers should be used to package ORS since the product can be compromised by highly humid conditions. A combination of polyethylene (on the inside), aluminum (on the middle), and polyester (on the outside) have proved to be an effective pack for ORS. However, the stability of the product is also influenced by these conditions: the raw material must be dry, the sealing must be perfect, and the final product must be stored correctly.

### **7. Write down the laboratory method of preparation and assay of sodium chloride.**

It is prepared by acid base reaction in which, strong acid is formed with strong base to form sodium chloride.



- **Assay of sodium chloride**

Dissolve 0.1 g in 50 ml of water in a glass stoppered flask. Add 50 ml of 0.1M silver nitrate, 5 ml of 2M nitric acid and 2 ml of dibutyl phthalate, shake well and titrate with 0.1M ammonium thiocyanate using 2 ml of Ferric ammonium sulphate solution as indicator, until the colour becomes reddish yellow.

## 8. Write down the assay and use of calcium gluconate.

Weigh 0.5 g and dissolve in 50 ml of warm water; cool, add 5.0 ml of 0.05 M magnesium sulphate and 10 ml of strong ammonia solution and titrate with 0.05 M disodium edetate using mordant black II mixture as an indicator. Carry out a blank titration

Use: It is used in electrolyte replacement therapy.

It is used as a source of calcium.

### Dental products

#### 1. Discuss the role of fluorides in dental caries. (5 marks)

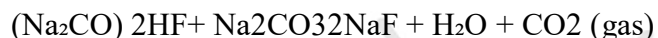
- Small quantity of fluoride is necessary to prevent dental caries. Fluoride is anticariogenic as it replaces the hydroxyl ion in hydroxyapatite with the fluoride ion to form fluorapatite in the outer surface of the enamel.
- Fluorapatite hardens the enamel and makes it more acid resistant.
- Fluoride is most beneficial upto an age of 12 or 13 because unerupted permanent teeth are mineralizing during that time.
- Fluoride can be administered by two routes orally and topically. The fluoridation of the public water supply is the most convenient and effective way of oral administration. This can be achieved by adding sodium fluoride, giving a fluoride concentration of 07-10 ppm. Fluoride can also be administered orally as sodium fluoride tablets or drops added in water or fruit juice.
- fluoride can be administered topically. A 2% aqueous solution of sodium fluoride is widely used topically. A freshly prepared solution of stannous fluoride is also extensively used for topical application of fluoride.

#### 2. Describe the method of preparation and uses of any two dental products. (5 marks)

- Sodium fluoride is an inorganic chemical which is widely used for fluoride ion in dental products preparations. It protects the teeth from acid demineralization during bacterial growth it provides the strength for tooth enamel and prevents the tooth decay. Minor quantity of sodium fluoride is used in drinking water.

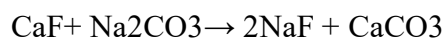
#### **Preparation:**

It may be prepared by neutralization of hydrofluoric acid with (HF) sodium carbonate



## Another Method

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



## Uses:

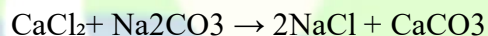
- To prevent dental caries
- Usual dose 2.2 mg (equivalent to 1 mg of fluoride ion)
- Application: 15-3.0 ppm (equivalent to 0.7-13 ppm of fluoride ion) in drinking water topically as 2% solution to the teeth.
- Formulations: Sodium fluoride is administered as solution, tablet, oral gel for systemic use or as mouth wash for local

## Calcium carbonate( $\text{CaCO}_3$ ):

- It is the most abundant and widely distributed calcium salts It occurs as chalk, marble, calcite, corals, pearls aragonite, calcite, and limestone, marble

## Preparation:

It is prepared by precipitation by mixing the boiling solutions of calcium chloride and sodium carbonate and allowing the precipitation to cool



## Uses

- Precipitated chalk, which is having a fine powdery texture, is used as dentifrice, both powders and pastes.
- It furnishes both abrasive effect in the mouth
- Non-systemic antacid

### 3. What is dental caries? Name two anticaries agents. (2 marks)

Dental caries or tooth decay is caused by acids produced by the action of microorganism on carbohydrates It is believed that food particles containing carbohydrates lodged between the teeth undergo decay because of bacterial action and produce acids.

This disease is characterized by decalcification of tooth (calcium deposition) accompanied by foul mouth odor.

To prevent dental caries and to maintain clean and healthy teeth, it becomes necessary to use dentifrices, which clean the surface of teeth.

- **Example of Anticaries agents** - Sodium fluoride, stannous fluoride

#### 4. What is desensitizing agents? Give examples. (2 marks)

- Desensitizing agents are used in dental preparations to reduce sensitivity of teeth to heat and cold
- They act as local anesthetic

**Example-** Strontium chloride, Zinc chloride

#### 5. What are Dentifricing agents? Give examples. (2 marks)

- A dentifrice is a substance used with a tooth brush for the purpose of cleaning the surface of teeth.
- Dentifrices contain agents for cleaning tooth surfaces and providing polishing effect on the cleaned teeth. These agents are abrasive in nature. They are responsible for physically removing plaque and debris. The overall effect provides whiteness to the teeth. Dentifrices are applied as powders or pastes.
- Examples -Dicalcium phosphate,

sodium metaphosphate.

calcium pyrophosphate,

calcium carbonate and

calcium monohydrogen phosphate

#### 6. Write a note on 'Zinc oxide eugenol cement'.

- Zinc oxide eugenol (ZOE) is a material formed by the combination of zinc oxide and eugenol contained in oil of cloves.
- They are cements of low strength. Also, they are the least irritating of all dental cements and are known to have an obtundent effect on exposed dentin.

Classification:

Type I ZOE: For temporary cementation

Type II ZOE: Permanent Cementation

Type III ZOE: Temporary filling and thermal base

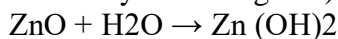
Type IV ZOE: Cavity Liners

ZOE cement is available as:

1. Powder and liquid
2. Paste system

**Method of Preparation:**

- In the First Step Hydrolysis of Zinc Oxide to its hydroxide takes place. Water is essential for the reaction (dehydrated zinc oxide will not react with dehydrated eugenol)



- The reaction proceeds as a typical acid – base reaction



(Zinc hydroxide) (Eugenol) (Zinc eugenolate)

- The Chelate formed is an amorphous gel that tends to crystallize imparting strength to the set mass

Structure of set cement: The set cement consists of particles of zinc oxide embedded in a matrix of zinc eugenolate.

Setting time is around 4-10min.

Uses:

1. Zinc oxide eugenol is used in temporary and permanent cementation and also used as pulp capping agent.
2. It is used to reduce pain sensation in teeth and also has anesthetic and anti bacterial activity.

### UNIT III

#### Gastrointestinal agents

##### Acidifiers

#### 1. Define acidifiers. Classify it.

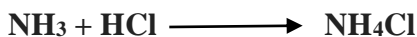
- Acidifiers or Acidifying Reagents are the drugs which are able to increase the acidity temporarily in GIT.
- In another words Acidifiers are inorganic chemicals that either produce or become acid.
- These chemicals increase the level of gastric acid in the stomach when ingested, thus decreasing the stomach pH.
- Systemic acidifiers given via injection reduces the alkali accumulation in the body and useful in reducing metabolic alkalosis.

Mainly there are 3 types of acidifiers.

- a) Gastric acidifiers: used in controlling acidic pH in stomach.
- b) Urinary acidifiers: used in controlling acidic pH in urine.
- c) Systemic acidifiers: used in controlling acidic pH in all parts of body.

#### 2. Write down the method of preparation, assay, properties and use of ammonium chloride.

- Ammonium chloride is prepared by commercial method.
- Neutralization of Ammonia with HCl yields Ammonium Chloride.
- The purification is done by sublimation process.



#### ➤ Properties:

**Appearance:** White solid, hygroscopic

**Odor:** Odourless

**Taste:** Cooling saline

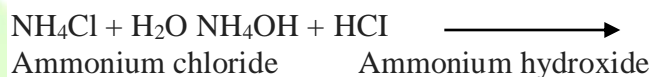
**Density:** 1.5274 g/cm<sup>3</sup>

**Melting point:** 338 degree C

**Solubility:** Free soluble in water and glycerol, sparingly soluble in alcohol.

➤ **Assay:**

- Acid base titration reaction.
- Dissolve 1.000 g of Ammonium chloride in 20 ml of water and add a mixture of 5 ml of formaldehyde solution, with few drops of phenolphthalein solution. After 1 min to 2 min, titrate slowly with 1M sodium hydroxide.
- Neutralization reaction takes place.
- End point is the appearance of pale permanent pink colour.
- Indicator is colorless in acid and pink in alkaline medium.



**Uses:**

- Ammonium chloride is used as an expectorant in cough medicine.
- Ammonium salts are an irritant to the gastric mucosa and may induce nausea and vomiting.
- Ammonium chloride is used as a systemic acidifying agent in treatment of severe metabolic alkalosis.

## Antacid

### 1. Define antacid. Write down the ideal property of antacid preparation.

- **Antacids** are weak alkaline compounds used to neutralize hydrochloric acid in the stomach.
- Antacids are the substances which reduce gastric acidity resulting in an increase in the pH of stomach and duodenum. Gastric acidity occurs due to excessive secretion of HCl in stomach due to various reasons.
- The pH of the stomach is **1.5- 2.5** when empty and raises to **5-6** when food is ingested.
- Low pH is due to the presence of endogenous HCl, which is always present under physiological conditions.
  - **Ideal property of antacid preparation:**
    - The antacid should not be absorbable or cause systemic alkalosis
    - The antacid should not be a laxative or causes constipation
    - The antacid should exert its effect rapidly and over a long period of time
    - The antacid should buffer in the pH **4-6** range

- The reaction of the antacid with gastric HCl acid should not cause a large evolution of gas
- The antacid should probably inhibit pepsin.

## 2. Differentiate non systemic antacid and systemic antacid.

| Non-systemic antacids  | Systemic antacids   |
|--|---|
| <ul style="list-style-type: none"> <li>• Non-systemic antacids are compounds that are not absorbed into the systemic circulation.</li> <li>• Their anionic group neutralizes the H<sup>+</sup> ions in gastric acid. This releases their cationic group which combines with HCO<sub>3</sub><sup>-</sup> from the pancreas to form an insoluble basic compound that is excreted in feces.</li> <li>• Thus these agents do not produce metabolic alkalosis.</li> <li>• Examples: Aluminum Hydroxide<br/>Magnesium Hydroxide</li> </ul> | <ul style="list-style-type: none"> <li>• Systemic antacids are absorbed into the systemic circulation.</li> <li>• They have a cationic group that does not form insoluble basic compounds with HCO<sub>3</sub><sup>-</sup>.</li> <li>• Thus the HCO<sub>3</sub><sup>-</sup> can be absorbed producing a metabolic alkalosis.</li> <li>• Examples: Sodium bicarbonate</li> </ul> |

## 3. Write down the synonym, properties, method of preparation, assay and use of sodium bicarbonate.

- Synonym: Baking soda; Bread soda, Cooking soda, Bicarbonate of soda

### Properties:

Appearance: White crystalline powder or granules

Odor: Odourless

Taste: Saline taste

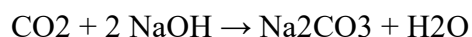
Density: 1.1 to 1.3 g/cm<sup>3</sup>

Melting point: Decomposes to sodium carbonate starting at 500 C

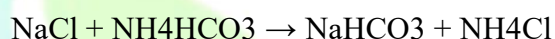
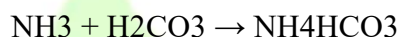
Solubility in water: Freely soluble in water

### Preparation

- NaHCO<sub>3</sub> may be obtained by the reaction of carbon dioxide with an aqueous solution of sodium hydroxide. The initial reaction produces sodium carbonate. Further addition of carbon dioxide produces sodium bicarbonate



- On an industrial scale it is obtained by **Solvay process**:



### Assay

- Weigh accurately 1gm of Sodium bicarbonate and dissolve in 20 ml of water, titrate the solution with 0.5N sulphuric acid using methyl orange as indicator.

- Each ml of 0.5N sulphuric acid  $\equiv$  0.0425gm of NaHCO<sub>3</sub>

### Uses:

- It is used as Systemic antacid and in electrolyte replacement.
- It is used as systemic alkalinising agent used in the treatment of metabolic acidosis (increase in acidity).
- Bicarbonate of soda can also be useful in removing splinters from the skin.
- Sodium bicarbonate can be added to local anaesthetics, to speed up the onset of their effects and make their injection less painful.

Used in preparation of effervescent formulation.

**4) Write down the property, method of preparation and uses of aluminium hydroxide gel.**

### Properties:

Appearance: White amorphous powder

Odor: Odourless

Taste: Tasteless

Density: 2.42 g/cm<sup>3</sup>

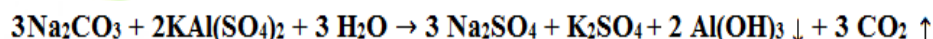


Melting point:300°C

Solubility:Practically insoluble in water and alcohol; Soluble in in dilute mineral acid and in solution of alkali hydroxide.

## Preparation

- It is prepared by hot solution of potash alum slowly with constant stirring to a hot solution of sodium carbonate.



## Uses

- Aluminum salts remain in the stomach for long periods and slowly react with stomach acid to form aluminum chloride. Aluminum hydroxide may inhibit the action of pepsin and stimulate stomach mucus secretion.
- Aluminium hydroxide used as gastric antacid.
- Aluminium hydroxide used in treatment of Gastro esophageal reflux disorder.
- ULCER PROTECTIVES: Basic aluminium hydroxide of sulfated sucrose is known as Sucralfate, which is used as protective Sucralfate is minimally absorbed after oral administration; action is entirely local. It promotes healing of both duodenal and gastric ulcers. (Sucralfate must be taken before meals)
- In treatment of Zollinger-Ellison Syndrome.

**5. Write down the property, method of preparation and uses of magnesium hydroxide mixture.**

## Properties

Appearance:White amorphous powder

Odor:Odorless

Taste:Tasteless

Density:2.34 g/cm<sup>3</sup>

Melting point:350° C

Solubility: Insoluble in water

**Laboratory Preparation:**  $\text{MgCO}_3 + 2 \text{NaOH} \rightarrow \text{Mg(OH)}_2 + \text{Na}_2\text{CO}_3$

**Uses:**

- Used as weak antacid and laxative.
- Most commonly used antacids combine aluminum hydroxide and magnesium hydroxide. The combination decreases the adverse effects of diarrhea (with magnesium products) and constipation (with aluminum products). Calcium carbonate is effective in relieving heartburn, but it is infrequently used to treat peptic ulcers or GERD.

### Antimicrobials

1. **What is Antimicrobial? Give its Example. Write down the method of preparation, property and uses of potassium permanganate, hydrogen peroxide and chlorinated LIME.**  
**10 marks**

An antimicrobial is a substance that kills or inhibits the growth of microorganisms, including bacteria, viruses, fungi, and parasites. Antimicrobials are used to prevent and treat infections in humans and animals.

**Example:** potassium permanganate, hydrogen peroxide and chlorinated LIME, iodine etc.

Potassium manganate can be oxidized by chlorine



- Potassium manganate when treated with Hydrochloric acid



**Properties:**

**Appearance:** purplish-bronze-gray needles      **Odor:** odorless      **Density:** 2.703 g/cm<sup>3</sup>      **Melting point:** 2400 C

**Solubility:** Freely soluble in water and alcohol      **Refractive index:** 1.59      **Taste:** Better with metallic taste

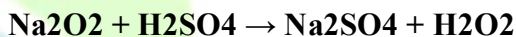
**Uses**

- Due to its strong oxidising properties it is used as disinfectant and deodorant.
- It is also used as astringents, anti-infective and bactericidal.
- 1-5% hydroalcoholic solution of potassium permanganate used as wet dressing.
- Potassium permanganate has been used in attempts to induce abortions at home. But it is legal restrictions on the chemical in response to its use as an abortifacient.
- Potassium permanganate was used as a bleaching agent.
- Potassium permanganate is used extensively in the water treatment

## HYDROGEN PEROXIDE:

From Sodium Peroxide:

- Sodium peroxide decomposed by addition of cold dilute sulphuric acid forms hydrogen peroxide:



Properties:

Colour: clear colourless liquid

Odour: odorless

Taste : Bitter

Solubility in water: miscible

## Uses:

o Medical uses:

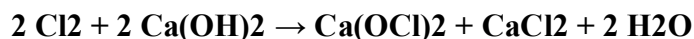
- Hydrogen peroxide used as an antiseptic, germicidal and disinfectant.
- Hydrogen peroxide can be used for the sterilization of various surfaces, including surgical tools and may be deployed as a vapour (VHP) for room sterilization.
- H<sub>2</sub>O<sub>2</sub> demonstrates broad-spectrum efficacy against viruses, bacteria, yeasts, and bacterial spores. In general, greater activity is seen against Gram-positive than Gram-negative bacteria.
- Hydrogen peroxide was used for disinfecting wounds.

## Chlorinated lime:

### Preparation:

- Calcium hypochlorite is produced industrially by treating slaked lime [Ca(OH)<sub>2</sub>] with chlorine gas.

Prepared By-Ms. Adyasha Senapati



**Synonym:** Hypochlorous acid; Bleaching powder; Calcium oxychloride; Calcium hypochlorite

**Mol. Formula:**  $\text{CaOCl}_2$

**Appearance:**

**Density:**

**Melting point:**

**Solubility in water:** 21 g/100 mL

Hypochlorous acid; Bleaching powder; Calcium oxychloride; Calcium hypochlorite

**Mol. Weight:** 142.98 g/mol

White/gray powder

2.35 g/cm<sup>3</sup> (200C)

1000 C

**Odour:** It has strong odour of chlorine

### Uses:

Sanitation

- Calcium hypochlorite has rapid bactericidal action. It kills most of bacteria, some fungi, yeast, algae, viruses and protozoa.
- Calcium hypochlorite is commonly used to sanitize public swimming pools and disinfect drinking water.
- Calcium hypochlorite is also used in kitchens to disinfect surfaces and equipment.
- Other common uses include bathroom cleansers, household disinfectant sprays, algacides, herbicides, and laundry detergents.

### Cathartics

**1. What is Cathartics? Classify cathartics on the basis of mechanism. Give one example of saline cathartics, its method of preparation and uses.**

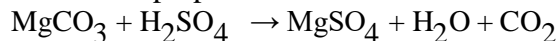
**Ans:** Cathartics are drugs used to relieve constipation or bring out defecation. The term laxative is used for mild cathartic whereas purgatives is used for strong cathartics.

#### **Cathartics according to mechanism**

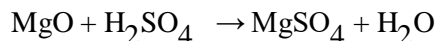
- Stimulant- In this, the drugs or chemicals act by local irritation on intestinal tract and bring stimulation of peristalsis activity. Since they act directly on intestine and stimulate peristalsis, they are called as stimulants. E.g drugs like senna, rhubarb, cascara, podophyllum, castor oil, aloe
- Bulk purgatives-These are the agents which increase bulk of intestinal contents. These are cellulose which swell when wet and due to increased bulk stimulate peristalsis. E.g methylcellulose, sodium CMC, ispgol
- Lubricants- Substances like liquid paraffin, glycerine, mineral oils etc. act as lubricants and bring smooth clearance of the faecal material.

• Saline cathartics- Fourth category are known as saline cathartics. It acts by increasing osmotic load of intestine by absorbing large quantity of water and thus stimulate peristalsis. The saline cathartics are water soluble mainly inorganic chemicals and they are taken with plenty of water  
Example of saline cathartics : Magnesium sulphate

Method of preparation:



Or



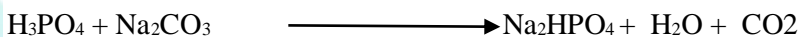
Use :

- used as saline cathartics
- used in treatment of cholecystitis and motion sickness

## 2. Write down the method of preparation of sodium orthophosphate and its use.

Preparation:

It is obtained by adding sodium carbonate to a hot solution of phosphoric acid.



Uses:

- It is used as cathartics.
- It is used as buffering agent.

## UNIT IV

### Miscellaneous compounds

#### Expectorants

### I. Short questions (2 Mark Each)

#### 1. Define Expectorants?

Expectorants are the drugs that are used to help in removal of sputum from respiratory tract or we can simply say that they are used for the treatment of cough. When dust particle packed in respiratory tract it will form as sputum.

#### 2. What is cough? What are their types?

The cough is a productive physiological reflex that help to clear the respiratory tract. Cough can further be divided into two parts.

- Dry cough (no sputum)
- Productive cough (sputum discharge)

#### 3. Write classification of expectorants on the basis of their mechanism of action?

Expectorant acts by two mechanisms:

- Increasing fluidity and reducing viscosity
- Increasing volume of sputum

On the basis of these mechanism, expectorant are divided into two types:

- Sedative expectorant
- Stimulant expectorant

#### 4. What do you mean by Miscellaneous Compound?

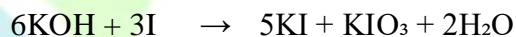
One of two/more compounds that have the same chemical formula but have the atoms in their molecules arranged in a different way and have different properties from each other.

#### 5. Expectorant and cough syrup are same or different drug?

Expectorant and Cough syrup are not same cough syrup suppress the cough center in the brain but expectorant remove the sputum from our respiratory tract.

#### 6. Write method of preparation of potassium iodide from hot aq. Potassium hydroxide?

Hot aqueous potassium hydroxide reacted with iodine solution

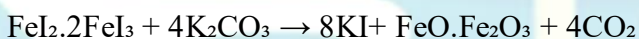


(Potassium hydroxide)      (Potassium iodate)

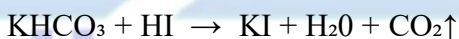
Again potassium iodate reacted with excess charcoal powder



#### 7. Write method of preparation of potassium iodide from Ferro ferric iodide? Iron filings are stirred up with iodine solution to form Ferro ferric iodide



#### 8. How to prepare potassium iodide from potassium bicarbonate If hydrogen iodide reacted with potassium bicarbonate



#### 9. What are the properties of KI?

Colorless or transparent crystal or white granular powder, Odorless,

Bitter in taste, Hygroscopic in nature

Soluble in both water and alcohol Boiling point - 1323°C

Melting point - 681°C

## 10. What is the category & uses of KI?

Category – antifungal, hypothyroid

Uses – expectorants, anti-fungal agent, iodine supplement

Also used as saline diuretics, mild antifungal, reducing agent

## 11. What is the difference between molecule and compound?

A molecule is a group of two/more atoms held together by chemical bond & a compound is a substance which is formed by two/more different types of element which are united chemically in a fixed proportion

## 12. Difference between sedative and stimulant expectorant with suitable Example.

### Sedative expectorant:

- Agents acting with reflex action, i.e. by stomach irritant increase gastric refluxes and sputum volume will be increase. It feels like uneasy.

- These are cause sedation (sleep)

- Example:  $\text{NH}_4\text{Cl}$  , KI Stimulant expectorant:

- They act by stimulating the secretory cells of the respiratory tract directly/indirectly.

- These drug stimulate secretion, more fluid gets produced in respiratory tract and sputum gets diluted & easily discharged from body through cough.

↑ Fluidity = ↓ viscosity

Example: eucalyptus, lemon, trephine hydrate.

## II. Long Answer questions (10 marks)

### 1. Write a note on expectorant with characteristics and example. Give preparation, properties, uses and assay of ammonium chloride.

Expectorants are the drugs that are used to help in removal of sputum from respiratory tract or we can simply say that they are used for the treatment of cough.

When dust particle packed in respiratory tract it will formed as sputum

The cough is a productive physiological reflex that help to clear the respiratory tract. Cough can further divided into two parts.

- Dry cough (no sputum)
- Productive cough (sputum discharge)

### **Expectorant acts by two mechanism**

Increasing fluidity and reducing viscosity

Increasing volume of sputum

**Now the basis of these mechanism, expectorant are divided into two types:**

- Sedative expectorant
- Stimulant expectorant

### **Sedative expectorant:**

Agents acting with reflex action, i.e. by stomach irritant increase gastric refluxes and sputum volume will be increase. It feels like uneasy.

These are cause sedation (sleep) Example:  $\text{NH}_4\text{Cl}$ , KI Stimulant expectorant:

They act by stimulating the secretory cells of the respiratory tract directly/indirectly.

These drugs stimulate secretion, more fluid gets produced in respiratory tract and sputum gets diluted & easily discharged from body through cough.

↑ Fluidity = ↓ viscosity

Example: eucalyptus, lemon, trephine hydrate.

Expectorant → increase the volume of sputum / increase fluidity → stimulation of

Chemoreceptor On throat, bronchioles, lungs etc

↓ Removal of sputum ← more cough production

Physical properties:

white crystalline powder, Odorless, Cool saline taste, Hygroscopic in nature

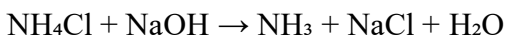
It acts by stimulating the gastric refluxes which helps to increase the respiratory secretion, causes mild irritation of gastric mucosa and may produce nausea and vomiting (if used large dose)



Chemical Properties: when we decompose ammonium chloride we will find ammonia and hydrochloric acid



$\text{NH}_4\text{Cl}$  reacts with strong base, it will release  $\text{NH}_3$  gas



### Method of Preparation:

Ammonia reacts with hydrochloric acid to form ammonium chloride

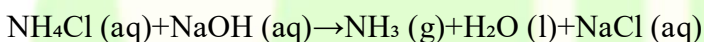


It is a reversible reaction.

### Assay of Ammonium Chloride:

To perform the assay of ammonium chloride by acid base titration

In an acid-base titration involving ammonium chloride ( $\text{NH}_4\text{Cl}$ ), the goal is to determine the concentration of ammonium chloride in a solution by titrating it with a base of known concentration. The reaction involved is between ammonium chloride and the base, typically sodium hydroxide ( $\text{NaOH}$ ). The balanced chemical equation is:



Principle: It is an acidic salt which reacts with formaldehyde to liberate free acid that free acid reacts with 0.1N  $\text{NaOH}$ . End point can be detected by using phenolphthalein as an indicator.

### Procedure:

Weigh accurately about 0.1 gm of ammonium chloride with 20 ml of distilled water and transfer into a conical flask.

Add mixture of 5 ml  $\text{HCHO}$  & 20 ml distilled water.

### Procedure:

Weigh accurately about 0.1 gm of in a conical flask and dissolved in 20 ml distilled water.

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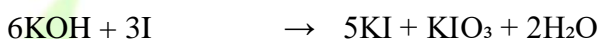
Add 2 drops indicator & allow stand for two minutes. Then fill the burette 0.1N NaOH Start titration until reach end point (A Pink colour that persist for more than 30 sec.)



### III.Short Answer questions (5 marks)

#### 1. Give preparation, properties and uses of potassium iodide Method of Preparation.

Hot aqueous potassium hydroxide reacted with iodine solution

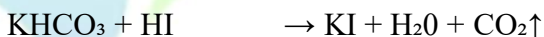


(Potassium hydroxide) (Potassium iodate)

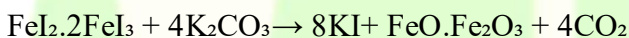
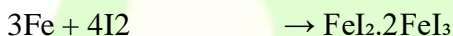
Again potassium iodate reacted with excess charcoal powder



If hydrogen iodide reacted with potassium bicarbonate



Iron filings are stirred up with iodine solution to form Ferro ferric iodide



#### Physical properties:

Potassium iodide is a chemical compound composed of potassium

(K) and iodine (I).

Its chemical formula is KI.

Colorless or transparent crystal or white granular powder, Odorless,

Bitter in taste, Hygroscopic in nature

Soluble in both water and alcohol Boiling point - 1323°C

Melting point - 681°C

Potassium iodide is an important source of iodine, a crucial element for the synthesis of thyroid hormones.

It is used as a supplement to prevent iodine deficiency, which can lead to thyroid disorders.

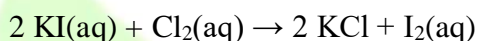
Category – antifungal, hypothyroid

Uses – expectorants, anti-fungal agent, iodine supplement

Also used as saline diuretics, mild antifungal, reducing agent

### Chemical properties:

Potassium iodide behaves as a simple ionic salt,  $K+I^-$ . Since the iodide ion is a mild reducing agent,  $I^-$  is easily oxidised to  $I_2$  by powerful oxidising agents such as chlorine



### 2. Write a notes on potassium iodide?

Potassium iodide is a chemical compound composed of potassium (K) and iodine (I).

Its chemical formula is KI.

Properties:

Colorless or transparent crystal or white granular powder, Odorless, Bitter in taste

Hygroscopic in nature, Soluble in both water and alcohol Boiling point -  $1323^\circ C$ , Melting point -  $681^\circ C$

- Potassium iodide is an important source of iodine, a crucial element for the synthesis of thyroid hormones.
- It is used as a supplement to prevent iodine deficiency, which can lead to thyroid disorders.
- Category – antifungal, hypothyroid

Uses –

Expectorants, anti-fungal agent, iodine supplement

Also used as saline diuretics, mild antifungal, reducing agent

### 3. Write a notes on Ammonium chloride?

Ammonium chloride is a chemical compound composed of ammonia ( $NH_3$ ) and hydrogen chloride (HCl).

Its chemical formula is  $NH_4Cl$ .

Ammonium chloride is a white crystalline solid at room temperature. It has a characteristic salty taste.

Ammonium chloride is highly soluble in water. The solubility increases with temperature.

Used in cough medicines as an expectorant.

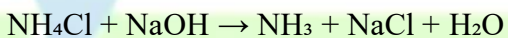
Ammonium chloride can be assayed through acid-base titration, where it reacts with a base (e.g., sodium hydroxide) to determine its concentration.

It acts by stimulating the gastric reflexes which helps to increase the respiratory secretion, causes mild irritation of gastric mucosa and may produce nausea and vomiting (if used large dose)

**Chemical Properties:** when we decompose ammonium chloride we will find ammonia and hydrochloric acid



NH<sub>4</sub>Cl reacts with strong base, it will release NH<sub>3</sub> gas



#### 4. Explain Assay of Ammonium chloride.

In an acid-base titration involving ammonium chloride (NH<sub>4</sub>Cl), the goal is to determine the concentration of ammonium chloride in a solution by titrating it with a base of known concentration. The reaction involved is between ammonium chloride and the base, typically sodium hydroxide (NaOH). The balanced chemical equation is:



##### **Principle:**

It is an acidic salt which reacts with formaldehyde to liberate free acid that free acid reacts with 0.1N NaOH. End point can be detected by using phenolphthalein as an indicator.

##### **Procedure:**

Weigh accurately about 0.1 gm of ammonium chloride with 20 ml of distilled water and transfer into a conical flask.

Add mixture of 5 ml HCHO & 20 ml distilled water.

##### **Procedure:**

Weigh accurately about 0.1gm of in a conical flask and dissolved in 20ml. distilled water.

Add mixture of 5ml. HCHO & 20ml. distilled water.

Add 2 drops indicator & allow stand for two minutes. Then fill the burette 0.1N NaOH Start titration until reach end point (A Pink colour that persist for more than 30 sec.)



## Emetics

### I.Short questions (2 Mark Each)

#### 1. Define Emetics? What is the meaning of emesis?

Emesis means vomiting. It is characterized by forceful elimination of gastric content through the mouth.

Emetic are used as Mechanical antidote which given before absorption of poison into intestine.

Emetics are the agents which when administrated orally or by injection induce vomiting.

#### 2. Give chemical formula of sodium thiosulphate, sodium potassium tartrate

$\text{Na}_2\text{S}_2\text{O}_3$ ,  $\text{KNaC}_4\text{H}_4\text{O}_6$

#### 3. What are the mechanism of action of emetics?

By stimulating of Chemoreceptor trigger zone By reflux producing irritation on GIT

#### 4. What is the most common side effects of emetics?

Dehydration

#### 5. Give examples of the commonly used antiemetic drug?

Domperidone, Metaclopramide, cyclizine, Haloperidole

#### 6. Mention the drugs name used as emetics along with their properties

Apomorphine: Semisynthetic derivative of Morphine

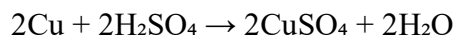
Inject through IM in a dose of 6mg, it promptly within 5min. induce vomiting Side effect is Parkinsonism disease

Ipecacuanha: The dried root of cephaelis ipecacuanha contain emetic action Used as syrup ipeca for induce vomiting .

Family : Rubiaceae

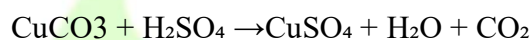
## 7. How to prepare copper sulphate from metallic copper?

1) Metallic copper in the presence of air with sulphuric acid

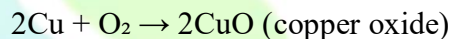


## 8. How to prepare copper sulphate from copper carbonate?

When copper carbonate treated with diluted sulphuric acid



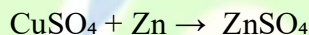
## 9. If metallic copper heated in presence of air then what will happen?



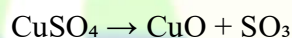
## 10. What are the chemical properties of copper sulphate?

### Chemical properties:

Displacement reaction = Aqueous copper sulphate react with Zn to form  $\text{ZnSO}_4$

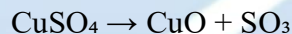


When Copper sulphate anhydrous heated then it will form copper oxide and sulphur trioxide



## 11. If copper anhydrous form heated then what will happen?

When Copper sulphate anhydrous heated then it will form copper oxide and sulphur trioxide



## II. Long Answer questions (10 marks)

### 1. What are emetics? Mention their characteristics and examples. Give preparation, properties, uses and assay of copper sulphate.

• Emesis means vomiting. It is characterized by forceful elimination of gastric content through the mouth.

• Emetics are used as Mechanical antidote which given before absorption of poison into intestine.

- Emetics are the agents which when administered orally or by injection induce vomiting.
- In medulla oblongata, vomiting center/ emetic center are situated that region is known as Area Postrema. In the Area Postrema, Chemoreceptor trigger zone & nucleus tractus solitarius is also present.
- Vomiting occurs due to stimulation of emetic center

### There is 2 mechanism of action

By stimulating of Chemoreceptor trigger zone

By reflux producing irritation on GIT

### Example:

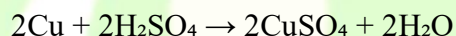
salt in high dose

Saline water Zinc sulphate

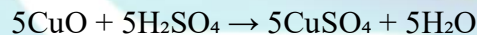
Sodium potassium tartarate

### Method of Preparation of copper sulphate:

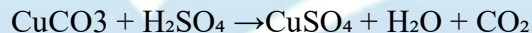
- 1) Metallic copper in the presence of air with sulphuric acid



- 2) When copper oxide treated with diluted sulphuric acid



- 3) When copper carbonate treated with diluted sulphuric acid



Physical properties:

- a. Highly poisonous compound. Powerful oxidizing agent.
- b. A blue crystalline powder Soluble in water, insoluble in alcohol
- c. Odorless
- d. Anhydrous form of  $\text{CuSO}_4$  is grayish white in appearance & Hydrated form of  $\text{CuSO}_4$  is blue in colour.

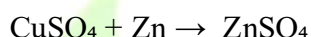
e. Synonym is Roman vitriol, copper vitriol and bluestone

f. At 100°C, the blue crystal loses four molecules of water and the residual monohydrate is bluish white.

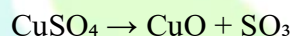
g. At 230°C, white anhydrous copper sulphate is formed

### Chemical properties:

Displacement reaction = Aqueous copper sulphate reacts with Zn to form ZnSO<sub>4</sub>



When copper sulphate anhydrous is heated then it will form copper oxide and sulphur trioxide



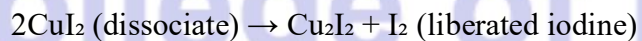
Uses: Emetic Preparation Germicides and insecticides

Due to its toxicity it is used for killing fungus.

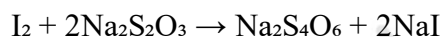
Book binding glues use copper sulphate to keep away insect from books

### Method of analysis:

- This assay is performed through Redox titration or Iodometric titration.
- Iodometric titration is an indirect method of analysis where the iodine is oxidized first and subsequently reduced by the reducing agent.
- Accurately weighed CuSO<sub>4</sub> dissolves in water.
- To this add excess amount of KI & acetic acid.



• Now liberated iodine is titrated with 0.1N sodium thiosulphate solution using starch as indicator.



• Add 2 gm. of potassium thiocyanate & titration continues until blue colour of solution disappears.



### III.Short Answer questions (5 marks)

#### 1. Explain method of analysis of copper sulphate?

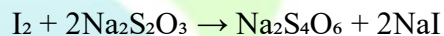
This assay is performing through Redox titration or Iodometric titration. Iodometric titration is an indirect method of analysis where the iodine oxidized first and subsequently reduced by the reducing agent.

Accurately weighed  $\text{CuSO}_4$  dissolve in water.

To this add excess amount of KI & acetic acid.



Now liberated iodine is titrated with 0.1N sodium thiosulphate solution using starch as indicator.



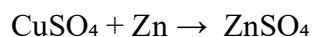
Add 2gm. Of potassium thiocyanate & titration continue until blue colour of solution disappear.

#### 2. Write a notes on copper sulphate Physical properties:

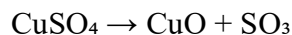
- Highly poisonous compound. Powerful oxidizing agent.
- A blue crystalline powder Soluble in water, insoluble in alcohol
- Odorless
- Anhydrous form of  $\text{CuSO}_4$  is grayish white in appearance & hydrated form of  $\text{CuSO}_4$  is blue in color.
- Synonym is Roman vitriol, copper vitriol and bluestone
- At  $100^\circ\text{C}$ , the blue crystal loose four molecule of water and the residual monohydrate is bluish white.
- At  $230^\circ\text{C}$ , white anhydrous copper sulphate is formed

#### Chemical properties:

Displacement reaction = Aqueous copper sulphate react with Zn to form  $\text{ZnSO}_4$

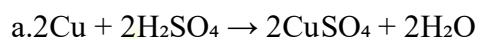


When Copper sulphate anhydrous heated then it will form copper oxide and sulphur trioxide

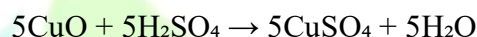


### 3. Give preparation, properties and uses of copper sulphate Method of Preparation of copper sulphate:

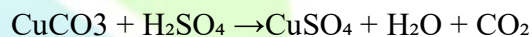
I. Metallic copper in the presence of air with sulphuric acid



I. When copper oxide treated with diluted sulphuric acid



II. When copper carbonate treated with diluted sulphuric acid



#### Physical properties:

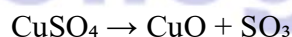
- I. Highly poisonous compound. Powerful oxidizing agent.
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- III. Odorless
- IV. Anhydrous form of  $\text{CuSO}_4$  is grayish white in appearance & Hydrated form of  $\text{CuSO}_4$  is blue in colour.
- V. Synonym is Roman vitriol, copper vitriol and bluestone
- VI. At  $100^\circ\text{C}$ , the blue crystal loose four molecule of water and the residual monohydrate is bluish white.
- VII. At  $230^\circ\text{C}$ , white anhydrous copper sulphate is formed

#### Chemical properties:

Displacement reaction = Aqueous copper sulphate react with Zn to form  $\text{ZnSO}_4$



When Copper sulphate anhydrous heated then it will form copper oxide and sulphur trioxide



#### Uses:

- Emetic Preparation Germicides and insecticides
- Due to its toxicity it is used for killing fungus.

- Book binding glues use copper sulphate to keep away insect from books.

## Haematinics

### 1. Define haematinics.

- Haematinics are those substances which provide the suitable condition for blood component formation and support the blood formation (Erythropoiesis).
- Its generally contains the iron/ferrous containing compounds, which are the essential substances required for the blood metabolism and provide the prevention against the deficiency syndrome of iron or ferrous..
- Example- zinc, copper, vitamins, folic acid etc

### 2. Write a note on preparation, property, assay, method of preparation and uses of ferrous sulfate.

Molecular formula –  $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$

Synonym – iron vitriol, green vitriol

Properties of ferrous sulfate

- Appearance – blue, green crystals (heptahydrate), white crystals (anhydrous), white, yellow crystals (monohydrate).
- Taste – it has a metallic taste and astringent-like taste. It is an odorless product.  
Melting point -  $680^\circ \text{C}$

#### Assay:

Using oxidation-reduction titration, the test is performed. It was measured that 0.03 gm of ferrous sulfate was dissolved in 25 ml of diluted sulfuric acid, and 0.02 ml of potassium permanganate was dissolved in 25 ml of freshly boiled and cooled water. The equivalent  $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$  (ferrous sulfate heptahydrate) is 27.802 mg per ml of 0.02M potassium permanganate. The equivalent concentration of  $\text{FeSO}_4$  (Anhydrous ferrous sulfate) in each milliliter of 0.02M potassium permanganate is 27.802 mg.

#### Uses:

- In treating and preventing iron deficiency anemia, ferrous sulfate is used as a haematinic agent. Inks, and especially iron gall ink, were manufactured using ferrous sulfate
- A silvery hue is achieved by coloring maple wood with ferrous sulfate solutions.
- Iron chlorosis is treated with it in horticulture.
- A corrosion-resistant protective coating is sometimes applied to the brass tubes of turbine condensers by adding ferrous sulfate to the cooling water.
- In gold refining, it is a corrosion inhibitor.
- It is also helpful to identify mushrooms with green vitriol

Preparation:  $\text{Fe} + \text{H}_2\text{SO}_4 \longrightarrow \text{FeSO}_4 + \text{H}_2$

### 3. Write down property and uses of ferrous gluconate.

Molecular formula –  $\text{C}_{12}\text{H}_{22}\text{FeO}_{14} \cdot x\text{H}_2\text{O}$

#### Properties

Melting point -  $188^\circ\text{C}$

Taste – it tastes like a caramel

Odour – slight caramel odor

Solubility - Easily soluble in hot water but is insoluble in alcohol; soluble in glycerine but not free soluble in water. Gives a greenish-brown solution.

Appearance – a greenish-yellow to grey powder.

#### Uses:

Anemia caused by hypochromic iron deficiency can be effectively treated with ferrous gluconate.

Food additives such as ferrous gluconate are also used in the production of black olives.

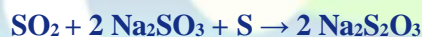
#### Poison and Antidote

### 1. Give preparation, properties, uses and assay of sodium thiosulphate.

#### **Sodium Thiosulfate: Preparation, Properties, Uses, and Assay**

#### **Preparation:**

Sodium thiosulfate ( $\text{Na}_2\text{S}_2\text{O}_3$ ) can be prepared by dissolving sodium sulfite ( $\text{Na}_2\text{SO}_3$ ) in aqueous sulfur dioxide ( $\text{SO}_2$ ) and then oxidizing it with hydrogen peroxide ( $\text{H}_2\text{O}_2$ ) or oxygen ( $\text{O}_2$ ).



#### **Properties:**

1. **Chemical Formula:**  $\text{Na}_2\text{S}_2\text{O}_3$
2. **Molecular Weight:** 158.11 g/mol
3. **Physical State:** White crystalline powder
4. **Solubility:** Highly soluble in water
5. **pH:** Neutral to slightly alkaline in aqueous solution

#### **Uses:**

1. **Photography:** Sodium thiosulfate is used as a fixing agent in photography to remove unexposed silver halide from photographic films and papers.
2. **Medical:** It is used as an antidote for cyanide poisoning. Sodium thiosulfate reacts with cyanide to form thiocyanate, which is less toxic and can be excreted from the body.

3. **Water Treatment:** It is used in water treatment processes to dechlorinate tap water and remove excess chlorine.
4. **Analytical Chemistry:** Sodium thiosulfate is used in titrations as a reducing agent and in iodometric assays.
5. **Industrial Applications:** It is used in various industrial processes, including the textile industry for dyeing and printing.

### Assay of Sodium Thiosulfate:

- An assay of sodium thiosulfate ( $\text{Na}_2\text{S}_2\text{O}_3$ ) typically involves an iodometric titration.

#### In short, the process can be summarized as follows:

1. Prepare a standard iodine ( $\text{I}_2$ ) solution of known concentration.
2. Accurately weigh a sample of sodium thiosulfate and dissolve it in distilled water.
3. Add an excess of standardized iodine solution to the sodium thiosulfate sample.
4. The sodium thiosulfate will react with the iodine to form sodium iodide ( $\text{NaI}$ ) and sodium tetrathionate ( $\text{Na}_2\text{S}_4\text{O}_6$ ).
5. After the reaction is complete, add a starch indicator, which turns blue in the presence of excess iodine.
6. Titrate the remaining unreacted iodine with a standardized thiosulfate solution (usually prepared from a primary standard, like potassium iodate,  $\text{KIO}_3$ ).
7. When the blue color disappears, the endpoint has been reached, indicating that all excess iodine has reacted with the thiosulfate.
8. Calculate the concentration of sodium thiosulfate in the sample using the volume of titrant used and the known concentration of the iodine solution.

#### Conclusion:

Sodium thiosulfate is a versatile compound with various applications in photography, medicine, water treatment, and industrial processes. Its properties as a reducing agent and its ability to form complexes make it valuable in analytical chemistry for titrations and assays. Proper understanding of its preparation, properties, and uses is essential for its effective utilization in various fields.

## 2. Define poison and antidote.

### Poison

- Poison refers to any substance that can cause harm or death when introduced into or absorbed by a living organism.
- Poisons can come from a variety of sources, including chemicals, plants, animals, and medications.
- The effect of a poison depends on multiple factors, including its nature, the amount absorbed, the mode of exposure, and the individual characteristics of the person exposed (such as age, health status, and genetics).

## Antidote

- Antidote is a substance that counteracts the effects of a poison, reducing or eliminating the harm caused by the poison.
- Antidotes work through different mechanisms depending on the poison involved.

### 3. Give preparation, properties, uses and assay of activated charcoal and sodium nitrite.

#### Activated charcoal:

##### Preparation:

- Activated charcoal is prepared by heating carbon-rich materials, such as wood, peat, coconut shells, or sawdust, in the presence of a gas (usually steam or carbon dioxide) at high temperatures.
- This process increases the surface area and porosity of the material.

##### Properties:

- Activated charcoal is a fine, black, odorless powder with a large surface area and highly adsorptive properties.

##### Uses:

- Activated charcoal has a variety of uses, including:
  - As an emergency treatment for certain types of poisoning and drug overdoses by adsorbing the toxic substances and reducing their absorption in the gastrointestinal tract
  - In water purification and air filtration systems
  - In the cosmetic and personal care industry for face masks, toothpaste, and deodorant

##### Storage:

- Activated charcoal should be stored in a cool, dry place, away from heat, moisture, and sunlight. It should be kept in a tightly closed container.

#### Sodium nitrite:

##### Preparation:

- Sodium nitrite is commonly produced by the reaction of nitrous acid with sodium hydroxide or sodium carbonate.



##### Properties:

- Sodium nitrite is a white or slightly yellowish crystalline powder that is soluble in water.
- It is a strong oxidizer and can be corrosive.

##### Uses:

- Sodium nitrite has several applications, such as:
  - As an antidote for cyanide poisoning, in combination with sodium thiosulfate
  - As a food preservative, especially in cured meats
  - In the production of dyes and rubber chemicals

## Storage:

- Sodium nitrite should be stored in a cool, dry place, away from heat, moisture, and incompatible materials, such as acids and reducing agents.
- It should be kept in a tightly closed container.

### 4. Give some examples of poison and its antidote.

#### Examples of Poisons and Their Antidotes

1. Acetaminophen (Tylenol) Overdose: N-acetylcysteine (NAC) acts to replenish glutathione stores, helping to detoxify the harmful metabolite of acetaminophen.
2. Opioid Overdose: Naloxone rapidly displaces opioids from their receptors, reversing opioid effects, especially life-threatening respiratory depression.
3. Benzodiazepine Overdose: Flumazenil blocks the effect of benzodiazepines on the GABA receptor, reversing sedation.
4. Organophosphate Poisoning (certain pesticides): Atropine and pralidoxime (2-PAM) work together, with atropine relieving muscarinic symptoms and pralidoxime reactivating acetylcholinesterase, which is inhibited by organophosphates.

## Astringents

### 1. Mention the uses of potas alum with chemical formula?

#### Ans:

Potash alum is a chemical compound widely used as the potassium sulfate dodecahydrate. It is double salt that is used commonly in medicine and the water treatment process. Potash alum is also known as potassium alum or potassium aluminium sulfate. The chemical formula of potash alum is  $K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$ . It is also commonly referred to as 'fitkari.'

#### Uses of Potash Alum

##### Fire Retardant

The use of potassium alum for textiles, wood and paperless flame resistance is a fire-retardant.

##### Tanning

For leather tanning, potassium alum is used to extract moisture from the hide and avoid rotting. Alum is not covered and can be washed out, as compared to tannic acid.

##### Iron and Steel Dissolving

This aluminium solution has the property that steels are dissolved without affecting aluminium or base metals. For machined castings of steel parts of machinery, alum solutions can be used.

##### Gourmet Food

Potassium alum may be an acidic component in baking powder to provide a second leavening step at high temperatures (although sodium alum is more widely used for this purpose). Bakers in England made bread whiter with alum during the 1800s.

##### Used for Dyeing

Alum was used to form a permanent link between natural textile fibres like wool and dye, as mordant.

##### Pigmentation of the Lake

Aluminium hydroxide from alum acts as a base for most lake pigments.

##### Blocking Chemicals

Since remote antiquity, potassium alum was used for purifying turbid liquids. The drinking water and industrial water systems, effluent treatment, and post-storm lake procedures continue to be commonly used for the treatment of pollutants in precipitation.

## 2. Define astringent. Give two example.

- ✓ Astringent → Are the substances which precipitates the protein.
- ✓ Is a drug which makes the cell shrink by precipitating the proteins from their surfaces.
- ✓ Used in lotions to harden and protect the skin and to reduce bleeding from minor abrasions
- ✓ Other preparations, in which they are used are anti-perspirant preparation, mouth washes, eye drops, throat lozenges etc.,
- ✓ It stimulates growth of new tissues, when they applied topically and produces corrosive effect in concentrated solutions to remove undesirable tissue growth eg: Warts.

**Example:** zinc sulphate and potash alum.

## 3. Give preparation, properties and uses of potash alum.

It is prepared by adding a hot concentrated solution of potassium sulphate to a hot solution of an equal amount of aluminium sulphate concentrated, cooled and crystallizes out



PHYSICAL PROPERTIES:

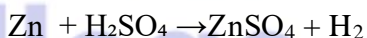
1. Colourless transparent crystals having a sweet astringent taste.
2. It is soluble in water but insoluble in alcohol.
3. At 200°C it loses its water at crystallization and becomes anhydrous.
4. Acidic to litmus and pH 4.6

MEDICINAL AND PHARMACEUTICAL USES:

1. Antiseptic and local styptic (to stop bleeding from cuts)
2. Precipitates the protein and protects to harden the skin
3. Used in Biological preparations of such as alum precipitated tetanus toxoid and alum precipitated diphtheria toxoid.

## 4. Give preparation, properties and uses of zinc sulphate.

Prepared by boiling the slight excess of Metallic zinc with dilute sulphuric acid.



Solution is filtered to remove unreacted zinc, concentrated and crystallized.

PROPERTIES:

- Colourless, transparent crystals or crystalline powder
- Odourless and astringent or metallic taste
- Florescent in dry air
- Easily soluble in water and insoluble in alcohol and glycerine.

PHARMACEUTICAL AND MEDICINAL USES:



- Internally used as a Emetic
- Externally used as Astringent in lotions and eye drops
- Treat conditions associated with zinc deficiency such as acrodermatitis enteropathica.
- Used as a ophthalmic ingredient in ophthalmic solution

## UNIT V

### Radiopharmaceuticals

#### **1. Define radiopharmaceuticals. Write down its unit.**

Radiopharmaceuticals are unique medicinal formulations containing radioisotopes that are used in major clinical areas for diagnosis and/or therapy. The facilities and procedures for the production, use, and storage of radiopharmaceuticals are subject to licensing by national and/or regional authorities. They may be given to the patient in several different ways.

Unit:

- 1 curie =  $3.7 \times 10^{10}$  radioactive decays per second [exactly].
- In the International System of Units (SI) the curie has been replaced by the becquerel (Bq), where
- 1 becquerel = 1 radioactive decay per second =  $2.703 \times 10^{-11}$  Ci.
- The gray (Gy) is defined as the absorbed dose of radiation per unit mass of tissue. 1 Gy = 1 joule per kilogram

#### **2. What is half life period. Write down its importance.**

The term half-life is defined as the time it takes for one-half of the atoms of a radioactive material to disintegrate. Half-lives for various radioisotopes can range from a few microseconds to billions of years.

Half-life:

$$t_{1/2} = 0.693/\lambda$$

Where  $\lambda$  is disintegration constant in a unit of  $\text{Sec}^{-1}$

**Significance:** The half-life of a nucleotide will decide utility in medicine. If the half-life is short will be inconvenient for setting satisfactory experiment. Too long half-life is an absolute property of nuclide and is unaffected by the chemical and biological condition.

#### **3. Write down the properties of alpha, beta and gamma rays.**

Alpha Rays

Alpha rays are the positively charged particles. Alpha-particle is highly active and energetic helium atom that contains two neutrons and protons. These particles have the minimum penetration power and highest ionization power. They can cause serious damage if get into the body due to their high ionization power. They are capable of ionizing numerous atoms by a short

distance. It is due to the fact that the radioactive substances that release alpha particles are required to be handled after wearing rubber gloves.

## Beta Rays

Beta particles are extremely energetic electrons that are liberated from the inner nucleus. They bear negligible mass and carry the negative charge. A neutron in the nucleus splits into a proton and an electron on the emission of a beta particle. Hence, it is the electron that is emitted by the nucleus at a rapid pace. Beta particles have a higher penetration power when compared to alpha particles and can travel through the skin with ease. Beta particles can be dangerous and any contact with the body must be avoided, though their ionization power is low.

## Gamma Rays

The waves arising from the high-frequency end of the electromagnetic spectrum that has no mass are known as gamma rays. They hold the highest power of penetration. They are the most penetrating but least ionizing and very difficult to resist them from entering the body. The Gamma rays carry a large amount of energy and can also travel via thick concrete and thin lead.

The below table describes the characteristics of beta, alpha and gamma radiations and compares the masses and charges of the three rays.

| Property        | $\alpha$ ray                                      | $\beta$ ray  | $\gamma$ ray  |
|-----------------|---|--|---|
| Nature          | Positive charged particles, 2He 4 nucleus         | Negatively charged particles (electrons).                        | Uncharged ?<br>~0.01a, electromagnetic radiation          |
| Charge          | +2e   | -e   | 0   |
| Mass            | $6.6466 \times 10^{-27}$ kg                       | $9.109 \times 10^{-31}$ kg                                       | 0   |
| Range           | ~10 cm in air, can be stopped by 1mm of Aluminium | Upto a few m in air, can be stopped by a thin layer of Aluminium | Several m in air, can be stopped by a thick layer of Lead |
| Natural Sources | By natural radioisotopes e.g. $^{92}\text{U}236$  | By radioisotopes e.g. $^{29}\text{Co}68$                         | Excited nuclei formed as a result of Gamma decay          |

#### 4. Write a note on measurement of radioactivity.

Measurement of Radioactivity –

For measuring radioactivity, three types of devices are available:

1. Gas-filled tube counters e.g. the Geiger Muller Counter
2. Scintillation Counters
3. Semi-conductor Detectors

**The Geiger Counter:** A potential difference just below that required to produce a discharge is applied to the tube (1000 V). Any atoms of the gas struck by the  $\gamma$ -rays entering the tube are ionized, causing a discharge. Discharges are monitored and counted by electronic circuitry and the output is reported as counts/sec or Rontgens/hr or mR/hr.

**Scintillation Counters:** Crystals of certain substances e.g. cesium fluoride, cadmium tungstate, anthracine and sodium iodide emit small flashes of light when bombarded by  $\gamma$ -rays. The most commonly used phosphor in scintillation counters is NaI with a minute quantity of thallium added. In the instrument, the crystal is positioned against a photocell which in turn is linked to a recording unit. The number of flashes produced per unit time is proportional to the intensity of radiation. Small portable scintillation counters are available.

**Semi-Conductor Detectors:** A semi-conductor is a substance whose electrical conductivity is between that of a metal and an insulator. It is noted that Ge(Li) semi-conductors are excellent detectors of  $\gamma$ -rays with a resolution ten times higher than NaI (Th) scintillometers. The main disadvantage of these is a lower efficiency for higher energy x-rays. Besides, Ge(Li) semiconductors need to be cooled by liquid nitrogen and are hence cumbersome and not suitable as field instruments.

#### 5. Write down the pharmaceutical application of radioactive substances.

- Treatment of Cancers and Tumours
- Americium 241 used as antineoplastic.
- Californium 252 used as antineoplastic."
- Cobalt 60 used as antineoplastic.
- Gold 94 used as antineoplastic.
- Holmium 66 (26 h) being developed for diagnosis and treatment of liver tumours.
- Iodine-125 (60 d) used in cancer brachytherapy (prostate and brain). - Treatment of Thyroid Disease with Iodine 131
- Iodine-131 is therapeutically used for to treat thyroid cancer, hyperthyroidism (including Graves' disease, toxic multinodular goiter, and toxic autonomously

- functioning thyroid nodules), and Nontoxic multinodular goiter. - Palliative Treatment of Bone Metastasis
- Various radioisotopes and pharmaceuticals are used to deliver palliative treatment of bone metastases, including samarium-153 (Sm-153), strontium-89 (Sr-89) chloride, and phosphorus-32 (P-32) sodium phosphate. The two most common side effects occurring from radiopharmaceutical therapy for metastatic bone disease are initial increased bone pain (flare) and a decrease in WBC and platelet counts. - Treatment of Arthritis
  - Erbium-169: Use for relieving arthritis pain in synovial joints - Diagnostic Radiopharmaceuticals
  - Ammonia N 13 Injection used for diagnostic coronary artery disease.
  - Chromium 51 used for diagnosis of pernicious anaemia.
  - Holmium 166 used for diagnosis and treatment of liver tumours.
  - Iodine 125 used diagnostically to evaluate the filtration rate of kidneys.

## 6. Write a note on storage condition and precautions of radiopharmaceuticals.

### Storage of Radioactive Substances –

- Radiopharmaceuticals should be kept in well-closed containers and stored in an area assigned for the purpose. The storage conditions should be such that the maximum radiation dose rate to which persons may be exposed is reduced to an acceptable level.
- Care should be taken to comply with national regulations for protection against ionizing radiation.
- Radiopharmaceutical preparations that are intended for parenteral use should be kept in a glass vial, ampoule or syringe that is sufficiently transparent to permit the visual inspection of the contents. Glass containers may darken under the effect of radiation.

### Precautions For Handling Radioactive Substances

The following guidelines provide information on the safe handling of radioactive substances. They are based on the relevant legislation and on the Code of Practice for Handling Radioactive Substances.

The radioactive substances used should comply with the following characteristics:

- Radiotoxicity must be as low as possible.
- Short-living isotopes are preferred to long-living ones
- The amounts used must be kept to a minimum.

- Never work alone in a radioactive lab, especially not outside normal working hours. Always make sure to have someone nearby in case of emergency.
- Take all precautions to prevent radioactive contamination:
  - Always separate radioactive activities from non-radioactive activities.
  - As far as possible, limit the area where radioactive substances are used and mark the area, e.g. by using containers with absorbent paper.
  - Apply a radiation symbol to any containers and items that have come into contact with radioactive substances.
  - Never bring documents such as notes into the radioactive zone.
- When handling radioactive materials, always wear the appropriate protective clothing:
  - Wear a lab coat. If there is a risk of serious contamination, wear disposable clothing. Store your lab coat away from your regular clothes.
  - Always wear gloves when handling radioactive substances. Regularly check the radiation level of these gloves. Never touch anything with potentially contaminated gloves; use paper tissues instead.
  - Wear shoe covers in rooms where the floor may be contaminated.
  - Keep personal items such as handbags, etc., outside the lab.
- Use appropriate radiation shields. Return the stock solution to storage immediately after removing the amount needed.

To avoid internal contamination, strict hygiene is essential when handling radioactive materials

- Eating, smoking, drinking, and applying cosmetics are prohibited in radioactive labs.
- Never pipette by mouth. Use pipetting devices instead.
- Wash your hands thoroughly when you leave the lab.

Regularly check the radiation level of your working area and all objects used, or at least at the end of each working day. Replace contaminated absorption paper. Decontaminate contaminated objects.

Dispose of all radioactive waste in the appropriate containers. Limit the amount of waste to a bare minimum. Separate short-living and long-living radioactive waste.