Q1. What are Antacids? Describe the combination of antacid preparation with examples and explain Aluminium hydroxide.

Antacids are substances which, on ingestion, react with the gastric acid and lower the acidity of gastric contents. They produce a symptomatic relief of heartburn and pain, reduce spasms, and relieve the uncomfortable feeling of overeating and growing hungry between meals. Antacids are weak bases, and they raise the gastric pH above four by neutralising excess gastric hydrochloric acid, which may be causing pain and possible ulceration. One may also use antacids to inactivate the proteolytic enzyme pepsin.

Ideal characteristics of antacids: No antacid is perfect, but preferably, an antacid should have the following properties:-

i) It should not be absorbable or cause systemic alkalosis.
ii) It should not interfere with the absorption of food.
iii) Antacids should not be a laxative or cause constipation.
iv) Antacid should have a pH 4-6 buffer nature.
v) They should inhibit pepsin.

Examples are: - (a) Sodium bicarbonate $NaHCO_3$ (b) Aluminium hydroxide Al (OH)3 (c) Calcium carbonate $CaCo_3$ (d) Magnesium carbonate.

Antacids can be classified into two types:

1. Absorbable or systemic antacids are soluble, readily absorbable and capable of producing systemic electrolytic alterations and alkalosis, e.g. sodium bicarbonate.

2. Non-absorbable or non-systemic antacids: These are not absorbed significantly and thus do not exert an appreciable systemic effect, e.g. Calcium carbonate, Aluminium phosphate and hydroxide.

Combination of antacid preparation:- As no single antacid meets all the requirements for an ideal antacid, a combination of antacids is used to balance the constipation effect of calcium with the laxative effect of aluminium compounds. These products contain a fast-acting antacid, which supposedly has a longer duration of action.

Some commonly used combinations are:-

i) Aluminium hydroxide gel - Magnesium hydroxide combination

ii) Aluminium hydroxide gel - Magnesium trisilicate combination

iii) Calcium carbonate - Hydroxide gel & magnesium-containing antacid combination

iv) Alginic acid-containing antacid combination.

Aluminium hydroxide: Chemical formula: Al (OH) 3. It occurs in two forms:

1. Aluminium hydroxide gel

2. Dried Aluminium hydroxide gel

Properties: White, light, odourless, tasteless amorphous powder. It is practically insoluble in water and alcohol and soluble in dilute mineral acids and solutions of alkali hydroxides. It is amphoteric and slightly affects both red and blue litmus papers.

Uses: 1. It is used as a mild astringent and desiccant. 2. It is used in the treatment of diarrhoea and cholera.

Question No. 02. What are acids and bases? Discuss the various concepts about acids and bases. Acids & Bases: Acids and bases are substances or liquids which play an essential role in pharmaceutical chemistry. These are required in the manufacture and quality assurance of drugs and as pharmaceutical aids and necessities in dispensing pharmaceuticals for their stability, compatibility, and optimum distribution in various physiological systems. There are several concepts or theories of acids and bases. All of them are variations of the well-known classical Arrhenius theory of ionisation concept. One interpretation may be better suited, depending upon the particular acid-base reaction or the system involved.

Theories of acids and bases: The various theories of acids and bases are as follows:

1) **Arrhenius concept:** The first concept was given by scientist Arrhenius. According to him, acid is the substance which yields an H+ ion [hydrogen ion] in water and conversely, bases are substances which release hydroxyl ion [OH] in water.

For example:

$$HCl \xrightarrow{\text{Aqueous Media}} H^+ + Cl^- \quad \text{[Strong acid]}$$

$$NaOH \xrightarrow{\text{Hydroxyl ion}} Na^+ + OH^- \quad \text{[A base]}$$

Disadvantage:

i) It does not explain the essential nature of ammonia [NH3]. However, it does not liberate hydroxyl ions.

ii) It does not explain the acidic nature of CO2 but does not liberate hydrogen ions [H+].

iii) It explains the acidic and basic nature only in the presence of water.

2. Bronsted-Lowry concept: According to this concept, an acid is a substance that can donate a proton. So, it is called a proton donor. Whereas base is a substance that can accept a proton, i.e., a proton acceptor.

For example HCl + H2O (acid) H_3O^+ + Cl^- (Base)

3. Lewis concept: According to this concept, the base is a substance, which is an electron pair donor, and acid is a substance, which is an electron pair acceptor. Lewis base is also called nucleophillic, and Lewis acid is also called Electrophillic. For example, Lewis bases are Ammonia, Amine and Ether.

Advantage:

i) This concept also includes those reactions in which no protons are involved.

ii) It explains the long-accepted basic properties of metallic oxides and the acidic properties of non-metallic oxides.

4. Usanovich concept: According to this concept, acid is a chemical species capable of combining with anions or electrons or giving up cations. Conversely, a base is a chemical species capable of giving up anion or electrons or combining with cation.

SO_3 + Na_2O → Na_2SO_4

Acid — Base — Salt

$Fe(CN)_2$ + 4 KCN → $K_4[Fe(CN)_6]$

Acid — Base — Salt

Advantage: It explains all the acids and bases.

Question 3: What are the radiopaques? Explain with an example.

RadioOpaque contrast media (radiopaque): The X-ray contrast media are the chemical compounds which can absorb X-rays and block the passage of X-rays. Thus, they are opaque to X-ray examination. X-rays are capable of passing through most soft tissues. When a photographic film or a photosensitive plate is placed opposite to the X-ray source through the patient's body/organ portions, the film or plate is darkened in an amount proportional to the number of X-rays that can pass. Bony structures, cartilage and teeth can block the passage of X-rays and appear light on exposed X-ray film. But skin and soft structures, being less dense, appears only as shadows on X-ray film. So, to make a correct diagnosis of the soft organ, radiopaque substances are used. Radiopaque substances have no pharmacodynamic effect on the body. The most common example of contrast media is barium sulphate.

Barium sulphate:

Synonym: Barium meal

Chemical formula: BaSO4

Preparation: It is prepared from a Barium chloride solution with cold dilute H2SO4 or soluble sodium sulphate.

$BaCl_2 + H_2SO_4 \longrightarrow BaSO_4 + 2\ HCl$

$BaCl_2 + Na_2SO_4 \longrightarrow BaSO_4 + 2$

NaCl The Barium sulphate precipitated, washed and dried.

Properties: It is a fine white powder free from gritty particles, odourless, tasteless, and insoluble in water and organic solvent. It dissolves in concentrated H_2SO_4 with the formation of bisulphate salt.

$BaSO_4 + H_2SO_4 \longrightarrow Ba\ [HSO_4]2$

Storage: Store in well-closed containers.

Uses:

i) Barium is given only by its salt, i.e. Barium sulphate. Its salt is given to identify the location of ulcers in G.I.T. wherever the ulcer is formed.

ii) It is also used on respiratory muscles and muscles of the cardiovascular system but causes toxicity.

iii) In G.I.T. mucosa, cells absorb $BaSO_4$, and the ulcer spot is identified with the help of X-Ray film.

Question 4: What are the official preparations of iodine? Describe povidone iodine, ammoniated mercury, and chlorinated lime.

Ans. 4 Preparation of Iodine: Iodine is used as an antimicrobial agent and acts by the formation of hypoiodous acid (HIO), which is six times more effective than hypochlorous acid. It is used for disinfecting unbroken skin. Iodine deficiency causes goitre. For this purpose, iodised salts with sodium iodides are.

There are various types of iodine solutions:-

1. Aqueous iodine solution B.P. /I.P. (1966).
2. Weak Iodine solution B.P. /I.P. (1966).
3. Strong iodine solution I.P. (1966).
4. Iodine tincture U.S.P.
5. Iodine Povidone ointment.

(i) Povidone-iodine: It is a complex of iodine with a polymer povidone [poly (2-oxo, pyrrolidine-1- ethylene)].

Physical properties: It is yellowish brown, amorphous powder, characteristic iodine odour, soluble in water and 95% ethanol but practically insoluble in chloroform and acetone.

Storage: It should be stored in airtight containers.

Uses:

1. It is an antiseptic for surgical scrubs and pre-operative skin antisepsis.
2. It is also used in gargles and mouthwashes to treat infections in the oral cavity.
3. The solution of povidone-iodine is also used for vaginal candidacies.

(ii) Ammoniated Mercury:

Synonyms: White precipitate, amino-chloride of mercury

Chemical formula: NH_2HgCl

Preparations: It is prepared by treatment of 5% mercuric chloride solution with 20% dilute ammonia solution. The precipitate is collected, washed with cold water and dried below 30o C. $HgCl2 + 2NH3 \longrightarrow NH_2HgCl + NH_4 Cl$ (Precipitates)

Physical properties: It is a white powder, odourless, practically insoluble in water, alcohol and ether.

Storage: It should be protected from light stored in well-closed containers.

Uses: It is used as an anti-infective. It is used externally in the form of ointments to destroy threadworms and in staphylococcal infections of the skin and psoriasis.

Disadvantage: Excess uses of ammoniated mercury develop chronic toxicities therefore prolonged use is not recommended.

(iii) Chlorinated lime:

Synonyms: Bleaching powder, Chlorinated lime, Chloride of lime

Chemical formula: Ca (OCl)Cl

Preparation: It is prepared by passing chlorine gas over dry calcium hydroxide in a lead chamber for 18-24 hours.

$$Ca (OH) 2 + Cl_2 \longrightarrow Ca (OCl) Cl + H_2O$$

Physical properties: It is a dry, dull white powder with a characteristic odour. It is slightly soluble in water and alcohol. Storage: It should be stored in well closed container. It slowly decomposes with a loss of chlorine.

Uses:

1) Used as a bleaching agent.
2) Used in preparations of detergents.
3) Used as a disinfectant in wounds and swimming pools.

Question No. 05. Define radiopharmaceuticals. What are the biological effects of radiation and storage conditions of radiopharmaceuticals? Discuss the method of quality control of active pharmaceutical ingredients as per pharmacopoeia.

Radiopharmaceuticals: The compounds or substances that emit radiations (alpha, beta, and gamma) continuously and are used in medicines are called radiopharmaceuticals.

Biological effects of radiation: The effect of radiation on biological tissues is known as the biological effect of radiation. Radiations have dangerous effects on biological tissues depending on the ability of radiation to penetrate the tissue, energy of radiation, surface area exposed etc. The radiation promotes several irreversible changes in living cells. These are:

1. The chemicals change the pH or initiate free radical chain reactions and form peroxides and other toxic substances.
2. These can create necrosis and ultimately destruction of cells, tissue or organs.
3. The toxic substances produced from reactions of free radicals after DNA in cells cause cross-linking between amino acids and proteins. This leads to various defects in the body. The reaction of free radicals occurs in the following steps:-

(I) Chain Initiation Radiation

Radiation

H2O H. H. + HO.

Particles

(II) Chain propagation

H_2O + H. H2 + .OH

H2O+OH. H2O2 + H.

(III) Chain termination

H.+H. H2

OH. + OH. H2O2

H. + OH. H2O

Handling and storage: Care should be taken to protect people and personnel from harmful radiation while handling and storing radioactive material. The following precautions are taken:

1. These materials should be handled with forceps or suitable instruments and direct contact should be avoided.
2. Any substance taken internally [food, drinks], should not be carried in the laboratory.
3. Sufficient shielding must be provided on protective cloths.
4. Sufficient protective clothing must be used while handling the materials.
5. Disposal of radioactive materials should be done with great care.

Methods used for quality control:

The pharmacopoeial monograph of each compound/product is the guiding document. A substance is required to confirm with the following parameters:

1. **Description:** Statements of those superficial qualities that can be determined without formal scientific examination e.g. colour, crystalline form, odour, taste etc.
2. **Identification:** It includes various specific and non-specific tests, physical constants and spectrophotometric matching.
3. **Method of assay: -** The term assay is used in the pharmacopoeias for the quantitative deterioration of principal ingredients of the official substance and their preparations. This is the quantitative determination of principal ingredients by gravimetric or volumetric instrumental or biological method, etc.
4. **Tests for purity: -** I.P. prescribes tests for purity of almost all the official substances. These tests include melting point, boiling point, weight per ml., limit tests for chlorides, sulphates, iron, heavy metals, lead and arsenic, specific optical rotation, sulphated ash, loss drying, pH of solution etc. as may be applicable for the substance. Over 130 different categories of tests are mentioned in the pharmacopoeia concerning inorganic pharmaceutical substances. Specific tests which are performed on the substances are:

a) **Colour, odour and taste-** Though these have limited values, they are still helpful in determining whether the substance is reasonably pure, hygienic etc. or not, especially when other purity tests are unavailable.

b) **Physico-chemical constants -** Physico-chemical constants are essential criteria for the purity of many pharmaceutical substances. Specific materials of indefinite or variable composition do not respond well to chemical analysis; these physical methods are of prime importance. The pharmacopoeia attaches importance to solubilities, determination of melting point, distillation range/boiling point, weight per ml/ density/ specific gravity, viscosity and other physical measurements. Chromatographic constants e.g. Rf values and retention time also serve as suitable constants.

c) **Acidity, alkalinity and pH -** Because of incomplete purification of substances by inappropriate and insufficient washings after their separation in acidic or alkaline media, some degree of acidity or alkalinity may remain in the final product. Further, solutions of certain substances have a definite pH at a specified concentration. A deviation of pH from

an average value in a given substance at the specified concentration will indicate the presence of incorporated impurities.

d) **Anions and cations-** Because of co-precipitation/post-precipitation or adsorption certain anions and/or cations often get included in the final product. Chloride, sulphate, iron, lead, arsenic and heavy metals are the few most common impurities and the pharmacopoeia prescribes general quantitative or limit tests of tolerance of the impurities. For other anions or cations special tests of a quantitative nature are prescribed.

e) **Moisture determination-** Of some substances especially crude drugs provide valuable information about purity of specified substances.

f) **Insoluble residue-** Pure substances generally give a clear solution in a proper solvent at a specified concentration. Insoluble ingredients or impurities may make the solution cloudy, turbid or opaque or even insoluble suspension. The measurement of turbidity or opalescence or weighing the filtered the insoluble residue can serve as determination of the insoluble residue.

g) **Loss on drying/ignition-** On specified heating loss in weight upon drying or ignition also serves as an useful index towards purity determination.

h) **Ash, sulphate, ash, water insoluble ash-** Determination of ash in crude vegetable drugs, organic compounds and certain inorganic substances serves as a good indicator about the presence of heavy metals or minerals.

i) **Organic impurities and carbonisable substances-** These are determined in the specified substances as required in the monograph of the pharmacopoeia to ensure desired purity.

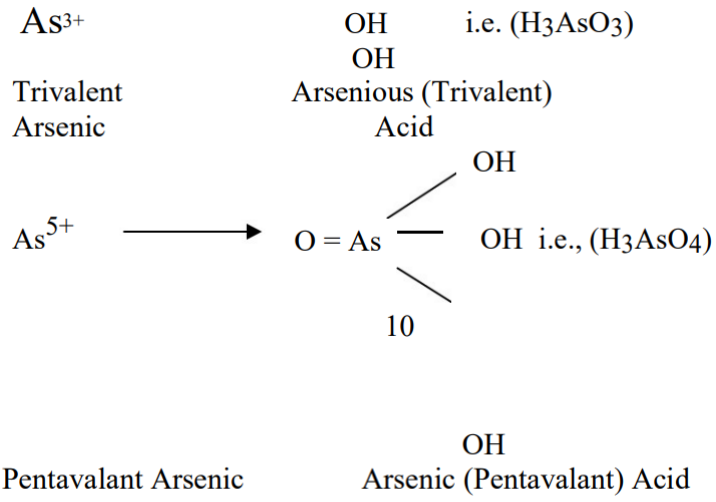
j) **Other physic-chemical parameters-** Such as swelling powder (e.g. bentonite, kaolin), bulkiness (barium sulphate), sedimentation volume (bentonite), soluble matter (kaolin) and stability of solution etc. also serves as parameters toward ensuring properties.

Question No. 06. Describe in detail the principle and procedure involved in limit test for arsenic and sulphate.

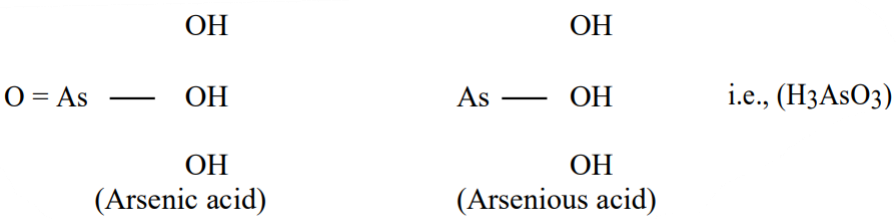
Limit test for Arsenic: Arsenic produces toxicity in the body therefore presence of arsenic, as impurity in the drug is not desirable. Indian Pharmacopoeia prescribes the limit for presence of arsenic as an impurity in various drugs.

Principle:

1. The sample is dissolved in acid, which converts the arsenic impurity into arsenious acid or arsenic acid depending upon the valency state of arsenic present in the sample.

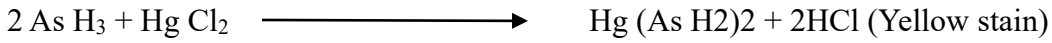


2. The solution is then treated with reducing agents to convert the pentavalant arsenic acid into trivalent arsenic acid.



3. Arsenic acid is then allowed to react with nascent hydrogen [which is produced by Zn + HCl] and converted into gaseous arsenic hydride (arsenic gas).

4. Arsine gas is carried through the tube by the hydrogen stream and out through the mercuric chloride paper. A reaction occurs between arsine and mercuric chloride which may be represented as follows.

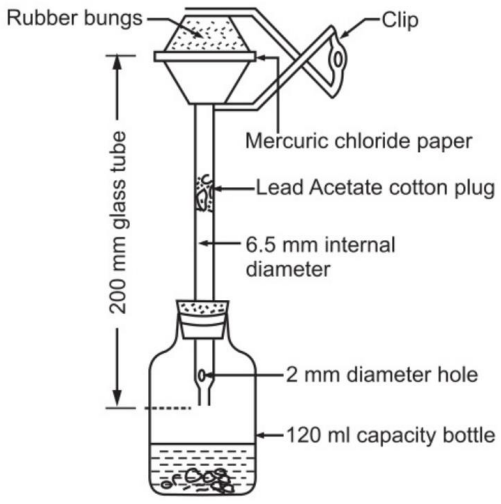


This results in the formation of a yellow or brown stain on the mercuric chloride paper. The intensity of standard and sample stains is compared. The intensity of the test solution should be at most the standard solution.

The procedure of limit test

Steps	Test Solution	Standard Solution
01.	Place 50 ml of distilled water in the bottle of an arsenic test apparatus (as shown in the figure) and label it as a label as test preparation.	Place 50 ml of distilled water in another Arsenic test apparatus bottle and label it as standard preparation.
02.	Add 2.5 gm of ammonium chloride to the bottle and dissolve it.	Add 1 ml of arsenic standard solution in the bottle (10ppm arsenic) and mix.
03.	Add 10 ml of stannated hydrochloric acid.	Add 10 ml of stannated hydrochloric acid.
04.	Add 5 ml of 1M Potassium iodide solution.	Add 5 ml of 1 M Potassium iodide solution.
05.	Add 10 gm of granulated zinc to fix all the apparatus's fittings as shown in the figure and allow standing for 40 minutes in the dark.	Add 10 gm of granulated zinc, fix all the apparatus's fittings as shown in the figure, and allow standing for 40 minutes in the dark.

Given substance passes the limit test if compared to the yellow stain of the test and standard preparation in daylight as soon as possible after the test is completed. If the stain produced in the test is of low intensity then standard preparation the test is passed.



Limit test for Sulphates:-

Principle: The limit test for sulphates depends upon the interaction of sulphates with barium chloride in the presence of hydrochloric acid. This results in the precipitation of sulphates as barium sulphates. Hydrochloric acid is added to prevent the precipitation of other acid radicals by the common ion effect with barium chloride solution so that fewer barium ions are formed and precipitation of other acid radicals such as phosphate and oxalate is prevented. However, in the presence of hydrochloric acid, only sulphates are precipitated.

The procedure of limit test:

Steps	Test solution	Standard solution
01.	Dissolve a specified quantity of substances as given in the monograph or prepare a solution as directed in the individual monograph. In Nessler's cylinder labelled as "Test". Make up volume up to 10 ml.	Place 1 ml. of 0.1089 w/v potassium sulphate solution in a Nessler cylinder labelled as "Standard" Add about 9 ml, of distilled water.
02.	Add 2 ml, of dilute hydrochloric acid.	Add 2 ml, of dilute hydrochloric acid.
03.	Dilute to 45 ml, with distilled water.	Dilute to 45 ml, with distilled water.
04.	Add 5 ml of BaSO4 reagent.	Add 5 ml of BaSO4 reagent.

Stir the test and standard solution and allow to stand for 5 minutes. Compare the turbidity against the dark background; if turbidity produced in the standard is more than that in the test, the sample compile limit test of sulphate as per I.P. 1985. The reaction will be as given below:

$BaCl_2$ + sulphates $\longrightarrow$ $BaSO_4$ + Chlorides

Question No. 07. Describe in detail the sources of impurities in pharmaceutical chemicals. Give importance to quality control of the drugs.

Sources of impurities: Chemical purity means freedom from foreign matters in pharmaceutical preparation. Pharmacopoeias fix tolerance limits for certain impurities such as arsenic, lead, heavy metals, iron etc. The various sources of impurities are as follows:

(a) Raw material: If impurities are present in raw material, which is used in the preparation of pharmaceutical chemicals then these impurities can be carried out during the manufacturing process to the final product. For example, copper sulphate is prepared by the action of sulphuric acid on copper turnings.

$$Cu + 2\ H_2SO_4 \longrightarrow CuSO_4 + 2\ H_2O + SO_2$$

Copper turning does contain iron and arsenic as impurities. These may be present in negligible amounts or more amounts; it will go to the final product. That is harmful. So, Indian Pharmacopoeia (I.P.) prescribes the limit for these impurities and they should be not more than as prescribed limit.

(b) Reagents used in the manufacturing process: The Reagents used in the manufacturing process are not entirely removed by washing. These may still be present in the final product. For example, precipitated calcium carbonate is prepared by inter-reaction of calcium chloride and sodium carbonate solution.

$$CaCl2 + Na2\ CO3 \longrightarrow CaCO3 + 2\ NaCl$$

Calcium carbonate precipitates have to be washed thoroughly to remove excess sodium carbonate and the soluble chlorides. If precipitates are not washed properly they may be present in the final product as impurity. So Pharmacopoeia prescribes limits of tolerance for the soluble alkali.

(c) Intermediate products in the manufacturing process: Sometimes an intermediate substance is produced during the manufacturing process and may be carried out to the final product. For example: –

$$6\ KOH + 3I_2 \longrightarrow 5\ KI + KIO_3 + 3H2O$$

The interaction of potassium hydroxide and iodine prepares potassium iodide. The resulting solution is evaporated to dryness and the residue is heated with charcoal.

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

In this potassium iodate is an intermediate product and if it is not entirely converted to potassium iodide, it may be present as impurity in the final product.

(d) Defects in the manufacturing process: Defects such as imperfect mixing, incompleteness of reaction, nonmaintenance of absolute temperature, pressure, pH or reaction conditions etc may result in the formation of chemical compounds with impurities.

(e) Solvents: Water is the cheapest solvent for pharmaceutical preparations. However, if purification is not done, these impurities of calcium, potassium, and magnesium are present and lead to impure products.

(f) Action of solvent and reagent on reaction vessels: Some solvents and reagents may react with metals of reaction vessel during the manufacturing process and may dissolve these metals which appear as impurities in the final product. For example – Iron contains some amount of arsenic. When preparation is made in an iron vessel, some arsenic and iron are released in preparation and impurities take place because I.P. prescribes the limit test for iron and arsenic.

(g) Atmospheric contamination during the manufacturing process: Atmospheric conditions around the manufacturing process especially in the industrial area may contain dust particles, some gases such as sulphur dioxide, hydrogen sulphide etc. and black smoke. These impurities may enter the preparations during manufacturing, resulting in impurities in the final product. Further, some substances may contaminate with atmospheric air, or carbon dioxide and water vapours during their preparation; for example, sodium hydroxide readily absorbs carbon dioxide from the atmosphere and forms sodium carbonate as an impurity. Therefore sodium hydroxide should not be exposed to the atmosphere during its manufacturing.

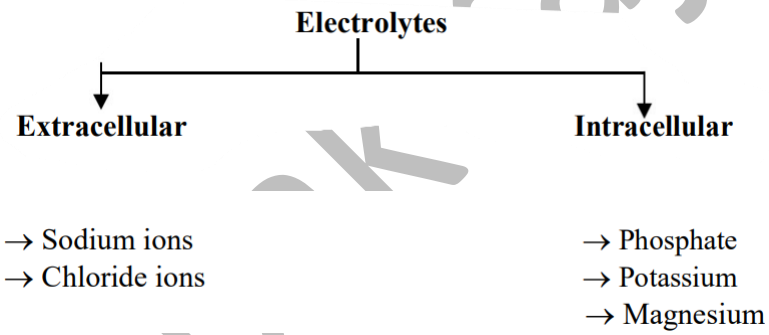
(h) Adulteration: Some of the pharmaceutical substances, which are expensive, may be adulterated with cheaper chemicals deliberately; for example, potassium bromide is adulterated with sodium bromide, as the former is more expensive than the latter.

(i) Defective storage of final products: Some pharmaceuticals undergo decomposition (Physical/ Chemical/ Biological) if the final product is not preserved under the prescribed conditions. For example, Iodine reacts with cork, rubber and some metals. These substances may be extracted in the final product as impurities; therefore iodine shall be preserved in the glass container with a glass stopper.

Importance of quality control: Quality control is vital in the case of drugs and pharmaceuticals. There cannot be any compromise in this regard and one cannot even think of any second quality in drugs and pharmaceuticals. Standards for drugs and quality control methods are monographed in pharmacopoeia, official publications made in various countries. For example in our country "Indian Pharmacopoeia" is official and substances which are prepared and purified keeping in view the requirements of Indian pharmacopoeia and these when tested or analyzed, must confirm to the standards of quality prescribed for them.

Question No. 08. Define electrolyte replacement therapy. What are the roles of significant intra and extra-cellular electrolytes? Explain the preparation, properties and uses of sodium chloride.

Electrolytes: These are those substances which are used to improve or correct the imbalance of intracellular and extracellular ions in the body for normal metabolism Electrolytes are classified as:



Role of extracellular electrolytes:

Sodium ion (Na+): It maintains normal hydration and osmotic pressure, buffer constituent, acid-base balance, cell membrane permeability, muscle contraction, carbon dioxide transport, and the transmission of nerve impulses in nerve fibres. It is completely and readily absorbed, and excreted in sweat and urine. Low serum Na+ may occur with extreme loss of urine in diabetes leading to condition hyponatremia. High serum Na+ levels may occur in Cushing's syndrome leading to the condition hypernatremia.

Chloride ion (Cl-): It maintains proper hydration, osmotic pressure, normal electrolyte balance, acid-base balance and gastric HCl. It is obtained from common table salt and animal foods. It is completely absorbed, eliminated from blood by glomerular filtration and possibly reabsorbed by the kidney. Kidney diseases, diabetes and prolonged vomiting lead to a

deficiency of Cl-, a condition known as hypochloremia. Excessive Cl- intake leads to the condition of hyperchloremia.

Role of Intracellular Electrolytes:

Phosphate ion (HPO4 2- and H2PO4 -): It is the predominant constituent of bones, teeth, HPO_4^{2-} /$H_2PO_4^-$ buffer, cell phosphoproteins, phospholipids and cofactors of ATP, NAD, and FAD etc. It is obtained from milk and milk products, whole grains, legumes and egg yolk. It is easily absorbed from the intestines and excreted mainly through urine. Excess and deficiency lead to conditions of hyperphosphatemia and hypophosphatemia respectively.

Potassium (K+): It maintains acid-base and water balance. It is a buffer constituent that helps in muscle contraction, membrane transport and carbon dioxide transport. It is obtained from fruits, vegetables, legumes and meat. It is rapidly absorbed, and excreted by the kidneys. Excess and deficiency lead to conditions hyperkalemia and hypokalemia respectively.

Magnesium (Mg2+): It is an essential component of several enzymes involving phosphate metabolism, a constituent of bones, and teeth, and helps in protein synthesis and smooth neuromuscular function. It is not readily absorbed from GIT, unabsorbed Mg^{2+} is eliminated through faeces and absorbed portion is excreted through urine and intestinal secretions. Excess and deficiency lead to conditions hypermagnesemia and hypomagnesaemia respectively.

Sodium Chloride:

Chemical Formula: NaCl

Properties: It is colourless crystals or white crystalline powder. It is odourless but possesses a saline taste. It is freely soluble in water, soluble in glycerin and slightly soluble in alcohol.

Preparation:

(I) **From rock salt-** Sodium chloride is manufactured from underground rock salt deposits. Bore holes are drilled and water is run straight to the rock salt. This dissolves sodium chloride to form its solution. The resultant clear saturated brine is then pumped above to the surface. This is then evaporated in triple-effect evaporators to obtain sodium chloride.

(II) **From seawater:** It is well known that seawater contains salts, especially sodium chloride. Common salt has been manufactured for hundreds of years by evaporation

of seawater in shallow pans or tanks. This process is still used for manufacturing common salt.

Storage: It should be stored in tightly closed containers as it absorbs moisture.

Uses: Sodium chloride is primarily used as an electrolyte replenisher. It is a crucial salt present in the body fluids. A 0.9% aqueous sodium chloride solution is isotonic with body fluids, known as normal saline solution

Question No. 09. Give each compound's physical and chemical properties and uses. (a) Borax (b) Alum (c) Boric Acid (d) Zinc sulphate (e) Zinc chloride

(a) Borax

synonym: Sodium Borate, Sodium Tetraborate

Chemical formula: $Na_2B_4O_7.10H_2O$

Physical and chemical properties: It is colourless transparent crystals or white crystalline powder, odourless with saline or alkaline taste. It is soluble in water and glycerin but insoluble in alcohol. Its aqueous solution is alkaline to phenolphthalein test solution due to hydrolysis.

$Na_2B4O7 + 3H_2O \longrightarrow 2NaBO_2 + 2H_3BO_3$ Sodium metaborate

If the solution is diluted further, sodium metaborate further hydrolyses giving rise to alkali and boric acid.

$NaBO_2 + 2H_2O \longrightarrow NaOH + H_3BO_3$

Storage: It should be stored in air-tight containers in a cool place.

Uses:

1. It has antibacterial action but causes toxicity.
2. Its 1 to 2% concentration is used as eyewash, gargle, in mouthwash and as wet dressings.

(b) Alum

Synonym: Alum is Potash Alum, [Aluminium Potassium sulphate or Ammonia alum and others].

Chemical formula: $KAl(SO_4)\ 2.12H_2O$

Physical and chemical properties: Alum occurs as large, colourless crystals and white powder. It is odourless with a sweetish strongly astringent taste. Its solutions are acidic

to litmus paper. Alums are freely soluble in water but slowly dissolve in glycerin and insoluble in alcohol. When heated, it melts and at about 2000 C loses its water of crystallization with the formation of the anhydrous salt. It is required to be stored in air-tight containers.

Storage: It should be stored in air-tight containers.

Uses:

1. Alum precipitates proteins and is a powerful astringent.
2. Athletes use a 5% alum solution to harden the skin of their feet and 15% powder in talc is
3. Used as a Foot powder.

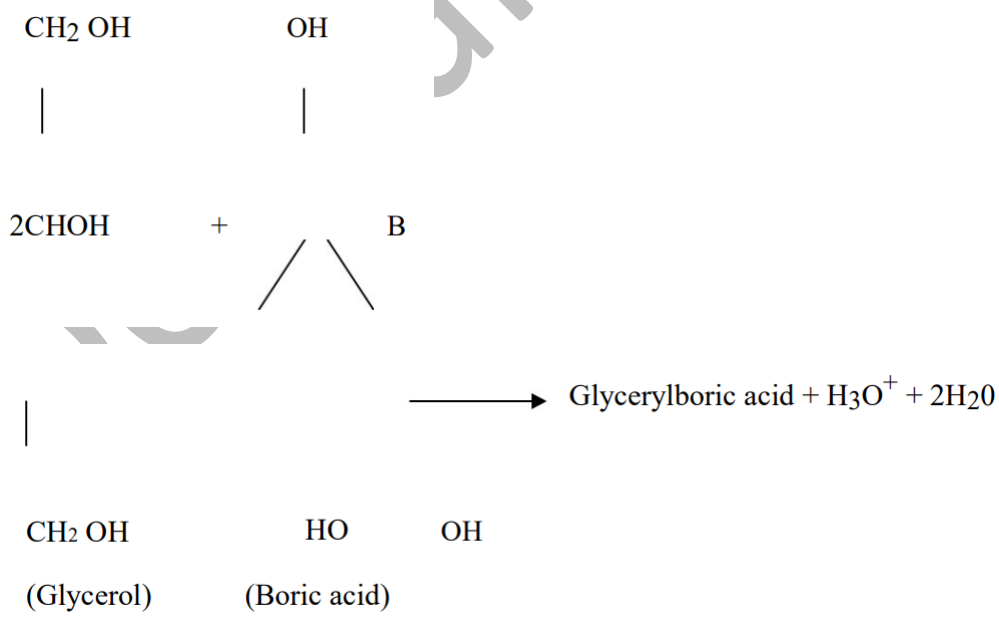
(c) Boric Acid

Synonym: Boracic acid

Chemical formula: H_3BO_3

Physical and chemical properties: It occurs as colourless or white crystals powder that is odourless and possess a slightly acidic bitter taste and sweetish after taste. It is soluble in water and alcohol and freely soluble in glycerin. A solution containing 1.9% acid is isotonic with body fluids.

Boric acid forms ester with glycerol.



Boric acid on heating results in various dehydration products which depend upon temperature condition.

Boric acid Metaboric acid Pyroboric acid

Storage: It should be stored in well-closed containers.

Uses:

1. Boric acid is a local anti-infective.

2. It is also used in dusting powders, local antiseptic creams, and ointments.

3. Aqueous solutions used as mouthwashes, and eye lotions.

4. It has weak bacteriostatic and fungi static properties.

(d) Zinc Sulphate:

Synonym: White Vitriol

Chemical Formula: $ZnSO_4.\ 7H_2O$

Physical and Chemical properties: It occurs as a colourless, transparent crystal or crystalline powder. It is odourless, but it tastes metallic & astringent. It effloresces in dry air i.e. loses some part of its water of crystallization when exposed to air. It is very soluble in water & freely solution in glycerin, but insoluble in alcohol.

Storage: It should be stored in tightly closed containers.

Uses:

1. It is used as reflex emetics, especially in narcotic poisoning (opium alkaloid poisoning).
2. It is used as an antiseptic & astringent externally in powder & in lotions.
3. A 0.25% solution is used as an ophthalmic astringent.

(e) Zinc Chloride:

Synonym: Butter of Zinc

Chemical formula: $ZnCl_2$

Physical and chemical properties: White or nearly white, odourless crystalline granules. It may also be found as porcelain-like masses or moulded into cylinders. It is highly deliquescent. It is very soluble in water and freely soluble in alcohol and glycerine. Usually, its solution in water or alcohol is slightly turbid due to the formation of zinc oxychloride.

Storage: It should be stored in air-tight containers.

Uses:

1. It is used antiseptic, astringent to skin and mucous membrane.

2. It is used topically as a dentin desensitizer.

3. It is also used as mouthwashes for its antiseptic property.

4. It is used in ulcers.

Question No. 10. What are Antidotes? Explain their mechanism & discuss cyanide poisoning in detail?

A poison may be defined as any substance administered in whatever way (be mouth, infection, inhalation through skin or mucous membrane contact) produces ill- health, disease or death. An antidote is an agent that counteracts a poison. On the basis of mechanism of action, antidotes have been classified as

(i) Physiological antidote
(ii) Mechanical antidote
(iii) Chemical antidote

1) Physiological antidote: Which counteracts the effect of poison by producing other effects, e.g. sodium nitrite, which converts haemoglobin into methaemoglobin in order to bind cyanide?

2) Chemical antidote: Which changes the chemical nature of poison, e.g. sodium thiosulphate, which converts the systemically toxic cyanide into non-toxic thiocyanate and sodium or calcium edentate which is a chelating agent used for heavy metal poisoning.

3) Mechanical antidote: Which prevents absorption of the poison into the body e.g.

(i) Activated charcoal, which adsorbs the poison before adsorption across the intestinal wall, (ii) copper sulphate which inactivates and precipitates the toxic material as insoluble salts?

Cyanide Poisoning: It requires special attention because it may occur in several ways such as inhalation of hydrocyanic acid like fumigates or from the ingestion of soluble inorganic cyanide salt or cyanide-releasing substances like cyanamide, cyanogens chloride, seeds of chokecberry, peach and other. Consumption of 300 mg of potassium cyanide may cause death.

Signs and symptoms: Nausea, drowsiness, dizziness, headache, hypotension, coma, convulsion & death. Death may occur within minutes of inhalation of hydrogen cyanide while oral ingestion causes death in several hours. Process of cyanide poisoning in the body: Cyanide readily combines with ferric ion (Fe^{3+}) of cytochrome oxidase which prevents electron transfer & thus stops the cellular respiration or oxidation-reduction reaction.

Treatment: Sodium nitrite and sodium thiosulphate find a special place in treating cyanide poisoning. Firstly injection of sodium nitrite is given which causes the oxidation of the ferrous (Fe^{2+}) ion of haemoglobin to the ferric ion of methaemoglobin. The methaemoglobin so formed then combines with serum cyanide that has not yet entered the cell, to produce cyanmethaemoglobin. After 5 minutes, a slow intravenous infusion of sodium thiosulphate (50 ml in 10 minutes) is given. The thiosulphate ions react with cyanide ions set free owing to the slow dissociation of cyanmethaemoglobin and form non-toxic thiocyanate ions. The usual dose and antidote in cyanide poisoning used are:

1. Sodium Nitrite – 10 to 15 ml of 3% solution intravenously.

2. Sodium thiosulphate – 1g (range 500 mg to 2 g) in a 5 -10% solution intravenously.

Question No. 11. (a) Define anions and cations. Describe identification test for Na+ , K+ , Ca++ , Cl-- , SO4 - - and HCO3 - . (b) Describe limit test for Iron.

(a) Cations may be defined as an atom that gives its electrons to a high electronegative atom and it changes into cations. For example: K^{+}, Ca^{++}. Anions may be defined as an atom which accepts electrons from less electronegative atoms and changes into anion. For example Cl^{-}, $SO4^{--}$

Identification test for

1. **Sodium (Na+):** Dissolve the substance (0.1 g) in the water (2ml) and add potassium carbonate (2ml, 15% w/v) and boil the solution; no precipitates are formed. To this add freshly prepared potassium antimonate solution (4 ml) and boil. Cool and scratch the sides of the test tube to give a dense, white precipitate is formed.

$$NaCl + KH_2SbO_4 \longrightarrow NaH_2SbO_4 + KCl$$

Potassium Antimonate — Sod. pyroantimonate (white ppt.)

2. **Potassium (K+):** (i) An aqueous solution of the substance is acidified with dilute acetic acid (1ml). In addition to a freshly prepared solution of sodium cobalt nitrate (10% w/v) an orange-yellow ppt is formed immediately.

$$2\,KCl + Na_3[CO(NO_2)]6 \longrightarrow K_3Na[CO(NO)_2]_6 + 3NaCl$$

Sodium cobalt Nitrate — Yellow ppt

3. **Calcium ($Ca2^+$):** Dissolve a sample of the substance in a minimum quantity of dilute HCl acid and neutralize with dilute sodium hydroxide solution or use 5 ml of the prescribed solution; add 5ml of ammonium carbonate solution; a white precipitate is formed which, after boiling and cooling the mixture, is only sparingly soluble in ammonium chloride solution.

$$CaCl_2 + (NH_4)2CO_3 \longrightarrow 2NH_4Cl + CaCO_3 \text{ (white ppt.)}$$

4. **Chlorides (Cl-):** Aqueous solution of a substance containing chloride is acidified with dilute HNO_3 and treated with silver nitrate solution when a cruddy white precipitate of silver chloride is formed.

$$NaCl + AgNO_3 \longrightarrow AgCl + NaNO_3 \text{ White precipitates}$$

5. **Sulphate (SO--4):** Dissolve a little amount of the substance in dilute HCl and add barium chloride solution (1 ml). A white precipitates of barium sulphate in formed.

$$Na_2SO_4 + BaCl_2 \longrightarrow BaSO_4 + 2\,NaCl$$

6. **Bicarbonates (HCO3 -):** (i) When a solution containing bicarbonate is boiled, CO2 is evolved which can be passed in lime water to give a white ppt of calcium carbonate boil.

$$2NaHCO_3 \xrightarrow{\text{Heat}} Na_2CO_3 + CO_2 + H_2O$$

Ans. (b)

Limit test for Iron: The limit test of iron depends upon the interaction of thioglycolic acid with iron in the presence of citric acid in the ammoniacal alkaline medium. This results in the formation of purple-colored ferrous salt of thioglycollic acid.

Citric acid

$2\ HSCH_2COOH + Fe^{++}$ $Fe(HSCH_2COO)_2 + 2H^+$

Thioglycolic acid ferrous thioglycolate

1. Thioglycolic acid converts the iron impurities, if present, from the ferric form to the ferrous form.

2. Thioglycolic acid forms the purple colour with the ferrous form of iron in the ammoniacal alkaline medium.

Steps	Test solution	Standard solution
01.	Dissolve 1gm of test preparation (Sodium Chloride) in 40 ml of distilled water in a Nessler cylinder and label it as a test solution.	Dissolve 2 ml of standard iron solution (20 ppm) in about 40 ml of distilled water in a Nessler cylinder and label it as a standard solution.
02.	Add 2 ml of 20% solution of iron-free citric acid.	Add 2 ml of 20% solution of iron-free citric acid.
03.	Add 0.1 ml of Thioglycolic acid.	Add 0.1 ml of Thioglycolic acid
04.	Make the solution alkaline with an iron-free ammonia solution.	Make the solution alkaline with iron-free ammonia solution.
05.	Dilute up to 50 ml mark with distilled water, stir it with the help of glass rod and allow to stand for 5 minutes	Dilute up to 50 ml mark with distilled water, stir it with the help of glass rod and allow to stand for 5 minutes.

Compare the purple colours in the two Nessler cylinders by viewing vertically downward; if the intensity of the purple colour in standard is more than that in test, the sample complies with limit test of iron.

Question No. 12. Write a short note on the following: (a) Antimicrobials (b) Astringents (c) Protective and adsorbent (d) Antioxidants (e) Expectorant and Emetics.

Ans.

(a) Antimicrobials: Antimicrobials are the agents used to destroy or inhibit the growth of pathogenic micro-organisms. They are normally ineffective in the sporing state of micro-organisms. But they may apply to the skin, body membranes and cavities. The disinfectants are employed on inanimate objects and materials to eliminate micro-organisms. An antiseptic is applied before all invasive procedures; antiseptics are also applied prophylactically to the hands of surgeons, dentists, nurses and others in their routine procedures. Sterilization is the destruction of all living microorganisms, including bacterial spores. It can be achieved by physical methods and by chemicals (disinfectants). Example: Potassium permanganate ($KMnO_4$), Hydrogen peroxide (H_2O_2)

Potassium permanganate

Chemical formula: KMnO4

Properties: It is a dark purple or brownish-black granule that is odourless and soluble in water. A neutral or alkaline solution produces a brown precipitate of manganese dioxide

Preparation: Manganese dioxide is fused with excess potassium hydroxide in the presence of a free supply of air or with the addition of some suitable oxidizing agent such as potassium nitrate or potassium chloride.

$$2\ KMnO_4 + H_2O \longrightarrow 2\ MnO_2 + 2\ KOH + 3\ [O]$$

Uses: It is a strong oxidizing agent used for disinfectant, deodorant, gargles and mouthwashes.

(b) Astringent: Astringents are locally applied protein precipitate and reduce cell permeability. Astringents are used as

1. To check diarrhoea.

2. Styptic: to arrest haemorrhage by promoting coagulation of blood and constricting small capillaries.

3. To constrict pores on the skin.

4. Promote healing and harden the skin. Example: Alum, Zinc sulphate

(c) Protectives: Protectives are the compounds applied on the skin to protect ulcers or open wounds from irritation. These substances are insoluble and chemically inert. These may be applied to the surface to protect certain areas from irritation. Ideal protectives are biologically inactive. They generally absorb moisture and therefore also act as cutaneous desiccants. An ideal protective should be:-

(1) Insoluble in water

(2) Chemically inert

(3) Biologically inert

(4) Available as fine particles Protective and adsorbent are maximized with decreasing particle size because small particles offer a large surface area. Protective are generally used as dusting powders, and suspensions containing insoluble protective substances such as lotions, ointments and creams. Some of the inorganic protective compounds and preparations described here: Example: Talc, Zinc oxide, Calamine, Zinc stearate, Titanium dioxide,

Talc

Synonym: Purified talc, Talcum, Soapstone

Chemical formula: $3MgO\ 4SiO_2.\ H_2O$ is a naturally occurring hydrated magnesium silicate called soapstone or French chalk.

Properties: It is a very fine white powder that adheres to the skin and is free from grittiness, greasy to the touch, odourless, and tasteless. It is insoluble in water, dilute acids or alkalies.

Uses:

1. It is a dusting powder, medicated with zinc oxide or boric acid.

2. It should not be applied on broken skin wounds or surgical gloves because it causes toxicity.

3. It is used as filtering media.

4. Talc is also used as a lubricant and as an excipient in preparations of pills and tablets.

Adsorbent: Adsorbents are substances used to absorb undesirable substances on their surface. It is used in accidental or intentional poisoning, diarrhoea, sugar clarification and food poisoning. The adsorbents used internally for gastrointestinal irritation are different compounds. Example: light kaolin, activated charcoal.

(d) Anti-Oxidants: An antioxidant is an agent, which is added in any preparation to prevent oxidation and deterioration of the product. It is based on oxidation-reduction or redox reactions. Antioxidants should be handled with strong oxidizing agents. Examples are:-

1. Sulphur dioxide (SO_2)

2. Sodium bisulphate ($NaHSO_4$)

3. Sodium metabisulphite (Na_2SO_5)

4. Sodium thiosulphate ($Na_2S_2O_3.5H_2O$)

5. Sodium nitrite ($NaNO_2$) They act by two mechanisms: -

1. Antioxidant is oxidized in place of active constituents.

2. If active constituents are oxidized, antioxidants reduce them back to normal. Example: Sulphur Dioxide

Sulphur Dioxide

Chemical formula: SO_2

Properties: It is colourless, non-flammable and has an irritant odour. It forms an additional product with halogen in the presence of sunlight or camphor. It is a good reducing agent. It is stable even at high temperatures & does not burn or support combustion in the presence of a catalyst and with the combination of oxygen, it forms sulphur trioxide. It also gives a reaction with halogens.

$SO_2 + Cl_2 \longrightarrow SO_2Cl_2$ [Sulphuryl chloride]

$SO_2 + F_2 \longrightarrow SO_2F_2$ [Sulphuryl fluoride]

Uses:

1. Mainly used as an antioxidant.

2. Sulphur dioxide is gaseous. Hence used in single-dose injectables as antioxidants.

3. Sulphur dioxide in glycerine is used for sore throat, tonsillitis and skin infections.

(e) Expectorant and Emetics Expectorants: Expectorants are the drugs used to help in the removal of exudate from the trachea, bronchi or lungs, & hence they are used in the treatment of cough. They act in two ways.

1. By decreasing the viscosity of bronchial secretion and facilitating their elimination.

2. By increasing the amount the respiratory tract fluid. E.g. Ammonium chloride NH_4Cl and Potassium iodide KI.

Ammonium Chloride:

Synonym: Amchlor

Chemical formula: NH_4Cl

Preparation: It is prepared by neutralizing acid with ammonia.

$NH_3 + HCl \longrightarrow NH_4Cl$

Physical properties: It is a colourless or white crystalline powder, odourless, and saline in test. Freely soluble in water and 5% solution is acidic.

Uses: It is an expectorant, diuretic in lead poisoning and systemic acidifier in treating urinary infections.

Emetics: These are the agents, that induce vomiting by producing irritation of G.I.T muscle and produce vomiting, an example is antimony potassium tartrate. Sometimes its low dose is used in cough preparations. They probably stimulate the flow of respiratory tract secretions. Emetics should not be used in CNS depression, shock and in pregnancy e.g. antimony potassium tartrate.

Antimony potassium tartrate

Synonym: Antimony Pot. Tartarate

Chemical formula: $C_4H_4KO_7Sbk.1/2\ H_2O$ Preparation: It is prepared by mixing antimony trioxide [Sb2O3] with potassium acid tartrate in the ratio of 5: 6. The paste is made and kept aside for 24 hrs. Which is then boiled with water and the liquid is filtered while hot.

$Sb_2O_3 + 2\ C_4H_4O_6KH \longrightarrow 2\ C_4\ H_4\ O_7Sbk + H_2O$

Physical properties: It is a white crystalline powder, odourless, sweet soluble in 17 parts of water and insoluble in alcohol.

Uses:

1. It is used as emetics in Kala Azar disease given by I.V. route; I.M. should never give it because it causes severe pain.

2. It is also used in cough syrups in low doses.

Question No. 13. Discuss in brief the dental products.

Ans. Due to the habits of chewing betel leaves, tobacco and pan masala etc. common problems associated with teeth are the formation of cavities, reduction of shining over teeth. These problems are overcome by using anti-caries agents, dentifrices and polishing agents.

Common local dental products are:-

i) **Anti-caries agents:** Dental carries occur due to the action of lactic acid obtained from bacterial metabolism of dietary carbohydrates. The various anti-cancer agents are the following (i) Sodium fluoride (ii) Stannous fluoride ii)

ii) **Dentifrices and polishing agents:** It is also called cleaning agents. They are mixed with desensitizer and with polishing agents. Desensitizers used are strontium chloride and zinc chloride. The polishing agent used is calcium carbonate.

iii) **Abrasives:** They are used by the dentist in cleaning & polishing teeth e.g. pumice cavities i.e. dental cement.

iv) **Desensitizers:** They decrease hypersensitivity of teeth when applied on their surface e.g. ammonical silver nitrate solution.

v) **Mouthwash:** They are antiseptics medicated liquids use for cleaning the mouth e.g. hydrogen peroxide.

Examples of dental products are:-

(i) Sodium fluoride (NaF)

(ii) Calcium carbonate (CaCo3)

(iii) Dicalcium phosphate (Zinc chloride (Zncl2).

Sodium fluoride:-

Chemical formula: NaF

Preparation: It is prepared by passing hydrogen fluoride into a sodium carbonate solution. Properties: It is colourless, odourless, soluble in water and practically insoluble in alcohol.

Usual dose: 2.2 mg once a day for adults.

Use:

1. It is used for dental caries.

2. It may be added to water supplies.

3. 20% solutions in water may be applied to children's teeth.

Question 14 Define the buffer solution. How many types of buffer solutions are there? Explain.

Ans. 14 Buffer solutions are defined as those solutions which are able to resist the change in pH value. Buffer solution consists of a mixture of a weak acid or weak base and their salt respectively:- **There are many types of Buffer solutions:**

1) Acidic buffer

2) Basic buffer

3) Neutral buffer

Acidic buffer solution: The solution has a mixture of weak acid and salt. For example: a mixture of acetic acid and sodium acetate.

Basic buffer solutions: The solution having a mixture of weak base and its salt. For example: a mixture of ammonium hydroxide and ammonium chloride.

Neutral buffer solution: The solution has a mixture of weak acids or weak bases. For example: a mixture of acetic acid and ammonium hydroxide.

Question No.15. Write down:- (a) Chemical formula and use of laughing gas (b) Pharmaceutical uses of nitrogen (c) Composition of soda lime (d) Buffer capacity (e) Temperature range for storage of drugs under cold conditions and cool condition (f) Differentiate very soluble and freely soluble salts.

(a) Chemical formula and uses of laughing gas

Chemical formula: N_2O

Uses: It is used by inhalation for operations of short duration like dental extractions, and minor operations of boils and abscesses. It is often used in conjunction with local anaesthetics and muscle relaxants.

(b) Pharmaceutical uses of nitrogen

1) Nitrogen can be used to protect chemicals, reagents and pharmaceuticals from air oxidation by displacing the air in the reaction vessels and containers, e.g. cod liver oil, olive oil castor oil etc.

2) Liquid nitrogen is used in the food-freezing process, and the laboratory as a coolant.

3) Liquid nitrogen is used in cryoscopic surgery to remove some tumours.

4) Other uses of nitrogen are in manufacturing ammonia, nitric acid, nitrates, cyanides, explosives etc.

5) It is also used to replace the air in containers of parenteral, solution for topical applications and injections.

(c) Composition of soda lime

The main components of the soda lime are

1. Calcium hydroxide Ca (OH)2 (about 75%)
2. Water, H2O (about 20%)
3. Sodium hydroxide, NaOH (about3%)
4. Potassium hydroxide, KOH (about 1%)

Uses:-

(i) It is used as a pharmaceutical aid for adjusting the pH of solutions.

(ii) (ii) Sodium hydroxide is a powerful caustic and has been used to remove warts. Its 2.5% solution in glycerol may be used as a solvent for removing superficial skin.

(d) Buffer capacity: Buffer solution resist change in pH upon the addition of strong acids or strong bases. The buffering action is measured in terms of buffer capacity. Buffer capacity is defined as the moles of strong acid or strong base required to change the pH of one litre of buffer solution by one unit.

(e) Temperature range for storage of drugs under cold condition and cool condition:

Cold: Any temperature not exceeding 8°C and usually between 2°C and 8°C will provide cold conditions. A refrigerator is a cold place in which the temperature is maintained thermostatically between 2°c to 8°c.

Cool: Any temperature between 8°C and 25°C will provide cool conditions. An article for which storage in a cool place is directed, may alternatively be stored in a refrigerator, unless otherwise specified in the individual monograph

(f) Differentiate very soluble and freely soluble salts Solubility- According to I.P 2010, solubilities of the substance at 1 to 30°C are mentioned in the following terms:

Very soluble: A substance is said to be very soluble if the volume of solvent required for dissolving 1 part of solute is less than 1 part.

Freely soluble: A substance is said to be freely soluble if the volume of solvent required for dissolving 1 part of solute is less than 1 to 10 parts.

Question No. 16. Write the storage condition of the following compounds: iodine, normal saline solution, chlorinated lime, and sodium hydroxide & also explain the reason.

Ans.

Iodine- It should be stored in well-closed bottles fitted with glass stoppers because iodine is volatile and its vapours react to both cork and rubber.

Normal saline solution: - It should be stored in tightly closed containers as it absorbs moisture. Solutions on storage may cause the separation of small solid glass particles from glass containers. Solutions containing such particles must not be used and should be discarded. **Chlorinated lime: -** It should be stored in tightly closed containers because, on exposure to air, it slowly decomposes with the loss of chlorine. This change is due to the action of atmospheric carbon dioxide and moisture.

Sodium hydroxide: - As it is highly deliquescent and as it also readily absorbs carbon dioxide from the air, therefore, it must be stored in tightly closed containers. The glass stoppers may get jammed due to the formation of sodium silicate. Hence, non-reactive glass or plastic materials are to be preferred.

Question No.17. (a) Write note on physiological acid base balance.

Ans.

(a) Physiological acid-base balance All body fluids have definite pH values which must be maintained within relatively narrow limits. The normal range of pH values of few selected fluids are:

Blood	7.4-7.5	Duodenal fluid	5.5- 7.5
Saliva	6.4-7.4	Gall bladder bile	5.5-7.5
Urine	4.5-8.0	Gastric juice	1.5-1.8

There are three regulatory mechanisms which maintain the pH of the each system and equilibrium with one another. These are –

(1) Buffer (2) Respiratory mechanism (3) Renal regulation

(1) Buffers: Buffers are the chemical systems capable of maintaining a constant pH, e.g. phosphates, bicarbonates and some proteins which are able to bind free H+ or OH- ion and prevent a change in pH. Three major systems of buffering in the body are

i) Carbonic acid/ bicarbonate which mainly occurs in plasma and kidney.

ii) Monohydrogen phosphate / dihydrogen phosphate found in cells and kidney.

iii) Protein buffer system. Proteins are composed of amino acids bound together by peptide linkage. **(2) Respiratory mechanism:** When respiration is decreased, there is an accumulation of CO_2 in the body which uses up the alkali reserve of the blood resulting in the acidosis. On the other hand, if there is overbreathing which results in excessive excretion of CO_2, the condition of alkalosis may be develop. Thus, acidity and CO_2 increases are both powerful stimulants of respiratory mechanisms and cause an increase in the rate and depth of respiration. The H_2CO_3 is converted to CO_2 and water the CO_2 is rapidly breathed out. On the other hand, an increase in base leads to a decrease in acidity and H_2CO3 content.

(3) Renal regulation: Kidneys can form ammonia which combines with the acids produced during metabolism and is excreted in the urine. The pH of urine is highly variable between 4.8 to 8.0.

Disturbance in acid-base balance- The buffer, respiratory and excretory systems of the body work together to maintain the acid-base balance of the body, so that the pH range of various body fluids remains within normal but narrow limits. A primary defect in the elimination of CO_2 or a metabolic disorder can lead to an alteration of the pH of blood beyond physiological limits and these disturbances in acid-base balance are classified accordingly.

(1) Respiratory acidosis: The H_2CO_3 content of plasma is increased due to interference with the elimination of CO_2 by the lungs. This occurs mainly in conditions such as congestive heart failure, pneumonia and poisoning with barbiturates or narcotic drugs which depress the respiratory centre. **(2) Respiratory alkalosis:** There is a fall in H_2CO_3 level of plasma due to hyperventilation in the lungs. This occurs mainly in fever, anoxia, salicylate poisoning and at high altitudes.

(3) Metabolic acidosis: The HCO_3 - plasma fraction is lowered in conditions such as renal failure, diabetes mellitus and severe dehydration due to diarrhoea and vomiting. Compensation to some extent in the initial stages occurs by increased respiration whereby more CO2 is eliminated to maintain the HCO_3 - /H_2CO_3 ratio.

(4) Metabolic alkalosis: An increase in the bicarbonate content of plasma due to ingestion of large volume of alkalis in the treatment of peptic ulcer and vomiting due to high intestinal obstruction are the two leading causes. Compensation to some extent is attempted by a depression of respiration and an excretion of alkaline urine by the kidneys.

Question No.18 (a) Write down the theory of limit test for chloride. (b) Name four official compounds of calcium and explain the physiological roles of calcium in the human body.

Ans. (a)

Limit test for chloride: The limit test for chloride depends upon the interaction of chlorides with silver nitrate in the presence of nitric acid. This results in the precipitation of chloride as silver chloride. When only small quantity of chloride ions are present, silver chloride appears as opalescence and not as precipitate.

Limit test for chlorides in magnesium sulphate I.P

Test	Standard
1. Take 8.0 ml of solution A (prepared by dissolving in sufficient carbon dioxide-free	To take 10 ml of chloride standard solution (25 5.0 g (This is prepared by diluting 5

water and ppm Cl). transfer it to a Nessler cylinder labelled as a test.	volumes of 0.0824 per cent w/v sodium chloride solution to 100 volumes with water.)
2. Add 10 ml of dilute nitric acid.	2. Add 10 ml of dilute nitric acid.
3. Dilute to 50 ml mark with distilled water.	3. Dilute to 50 ml mark with distilled water.
4. Add 1 ml of 0.1 M solution of silver nitrate.	4. Add 1 ml of 0.1 M solution of silver nitrate.

Chlorides are present in pharmaceutical substances in very small quantities as an impurity and, therefore silver chloride appears as opalescence which is compared under uniform conditions of illumination with standard opalescence in a nessler cylinder.

$$\text{Chlorides} + AgNO_3 \longrightarrow AgCl + \text{Nitrates}$$

Ans. (b) Physiological role of calcium in the human body:- Calcium is one of the essential elements required for various functions of the body. About 90% of the body's calcium is found in bones as calcium carbonate and phosphate. The ionic form of calcium is involved in various physiological activities. The calcium ions are essential for maintaining some important body functions for example:

1. The cation is essential for the normal functioning of the automatic and voluntary nervous systems.

2. Calcium is necessary for normal cardiac function.

3. It is an important factor in coagulation of blood and cell membrane permeability.

4. It is important for the formation of specific tissues and bones.

When the a deficiency of ionized calcium in the blood, the condition is known as hypocalcaemia. The official compounds of calcium are discussed below:

1. Calcium acetate

Chemical formula: $C_4H_6CaO_4$

Properties: It is a white powder almost colourless and hygroscopic in nature. It is soluble in water but slightly soluble in alcohol.

Storage: As it is hygroscopic in nature, it is kept in a well-closed container in a dry place.

Uses: It is one of the ingredients of solutions used for haemodialysis and peritoneal dialysis. The haemodialysis solutions are solutions of electrolytes in concentration similar to those of normal extracellular body fluids and glucose may be included in such formulations.

2. Calcium gluconate

Chemical formula: $C_{12}H_{22}O_{14}Ca.H_2O$

Properties: It occurs as a white crystalline powder or as white granules. It is odourless and almost tasteless. It is slowly soluble in cold water but is freely soluble in boiling water. It is insoluble in alcohol. **Storage:** It should be stored in well closed container.

Uses: It is used as a calcium replenisher. It is an essential source of calcium in treating hypocalcemic tetany and other calcium deficiency conditions stated in the introduction. It is administered orally as tablets and in the form of injections. Calcium gluconate tablets are used extensively in supplementing the diet of convalescent and expectant mothers.

3. Calcium hydroxide

Chemical formula: $Ca(OH)_2$

Properties: - It is a soft white powder with an alkaline and slightly bitter taste that readily absorbs carbon dioxide from the air forming calcium carbonate. It is sparingly soluble in water. It is much more soluble in solutions of sugar and glycerol but is insoluble in alcohol.

Storage:- It should be stored in air-tight containers to prevent its interaction with atmospheric carbon dioxide.

Uses: - Calcium hydroxide is an antacid and astringent. It is given orally as a solution which, when added to milk, prevents the formation of a large clot of curd in the stomach. As an astringent, it is extensively used by betel leaf chewers. Its carbon dioxide-absorbing property is helpful in certain types of gas traps.

4. Calcium carbonate

Chemical formula: $CaCO_3$

Properties: It is a delicate white, microcrystalline powder, odourless and tasteless. It is stable in air. It is nearly insoluble in water and alcohol.

Uses: It acts as a non-systemic antacid. It produces a rapid onset of action. The antacid is due to its basic property and is not as atmospheric as aluminium compounds. It is also used in dentifrices.

Question no. 19. What is the principle of the Geiger muller counter?

Answer: Geiger- Muller counter- It is one of the oldest radiation detector types in existence, having been introduced by Geiger and Muller in 1928. It is referred to as a G-M counter or simply a tube. The simplicity, low cost and ease of operation of these detector have lead to their continued use to the present time. They detected α, β and γ radiations. It consists of a cylinder made up of stainless steel or glass coated with silver on the inner side which acts as a cathode. Coaxially inside the tube, a mounted fine works as an anode. It is the mixture of ionizing gas which contains a small proportion of quenching vapour. The functions of quenching vapour are to prevent the false pulse and to absorb the photons emitted by excited atoms and molecules returning to their ground state. Chlorine, bromine, ethyl alcohol and ethyl formate are commonly used quenching agents. Radiation when it enters the tube through a thin section of outer wall causes ionization of atoms of the gas. When a high voltage is maintained between two electrodes, the electrons and charged ions are attracted by the anode and cathode respectively. Each particle of radition produces a brief flow or pulse of current which can be recorded by a scalar.