TARGETING

TNPSC

GROUP-II

2023

16th TEST

Marks : 300
Time : 3 Hrs

QUESTION WITH SIMPLIFIED ANSWER

SCIENCE & TECH

CHEMISTRY

- Elements and Compounds
- Acids, Bases and Salts
- Oxidation and Reduction
- Carbon, Nitrogen and their Compounds
- Fertilizers - Pesticides, Insecticides.

MAINS WRITTEN EXAM

English Medium

ARISE AWAKE ACHIEVE

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TEST 16 வெற்றி ஒன்றே இலக்கு

Answer Key - English

Unit - 1

1) What are the difference between compound and mixture with examples? 6

S.No	Mixture	Compound
1.	It contains two or more substances.	It is a single substance
2.	The constituent may be present in any proportion.	The constituents are present in definite proportions.
3.	They show the properties of their constituents.	They do not show the properties of the constituent elements.
4.	The components may be separated easily by physical methods.	The constituents can only be separated by one or more chemical reactions
5.	Examples : Sand and water, Sand and iron filings, Concrete, Water and oil, Salad, Alcohol.	Examples : Water, Carbon dioxide, Cement.

2) What are metalloids? Explain its properties and uses?

Metalloids **2**

- The elements which exhibit the properties of metals as well as non-metals are called metalloids.
- Examples: Boron, Silicon, Arsenic, Germanium, Antimony, Tellurium and Polonium.

Properties of Metalloids **2**

- Metalloids are solids at room temperature.
- They can form alloys with other metals
- Some metalloids, such as silicon and germanium, can act as electrical conductors under specific conditions.
- Thus, they are called semiconductors.
- Silicon which is a metalloid appears lustrous, but it is neither malleable nor ductile.
- It is a much poorer conductor of heat and electricity than the metals.
- The physical properties of metalloids tend to be metallic, but their chemical properties tend to be non-metallic.

Uses of Metalloids **2**

- Silicon is used in electronic devices.
- Boron is used in fireworks and as a fuel for ignition in rocket.

3) How is plaster of paris prepared? Mention its uses?

Plaster of paris **3**

- Calcium Sulphate hemihydrate : $CaSO_4 \cdot H_2O$ (Plaster of Paris)
- It is a hemihydrate of calcium sulphate.
- It is obtained when gypsum, $CaSO_4.2H_2O$, is heated to 393 K it loses 1 molecules of water and forms plaster of paris with the formula $CaSO_4.H_2O$, Calcium Sulphate hemihydrate.
- The substance is known as plaster of paris because the large deposits of Gypsum used for the manufacture of plaster are at Montmeite (Paris).

  $2CaSO_4 . 2H_2O(s) \rightarrow 2 CaSO_4 . H_2O + 3H_2O$
- Above 393 K, no water of crystallisation is left and anhydrous calcium sulphate, $CaSO_4$ is formed.
- This is known as 'dead burnt plaster'

Properties **1**

- It has a remarkable property of setting with water. On mixing with an adequate quantity of water it forms a plastic mass that gets into a hard solid in 5 to 15 minutes.

Uses **2**

Plaster of Paris is used as/in,

- The building industry as well as plasters.
- For immobilising the affected part of organ where there is a bone fracture or sprain.
- Employed in dentistry, in ornamental work and for making casts of statues and busts.

- In making false ceilings.
- In making black board chalks.

4) Define hybridisation? Discuss about salient features regarding Hybridisation?

Hybridisation **3**

- Hybridization is the concept of intermixing of the orbitals of an atom having nearly the same energy to give exactly equivalent orbitals with same energy, identical shapes and symmetrical orientations in space.
- The new equivalent orbitals formed are known as the hybrid orbitals or hybridized orbitals.
- Hybrid orbitals have properties entirely different from the properties of the original orbitals from which they have been obtained.

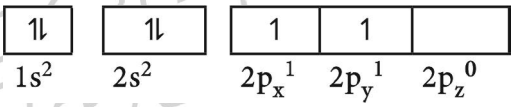
Salient Features regarding Hybridisation **3**

- Orbitals involved in hybridization should have nearly the same energy.
- The orbitals of one and the same atom participate in hybridization.
- The number of hybrid orbitals formed is equal to the number of hybridizing orbitals.
- The hybrid orbitals are all equivalent in shape and energy.
- A hybrid orbital which is taking part in bond formation must contain one electron in it.
- Due to the electronic repulsions between the hybrid orbitals, they tend to remain at the maximum distance apart.
- The head on overlap of atomic orbitals give sigma (ó) bonds.
- The sidewise or lateral overlap of atomic orbitals give pi (ð) bonds.

5) Define Hund's Multiplity rule?

Hund's rule of maximum multiplicity **4**

- The Aufbau principle describes how the electrons are filled in various orbitals.
- But the rule does not deal with the filling of electrons in the degenerate orbitals (i.e. orbitals having same energy) such as p_x, p_y and p_z
- In order these orbitals to be filled by the Hund's rule of maximum multiplicity.
- It states that electron pairing in the degenerate orbitals does not take place until all the available orbitals contains one electron each.
- We know that there are three p orbitals, five d orbitals and seven f orbitals.
- According to this rule, pairing of electrons in these orbitals starts only when the 4th, 6th and 8th electron enters the p, d and f orbitals respectively.
- For example, consider the carbon atom which has six electrons.
- According to Aufbau principle, the electronic configuration is $1s^2$, $2s^2$, $2p^2$
- It can be represented as below, **2**



- In this case, in order to minimise the electron-electron repulsion, the sixth electron enters the unoccupied $2p_y$ orbital as per Hunds rule. i.e. it does not get paired with the fifth electron already present in the $2p_x$ orbital.

6) How soap differs from detergent from chemical compound point of view?

Comparison between soap and detergents

Soap	Detergent 6
It is a sodium salt of long chain carboxylic acids.	It is sodium salts of sulphonic acids.
The ionic part of a soap is $-COO^-Na^+$.	The ionic part in a detergent is $-SO_3^-Na^+$.
It is prepared from animal fats or vegetable oils.	It is prepared from hydrocarbons obtained from petroleum (crude oil).
Its effectiveness is reduced when used in hard water.	It is effective even in hard water.
It forms a scum in hard water.	Does not form a scum in hard water.
It has poor foaming capacity.	It has rich foaming capacity.
Soaps are biodegradable.	Most of the detergents are non-biodegradable.

- In addition to a 'surfactant', the modern detergent contains several other ingredients.

They are listed as follows

- Sodium silicate, which prevents the corrosion and ensures that the detergent does not damage the washing machine.
- Fluorescent whitening agents that give a glow to the clothes.
- Oxygen bleaches, such as 'sodium perborate', enable the removal of certain stains from the cloth.
- Sodium sulphate is added to prevent the caking of the detergent powder.
- Enzymes are added to break down some stains caused by biological substances like blood and vegetable juice.
- Certain chemicals that give out a pleasant smell are also added to make the clothes fragrant after they are washed with detergents.

7) How does detergent soap help in cleaning the clothes?

Soaps and Detergents **3**

- Soaps and the Detergents are materials that are used by us for cleaning purposes because pure water alone cannot remove all types of dirt or any oily substance from our body or clothes.
- They contain 'surfactants', which are compounds with molecules that line up around water to break the 'surface tension'.
- Both of them having a different chemical nature.
- Soap is a cleaning agent that is composed of one or more salts of fatty acids.
- Detergent is a chemical compound or a mixture of chemical compounds, which is used as a cleaning agent, also.
- They perform their cleaning actions in certain specific conditions.

Cleansing action of soap **3**

- A soap molecule contains two chemically distinct parts that interact differently with water.
- It has one polar end, which is a short head with a carboxylate group (–COONa) and one non-polar end having the long tail made of the hydrocarbon chain.
- The polar end is hydrophilic (Water loving) in nature and this end is attracted towards water.
- The non-polar end is hydrophobic (Water hating) in nature and it is attracted towards dirt or oil on the cloth, but not attracted towards water.
- Thus, the hydrophobic part of the soap molecule traps the dirt and the hydrophilic part makes the entire molecule soluble in water.
- When a soap or detergent is dissolved in water, the molecules join together as clusters called 'micelles'.
- Their long hydrocarbon chains attach themselves to the oil and dirt.
- The dirt is thus surrounded by the non-polar end of the soap molecules.
- The charged carboxylate end of the soap molecules makes the micelles soluble in water.
- Thus, the dirt is washed away with the soap.

8) Name the laureates and explain their achievements who got nobel prize in chemistry 2022? **6**

- The Nobel prize for chemistry is given to the development of click chemistry and bioorthogonal chemistry.
- The click and bioorthogonal chemistry have taken chemistry into the new era of functionalism.
- The process of creating the combination of molecules for diagnosis.chemists often try to recreate complex chemical molecules found in nature.
- In the field of medical it is used to target the pathogens in cells.
- Barry Sharpless and Morten Meldal are awarded the Nobel Prize in Chemistry 2022 because they brought chemistry into the era of functionalism and laid the foundations of click chemistry.
- They share the prize with Carolyn Bertozzi, who took click chemistry to a new dimension and began using it to map cells.
- Her bioorthogonal reactions are now contributing to more targeted cancer treatments, among many other applications.
- This innovation led to a revolution in linking the molecules.
- In click chemistry, which molecular building blocks snap together quickly and efficiently.

- Bertozzi has taken click chemistry to a new dimension and started utilising it in living organisms.
- Dr. Sharpless's and Dr. Meldal's contributions, required a copper catalyst.
- The copper is called as the "CROWN JEWEL OF CLICK CHEMISTRY" which would be toxic to living organisms.
- But Dr. Bertozzi came up with a different way of getting the two molecules to click together, modifying the alkyne's structure to fill the catalyst's role.

9) What is pH scale? Write about the role of pH in everyday life?

pH Scale **2**

- A scale for measuring hydrogen ion concentration in a solution is called pH scale.
- The 'p' in pH stands for 'potenz' in German meaning power.
- pH scale is a set of numbers from 0 to 14 which is used to indicate whether a solution is acidic, basic or neutral.
- Acids have pH less than 7
- Bases have pH greater than 7
- A neutral solution have pH equal to 7.

Role of pH in Everyday Life **4**

Are plants and animals pH sensitive

- Our body works within the pH range of 7.0 to 7.8.
- Living organisms can survive only in a narrow range of pH change.
- Different body fluids have different pH values.
- For example, pH of blood is ranging from 7.35 to 7.45.
- Any increase or decrease in this value leads to diseases.
- The ideal pH for blood is 7.4.

pH in our digestive system

- It is very interesting to note that our stomach produces hydrochloric acid.
- It helps in the digestion of food without harming the stomach.
- During indigestion the stomach produces too much acid and this causes pain and irritation.
- pH of the stomach fluid is approximately 2.0.

pH changes as the cause of tooth decay

- pH of the saliva normally ranges between 6.5 to 7.5.
- White enamel coating of our teeth is calcium phosphate, the hardest substance in our body.
- When the pH of the mouth saliva falls below 5.5, the enamel gets weathered.
- It is called as tooth decay.
- Toothpastes, which are generally basic are used for cleaning the teeth that can neutralise the excess acid and prevent tooth decay.

pH of soil

- In agriculture, the pH of the soil is very important.
- Citrus fruits require slightly alkaline soil, while rice requires acidic soil and sugarcane requires neutral soil.

pH of rain water

- The pH of rain water is approximately 7, which means that it is neutral and also represents its high purity.
- If the atmospheric air is polluted with oxide gases of sulphur and nitrogen, they get dissolved in the rain water and make its pH less than 7.
- Thus, if the pH of rain water is less than 7, then it is called acid rain.
- When acid rain flows into the rivers it lowers the pH of the river water also.
- The survival of aquatic life in such rivers becomes difficult.

10) Explain the following.

a) Oxidation

b) Reduction

c) Redox reaction

a) Oxidation **2**

- The chemical reaction which involves addition of oxygen or removal of hydrogen or loss of electrons is called oxidation.

  $2\,Mg + O_2 \rightarrow 2\,MgO$ (addition of oxygen)

  $CaH_2 \rightarrow Ca + H_2$ (removal of hydrogen)

  $Fe^{2+} \rightarrow Fe^{3+} + e^{''}$ (loss of electron)

b) Reduction **2**

- The chemical reaction which involves addition of hydrogen or removal of oxygen or gain of electrons is called reduction.

  $2\,Na + H_2 \rightarrow 2\,NaH$ (addition of hydrogen)

  $CuO + H_2 \rightarrow Cu + H_2O$ (removal of oxygen)

  $Fe^{3+} + e^{''} \rightarrow Fe^{2+}$ (gain of electron)

c) Redox reactions **2**

- Generally, the oxidation and reduction occurs in the same reaction (simultaneously).

- If one reactant gets oxidised, the other gets reduced.
- Such reactions are called oxidation-reduction reactions or Redox reactions.

$2PbO + C \rightarrow 2Pb + CO_2$

$Zn + CuSO_4 \rightarrow Cu + ZnSO_4$

11) Write a short notes on Anti - oxidants and give examples?

Antioxidants 3

- Antioxidants are substances which retard the oxidative deteriorations of food.
- Food containing fats and oils is easily oxidised and turn rancid
- To prevent the oxidation of the fats and oils, chemical BHT (butylhydroxy toluene), BHA (Butylated hydroxy anisole) are added as food additives.
- They are generally called antioxidants.
- Anti oxidants protect us against cardiovascular disease, cancer and cataract and they slow down the effect of ageing.

Examples 3

- The most important antioxidants are vitamin C, vitamin E and beta - carotene.
- These materials readily undergo oxidation by reacting with free radicals generated by the oxidation of oils, thereby stop the chain reaction of oxidation of food.
- Sulphur dioxide and sulphites are also used as food additives.
- They act as anti-microbial agents, antioxidants and enzyme inhibitors.

12) Explain the following.

a) Why apples and some vegetables change colour when cut.

b) Photolysis reaction.

a) Why apples and some vegetables change colour when cut. 3

- Apples and fruits turn brown when cut Apples and some fruits turn brown due to chemical reaction with oxygen in air.
- This chemical reaction is called browning.
- The cells of apples, fruits and other vegetables contain an enzyme called polyphenol oxidase or tyrosinase.
- When in contact with oxygen it catalyses a biochemical reaction in which the phenolic compounds present in plants become a brown pigment known as melanins (or) enzymatic browning.
- In addition to apples, enzymatic browning is also evident in bananas, pears, avacados and even potatoes.

b) Photolysis reaction 3

- Light is an another form of energy, which facilitates some of the decomposition reactions.
- For example, when silver bromide is exposed to light, it breaks down into silver metal and bromine gas.
- As the decomposition is caused by light, this kind of reaction is also called '**Photolysis'**.

$2AgBr(s) \xrightarrow{Light} 2Ag(s) + Br_2(g)$

- The yellow coloured silver bromide turns into grey coloured silver metal.
- It is also a compound to element/element decomposition.

13) a) Mention the uses of halo alkane?

b) Mention the uses of alcohols?

a) Mention the uses of halo alkane?

Halo alkanes 3

- Mono halogen derivatives of alkanes are called haloalkanes.
- Haloalkanes are represented by general formula R – X, Where, R is an alkyl group (C_nH_{2n+1}) – and X is a halogen atom (X=F, Cl, Br or I).
- Haloalkanes are further classified into primary, secondary, tertiary haloalkane on the basis of type of carbon atom to which the halogen is attached.

Uses of haloalkane

Chloroform

- is used as a solvent in pharmaceutical industry
- is used for producing pesticides and drugs
- is used as an anaesthetic.
- used as a preservative for anatomical specimens.

Iodoform

- is used as an antiseptic for dressing wounds

Carbon tetrachloride

- is used as dry cleaning agent
- is used as a solvent for oils, fats and waxes
- As the vapour of CCl_4 is non – combustible, it is used under the name pyrene for extinguishing the fire in oil or petrol.

b) Mention the uses of alcohols 3

1. Uses of methanol :

- Methanol is used as a solvent for paints, varnishes, shellac, gums, cement, etc.

- In the manufacture of dyes, drugs, perfumes and formaldehyde.
- Antifreeze in automobile radiators
- Methanol is poisonous in nature and when taken orally can cause blindness and even death.
- Ethanol which contains 5% methanol is known as methylated or denatured spirit. It is used as a fuel in spirit lamp and as a solvent for wood polish, methanol is used as a motor fuel along with petrol

2. Uses of ethanol

- Ethyl alcohol one of the most extensively used organic compound in alcoholic beverage, industrial solvent, in pharmaceutical preparation, as a good solvent for recrystallisation and extraction of plant materials etc.
- It is also used in the preparation of
- Paints and varnishes.
- Organic compounds like ether, chloroform, iodoform, etc.,
- Dyes, transparent soaps.
- As a substitute for petrol under the name power alcohol used as fuel for aeroplane
- It is used as a preservative for biological specimens.

3. Uses of ethylene glycol:

- Ethylene glycol is used as an antifreeze in automobile radiator.
- Its dinitrate is used as an explosive with TNG.

4. Uses of glycerol

- Glycerol is used as a sweetening agent in confectionary and beverages.
- It is used in the manufacture of cosmetics and transparent soaps.
- It is used in making printing inks and stamp pad ink and lubricant for watches and clocks.
- It is used in the manufacture of explosive like dynamite and cordite by mixing it with china clay.

14) List out which chemical components were used for protection during Corona pandemic time? 6

- Isopropyl alcohol - used as a rubbing-alcohol antiseptic
- Ethanol - For alcohol based hand sanitizers, the Food and Drug Administration (FDA) recommends a concentration of 60 to 95 % ethanol or isopropanol.
- Dettol (chloroxylenol), Savlon (Cetrimide/ chlorhexidine) and TCP (Trichlorophenol).
- Hydrogen Peroxide – used for cleaning face masks
- Sodium hypochlorite (Bleach)
- Quaternary ammonium compounds (QACs)
- Soaps and Detergents – They contain surfactant molecules, which are basically sodium salt of long-chain fatty acid (for instance $C_{17}H_{35}COONa$, sodium stearate)

Hand sanitiser contains

- alcohol that can be either ethyl alcohol or isopropanol
- water
- glycerol
- hydrogen peroxide

15) Explain the role of students in the prevention of Plastic Pollution? 2

- As a student, you can share your scientific knowledge on plastics and their effects with your parents, relatives and friends to make them aware of plastic pollution.
- You can help by teaching them how to avoid harmful plastics by searching for the resin codes.
- You can educate them about the new rules and how important it is to stop one-time use plastics.

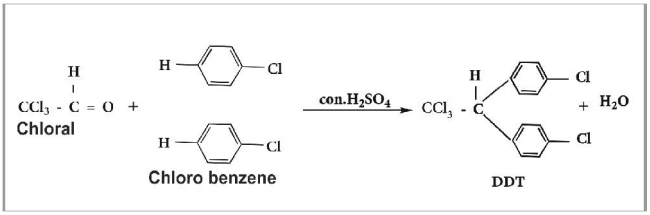
Practice in your daily life 4

- Do not litter the environment by throwing plastic items.
- Do not use Thermocol (resin code #6 PS) for your school projects.
- Do not use one-time use or throwaway plastics like plastics bags, tea cups, Thermocol plates and cups, and plastic straws.
- Do not burn plastics since they release toxic gases that are harmful to our health and contribute to climate change.
- Burning PVC plastic releases dioxins which are one of the most dangerous chemicals known to humans.
- Do not eat hot or spicy food items in plastic containers.
- Segregate your plastic waste and hand this over to the municipal authorities so that it can be recycled.
- Educate at least one person per day about how to identify the resin codes and avoid unsafe plastics (resin code #3 PVC, #6 PS and #7 ABS/ PC).

16) Explain about DDT? Mention its uses?

DDT (p,p'-dichloro diphenyl tri-chloro ethane) **3**

- DDT, the first chlorinated organic pesticide was prepared in 1873, and in 1939 Paul Muller discovered the effectiveness of DDT as an insecticide.
- He was awarded Noble prize in medicine and physiology in 1948 for this discovery.
- DDT can be prepared by heating a mixture of chlorobenzene with chloral (Trichloro acetaldehyde) in the presence of Conc.H_2SO_4



Uses **3**

- DDT is used to control certain insects which carries diseases like malaria and yellow fever
- It is used in farms to control some agricultural pests
- It is used in building construction as pest control
- It is used to kill various insects like housefly and mosquitoes due to its high and specific toxicity.

17) Write a short note on complex fertilizer? **6**

- Complex fertilizers contain two or three primary plant nutrients of which two primary nutrients are in chemical combination.
- These fertilisers are usually produced in granular form.
- Eg. Diammonium phosphate (DAP), nitrophosphates and ammonium phosphate (NPK).
- When it contains only two of the primary nutrients, it is called as incomplete complex fertiliser
- If there are 3 nutrients, they are considered to be complete.
- It has high content of plant nutrients more than 30 kg/100 kg of fertilizer, are called high analysis fertilizer
- They have uniform grain size and good physical condition
- Cheaper than individual fertilisers

18) How are herbicides classified? Give one example each?

Herbicides **3**

- Herbicides are compounds which can kill plants.
- Herbicides are classified as two.

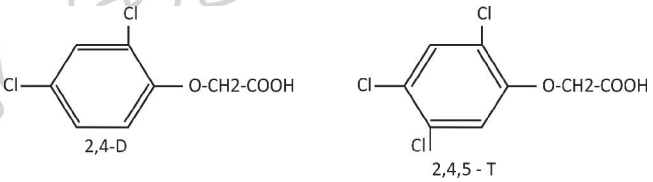
1. Non selective herbicides
2. Selective herbicides.

Non Selective herbicides **1.5**

- Non Selective herbicides such as sodium chlorate, sodium arsenite and some oils kill all types of plants

Selective herbicides **1.5**

- Selective herbicides on the other hand, kill only certain specific types of plants.
- Two commonly used selective herbicides for killing weeds are 2,4D (2,4 dichlorophenoxy acetic acid) and 2,4,5-T (2,4,5 trichlorophenoxy acetic acid) and their esters.
- These compounds kills a number of broad - leaved plants but do not injure narrow - leaved plants.
- These herbicides are commonly employed for killing weeds which tend to grow along with wheat and rice plants.
- The structures of these herbicides are given below.



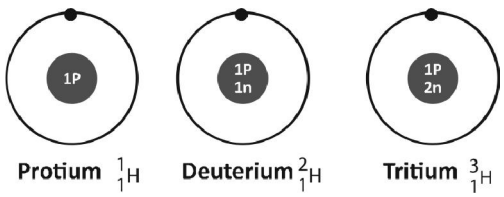
- Other important herbicides are trichloroacetic acid, atrazine, picloram, propazine and 2,3,6 - trichlorobenzoinc acid.

Unit - 2

1) Write a short notes on Isotopes, Isobars and Isotones with suitable examples?

Isotopes **4**

- In nature, a number of atoms of elements have been identified, which have the same atomic number but different mass numbers.
- For example, take the case of hydrogen atom, it has three atomic species as shown below:



- The atomic number of all the three isotopes is 1, but the mass number is 1, 2 and 3, respectively. They are called Isotopes.
- Other such examples are:

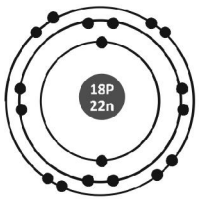
i) Carbon, $_6C^{12}$, $_6C^{13}$

ii) Chlorine $_{17}Cl^{35}$, $_{17}Cl^{37}$

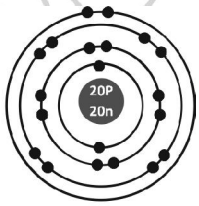
- On the basis of these examples, isotopes are defined as the different atoms of the same element, having same atomic number but different mass numbers.
- There are two types of isotopes: stable and unstable.
- The isotopes which are unstable, as a result of the extra neutrons in their nuclei are radioactive and are called radioisotopes.
- For example, uranium-235, which is a source of nuclear reactors, and cobalt-60, which is used in radiotherapy treatment are both radioisotopes.

Isobars **4**

- Let us consider two elements – calcium (atomic number 20), and argon (atomic number 18).
- They have different number of protons and electrons.
- But, the mass number of both these elements is 40. It follows that the total number of nucleons in both the atoms are the same.
- They are called isobars.
- Atoms of different elements with different atomic numbers, and same mass number are known as isobars.



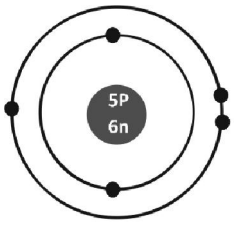
Argon $^{40}_{18}Ar$



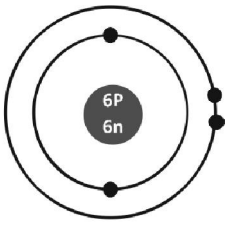
Calcium $^{40}_{20}Ca$

Isotones **4**

- Number of neutrons in boron = 11 – 5 = 6
- Number of neutrons in carbon = 12 – 6 = 6
- The above pair of elements Boron and Carbon has the same number of neutrons but different number of protons and hence different atomic numbers.
- Atoms of different elements with different atomic numbers and different mass numbers, but with same number of neutrons are called isotones.



Boron $^{11}_{5}B$



Carbon $^{12}_{6}C$

2) Explain in detail about the features of periods and groups in periodic table of elements?

Features of Periods **6**

- The horizontal rows are called periods. There are seven periods in the periodic table.
- **First period (Atomic number 1 and 2):** This is the shortest period. It contains only two elements (Hydrogen and Helium).
- **Second period (Atomic number 3 to 10):** This is a short period. It contains eight elements (Lithium to Neon).
- **Third period (Atomic number 11 to 18):** This is also a short period. It contains eight elements (Sodium to Argon).
- **Fourth period (Atomic number 19 to 36):** This is a long period. It contains eighteen elements (Potassium to Krypton). This includes 8 representative elements and 10 transition elements.
- **Fifth period (Atomic number 37 to 54):** This is also a long period. It contains 18 elements (Rubidium to Xenon). This includes 8 representative elements and 10 transition elements.
- **Sixth period (Atomic number 55 to 86):** This is the longest period. It contains 32 elements (Caesium to Radon). This includes 8 representative elements, 10 transition elements and 14 inner transition elements (Lanthanides).
- **Seventh period (Atomic number 87 to 118):** Like the sixth period, this period also accommodates 32 elements. Recently 4 elements have been included by IUPAC.

Features of Groups **6**

- The vertical columns in the periodic table starting from top to bottom are called groups. There are 18 groups in the periodic table.
- Based on the common characteristics of elements in each group, they can be grouped as various families.

Group Number	Family
1	Alkali Metals
2	Alkaline earth metals
3 to 12	Transition metals
13	Boron Family
14	Carbon Family
15	Nitrogen Family
16	Oxygen Family (or) Chalcogen family
17	Halogens
18	Noble gases

- The Lanthanides and Actinides, which form part of Group 3 are called inner transition elements.
- Except 'group 18', all the elements present in each group have the same number of electrons in their valence shell and thus have the same valency.
- For example, all the elements of group 1 have one electron in their valence shells ($1s^1$). So, the valency of all the alkali metals is '1'.
- As the elements present in a group have identical valence shell electronic configurations, they possess similar chemical properties.
- The physical properties of the elements in a group such as melting point, boiling point and density vary gradually.
- The atoms of the 'group 18' elements have stable electronic configuration in their valence shells and hence they are unreactive.

3) Explain about Corrosion? Mention its types and methods of preventing Corrosion?

Corrosion **4**

- The metal is oxidised by oxygen in presence of moisture. This redox process which causes the deterioration of metal is called corrosion.
- It is the gradual destruction of metals by chemical or electrochemical reaction with the environment.
- It is a natural process which converts a metal into its oxide, hydroxide or sulphide so that it loses its metallic characteristics.
- As the corrosion of iron causes damages to our buildings, bridges etc....it is important to know the chemistry of rusting and how to prevent it.
- Rust is chemically known as hydrated ferric oxide (it is formulated as $Fe_2O_3.xH_2O$).
- Rusting results in the formation of scaling reddish brown hydrated ferric oxide on the surface of iron and iron containing materials.

Types of Corrosion **4**

1. Dry Corrosion or Chemical Corrosion:

- The corrosive action in the absence of moisture is called dry corrosion.
- It is the process of a chemical attack on a metal by a corrosive liquids or gases such as O_2, N_2, SO_2, H_2S etc. It occurs at high temperature.
- Of all the gases mentioned above O_2 is the most reactive gas to impart the chemical attack.

2. Wet Corrosion or Electrochemical Corrosion

- The corrosive action in the presence of moisture is called wet corrosion.
- It occurs as a result of electrochemical reaction of metal with water or aqueous solution of salt or acids or bases.

Methods of preventing corrosion **4**

i. Coating metal surface by paint.

ii. Alloying

- The metals can be alloyed to prevent from the process of corrosion. E.g: Stainless Steel - an alloy of Fe and Cr .

iii. Surface Coating

- It involves application of a protective coating over the metal. It is of the following types:

a) Galvanization

- It is the process of coating zinc on iron sheets by using electric current.
- By coating with another metal such as zinc. zinc is stronger reducing agent than iron and hence it can be more easily corroded than iron. i.e., instead of iron, the zinc is oxidised.

b) Electroplating

- It is a method of coating one metal over another metal by passing electric current.

c) Anodizing

- It is an electrochemical process that converts the metal surface into a decorative, durable and corrosion resistant.
- Aluminium is widely used for anodizing process.

d) Cathodic Protection

- In this technique, unlike galvanising the entire surface of the metal to be protected need not be covered with a protecting metal.
- Instead, metals such as Mg or zinc which is corroded more easily than iron can be used

as a sacrificial anode and the iron material acts as a cathode.

- So iron is protected, but Mg or Zn is corroded.

iv. Passivation

- The metal is treated with strong oxidising agents such as concentrated HNO_3.
- As a result, a protective oxide layer is formed on the surface of metal.

4) a) Describe Holme's signal?

b) Explain about the Anamalous nature of Fluorine?

c) Describe about Etching on glass?

a) Describe Holme's signal **4**

Holme's signal

- Containers which have a perforated bottom and a hole at the top are filled with calcium phosphide and calcium carbide. These are thrown into the sea.
- Water enters the container through the bottom and reacts with calcium carbide and calcium phosphide to give acetylene and phosphine.
- Phosphine gets ignited spontaneously as it comes in contact with air and also ignites acetylene.
- Thus a bright red flame is produced which is accompanied by huge smoke due to the burning of phosphine.
- This serves as a signal to the approaching ships.

$Ca_3P_2 + 6H_2O \rightarrow 2\,PH_3 \uparrow + 3Ca(OH)_2$

$CaC_2 + 2H_2O \rightarrow C_2H_2 \uparrow + Ca(OH)_2$

b) Explain about the Anamalous nature of Fluorine

Anamalous Nature of Fluorine **4**

- Fluorine is the most reactive element among halogen.
- This is due to the minimum value of F–F bond dissociation energy.
- Fluorine decomposes cold dilute alkalies liberating OF_2 and with conc. alkali, O_2 is liberated.
- Under similar conditions, the other halogens will give rise to the hypohalites and halates respectively.
- It has the greatest affinity for hydrogen, forming HF which is associated due to the hydrogen bonding. Hydrofluoric acid is a weak acid whereas the other hydrohalic acids are strong acids. ..... H– F..... H– F..... H–F.
- It differs markedly from the other halogens in that it can form two types of salts with metals. NaF and $NaHF_2$.
- The salts of HF differ from the corresponding salts of other hydracids.
- AgF is soluble in water while the other AgX are insoluble.
- Being strongly electronegative it can have only a negative oxidation state while the other halogens can have negative as well as positive oxidation state.
- HF attacks glass while others do not.
- Fluorine, because of the absence of d-orbitals in its valence shell does not form any polyhalides.
- Thus we have $É_3^-$, Br_3^-, Cl_3^- ions but no F_3^- ion

c) Describe about Etching on glass. **4**

Etching on glass

- Industrially, hydrogen fluoride is obtained by heating fluorspar (CaF_2) with concentrated H_2SO_4 in a lead vessel.

$CaF_2 + H_2SO_4 \rightarrow CaSO_4 + 2HF.$

- HF distils over and the vapours are condensed in water in a lead receiver.
- Aqueous HF thus obtained is stored in wax bottles. It cannot be stored in glass or silica bottles as it attacks silicates and silica.

$Na_2SiO_3 + 6HFNa_2 \rightarrow SiF_6 + 3H_2O$

$SiO_2 + 4HF \rightarrow SiF_4 + 2H_2O$

- The action of hydrofluoric acid on silica and silicates is used for etching glass.
- The glass article is first covered with a film on wax.
- The design to be etched is now drawn on the waxed surface and is then exposed to the action of hydrofluoric acid.
- Now the glass can be very soon etched.
- The wax is finally washed off with turpentine.

5) a) What are the different types of petroleum exploration methods?

b) How do you reduce energy consumption by green chemistry?

a) What are the different types of petroleum exploration methods?

Petroleum **2**

- The term 'petroleum' is derived from the latin words 'petra' meaning rock and 'oleum' meaning oil.

- It is a fossil fuel formed from the remains of ancient marine organisms through decaying process.
- Petroleum is a complex mixture of hydrocarbons that occur in Earth in liquid, gaseous, or solid form.

Refining of crude petroleum 1

- The crude petroleum obtained from the well is a dark coloredviscous liquid which contains many impurities such as water, solid particles and gases like methane and ethane.
- To make it useful for different purposes, it must be separated into various components.
- The process of separating petroleum into useful by-products and removal of undesirable impurities is called refining.
- The steps involved in this process are given below

Separation of water 1

- The crude oil obtained from the oil wells will have salt water mixed with it.
- As the first step the water is removed from the crude oil.

Removal of sulphur compounds 1

- The crude oil will have harmful sulphur compounds as impurities.
- In this step these impurities are removed.

Fractional distillation 1

- Petroleum is a mixture of various constituents such as petroleum gas, petrol, diesel, kerosene, lubricating oil, paraffin wax, etc.
- The process of separation of various constituents or fractions of petroleum is done by fractional distillation in fractionating columns.
- The process of heating a mixture of liquids having different boiling points and then separating them by cooling is called fractional distillation.
- Crude petroleum is first heated to about 400°C in a furnace.
- As the vapours of crude oil move up the tower, the various fractions condense according to their boiling point ranges.
- Many useful substances are obtained from petroleum and natural gas.
- These are termed as 'petrochemicals'.
- These are used in the manufacture of detergents, fibres, and other man-made plastics like polythene.
- Hydrogen gas obtained from natural gas, is used in the production of fertilizers.
- Due to its great commercial importance, petroleum is also called 'black gold'.

b) How do you reduce energy consumption by green chemistry? 2

Green Chemistry 1

- Green chemistry is a chemical philosophy encouraging the design of products and processes that reduce or eliminate the use and generation of hazardous substances.
- For this, scientists are trying to develop methods to produce eco-friendly compounds.
- This can be best understood by considering the following example in which styrene is produced both by traditional and greener routes.

Traditional route 1

- This method involves two steps.
- Carcinogenic benzene reacts with ethylene to form ethyl benzene.
- Then ethyl benzene on dehydrogenation using Fe_2O_3/ Al_2O_3 gives styrene.

Greener route

- To avoid carcinogenic benzene, greener route is to start with cheaper and environmentally safer xylenes.

Green chemistry in day-to-day life 2

- A few contribution of green chemistry in our day to day life is given below

1. Dry cleaning of clothes

- Solvents like tetrachloroethylene used in dry cleaning of clothes, pollute the ground water and are carcinogenic.
- In the place of tetrachloroethylene, liquified CO_2 with suitable detergent, is an alternate solvent used.
- Liquified CO_2 is not harmful to the ground water.
- Now a days H_2O_2 used for bleaching clothes in laundry, gives better results and utilises less water.

2. Bleaching of paper

- Conventional method of bleaching was done with chlorine. Now a days H_2O_2 can be used for bleaching paper in presence of catalyst.

3. Synthesis of chemicals

- Acetaldehyde is now commercially prepared by one step oxidation of ethene in the presence of ionic catalyst in aqueous medium with 90% yield.

$$CH_2 = CH_2 + O \xrightarrow[Pd(II)/Cu(II)]{Catalyst} CH_3CHO$$

Ethylene Acetaldehyde

4. Instead of petrol, methanol is used as a fuel in automobiles.
5. Neem based pesticides have been synthesised, which are safer than the chlorinated hydrocarbons.

- Every individual has an important role for preventing pollution and improving our environment.
- We are responsible for environmental protection.
- Let us begin to save our environment and provide a clean earth for our future generations.

6) What is Neutralisation Reaction? List out the importance of Neutralisation reaction in our daily life?

Neutralisation Reaction **3**

- When neutrality is achieved between two different chemical substances with different chemical properties through a reaction then it is called neutralization in chemistry.
- Thus neutralization is a chemical reaction in which an acid and a base react with each other to form salt and water.
- Neutralization reaction between an acid and a base can be written as:

  Acid + BaseSalt + Water
- In this reaction, H^+ and Cl^- ions are produced by the hydrochloric acid and Na^+ and OH^- ions are produced by sodium hydroxide (base).
- When these ions combine together sodium chloride (NaCl) salt and water are produced.
- Similarly other acids also produce their salts when they react with bases.
- Some of the salts produced by neutralization reaction are given below in Table.

Salts produced by neutralization **3**

Acid	Base	Salt
Hydrochloric acid, HCl	Sodium hydroxide, NaOH	Sodium chloride, NaCl
Sulphuric acid, H_2SO_4	Sodium hydroxide, NaOH	Sodium sulphate, Na_2SO_4
Nitric acid, HNO_3	Sodium hydroxide, NaOH	Sodium nitrate, $NaNO_3$
Acetic acid, CH_3COOH	Sodium hydroxide, NaOH	Sodium acetate, CH_3COONa

Neutralisation reactions in our daily life **6**

- Balancing acids and bases is important for our health and for our environment.
- We come across various neutralization reactions in our daily life.
- Let us study about the importance of some of those reactions.

Bee bite

- Whenever bees or red ants bite us they inject an acid called formic acid into our body.
- This acid cause burning sensation and pain.
- To suppress the pain a suitable base in the form of calcium hydroxide (lime paste available at home) is applied so as to neutralise the formic acid

Wasp bite

- When we are bitten by wasp, we feel the burning sensation and pain.
- It is due to an alkaline substance injected by the insect.
- To neutralise the alkalinity we use vinegar which is an acid

Tooth decay

- Generally it is advised by the doctors that we should brush our teeth twice a day.
- This is because the bacteria present in our mouth decompose the food particles stuck in the gaps between our teeth thereby causing acid formation which leads to tooth decay.
- To prevent this we have to neutralize the acid.
- When we brush with tooth powder or tooth paste containing weak bases, the acid gets neutralized.
- So our teeth will be strong and healthy.

Acidity

- As we know, hydrochloric acid present in our stomach helps the digestion of food material along with the enzymes secreted by liver, gallbladder and pancreas.
- Sometimes due to excessive production of hydrochloric acid in our stomach we feel burning sensation in food pipe and in chest area.

- If this happens again and again ulcer will be formed in stomach and food pipe, which further aggravates the conditions.
- In order to neutralize, antacids which are nothing but weak bases like aluminium and magnesium hydroxides are used.
- As a result the acidity is removed.

Agriculture

- Acidic soil is not suitable for plant growth.
- So farmers add lime fertilisers such as powdered lime (CaO), limestone ($CaCO_3$) or ashes of burnt wood to the soil to neutralise the acidity.

Industries

- Effluents from the industries contain acids such as sulphuric acid.
- It is treated by adding lime to neutralise it before it is discharged into rivers and streams.
- Similarly, in power stations fossil fuels such as coal are burnt to produce electricity.
- Burning fossil fuels will liberate sulphur dioxide gas as an acidic pollutant in the air.
- Hence, power stations treat this acidic gas using powdered lime (CaO) or limestone ($CaCO_3$) to neutralise it so that air pollutant can be prevented.

7) Define oxidation number? List out its problems on determination of oxidation number?

Oxidation number **4**

- Oxidation number of an element is defined as the total number of electrons that an atom either gains or loses in order to form a chemical bond with another atom.
- Oxidation number is also called oxidation state.
- If the oxidation number is positive then it means that the atom loses electron, and if it is negative it means that the atom gains electrons.
- If it is zero then the atom neither gains nor loses electrons.
- The sum of oxidation numbers of all the atoms in the formula for a neutral compound is ZERO.
- The sum of oxidation numbers of an ion is the same as the charge on that ion.
- Negative oxidation number in a compound of two unlike atoms is assigned to the more electronegative atom. Positive oxidation Number is assigned to the less electronegative atom.

Example: **2**

- Oxidation number of K and Br in KBr molecule is +1 and –1 respectively.
- Oxidation number of N in NH_3 molecule is –3.
- Oxidation number of H is +1 (except hydrides).
- Oxidation number of oxygen in most cases is –2.

Problems on determination of Oxidation Number

- ON (Oxidation Number) of neutral molecule is always zero **6**

Illustration 1

Oxidation Number of H and O in H_2O

- Let us take ON of H = +1 and ON of O = –2

  $2 \times (+1) + 1 \times (-2) = 0$

  $(+2) + (-2) = 0$
- Thus, ON of H is +1 and ON of O is –2

Illustration 2

Oxidation Number of S in H_2SO_4

- Let ON of S be x and we know ON of H = +1 and O = –2

  $2 \times (+1) + x + 4 \times (-2) = 0$

  $(+2) + x + (-8) = 0$

  $x = +6$
- Therefore, ON of S is +6

Illustration 3

Oxidation Number of Cr in $K_2Cr_2O_7$

- Let ON of Cr be x and we know ON of K = +1 and O = –2

  $2 \times (+1) + 2 \times x + 7 \times (-2) = 0$

  $(+2) + 2x + (-14) = 0$

  $2x = +12$
- x = +6 Therefore, ON of Cr in $K_2Cr_2O_7$ is +6

Illustration 4

Oxidation Number of Fe in $FeSO_4$

- Let ON of Fe be x and we know ON of S = +6 and O = –2

  $x + 1 \times (+6) + 4 \times (-2) = 0$

  $x + (+6) + (-8) = 0$

  $x = +2$
- Therefore, ON of Fe in $FeSO_4$ is +2

8) What is Allotropy? Explain about the Allotropes of carbon?

Allotropy **3**

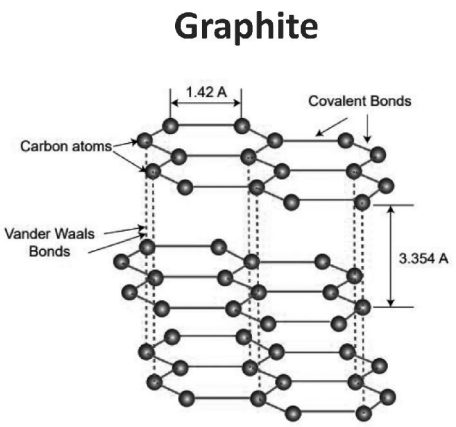
- Allotropy is a property by which an element can exist in more than one form that are physically different and chemically similar.

- The different forms of that element are called its allotropes.
- The main reason for the existence of allotropes of an element is its method of formation or preparation.

Allotropes of carbon

- Carbon exists in many allotropic forms.
- Graphite and diamond are the most common allotropes.
- Other important allotropes are fullerenes, carbon nanotubes and graphene.

Graphite **2**

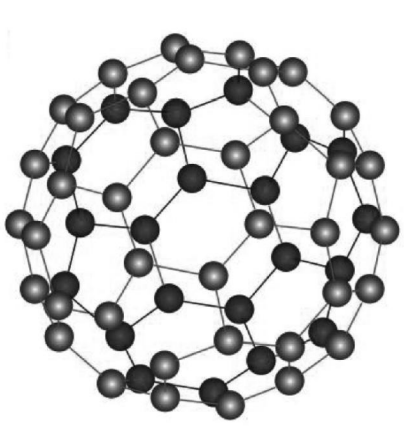


- Graphite is the most stable allotropic form of carbon at normal temperature and pressure.
- It is soft and conducts electricity.
- It is composed of flat two dimensional sheets of carbon atoms.
- Each sheet is a hexagonal net of sp^2 hybridised carbon atoms with a C-C bond length of 1.41 Å which is close to the C-C bond distance in benzene (1.40 Å).
- Each carbon atom forms three ó bonds with three neighbouring carbon atoms using three of its valence electrons and the fourth electron present in the unhybridised p orbital forms a ð-bond.
- These ð electrons are delocalised over the entire sheet which is responsible for its electrical conductivity.
- The successive carbon sheets are held together by weak vander Waals forces.
- Since the layers are held by weak forces, graphite is softer than diamond. The distance between successive sheet is 3.40 Å.
- It is used as a lubricant either on its own or as a graphited oil.

Diamond **2**

- Unlike graphite the other allotrope diamond is very hard.
- The carbon atoms in diamond are sp^3 hybridised and bonded to four neighbouring carbon atoms by ó bonds with a C-C bond length of 1.54 Å.
- This results in a tetrahedral arrangement around each carbon atom that extends to the entire lattice as shown in figure.
- Since all four valance electrons of carbon are involved in bonding there is no free electrons for conductivity.
- Being the hardest element, it used for sharpening hard tools, cutting glasses, making bores and rock drilling.

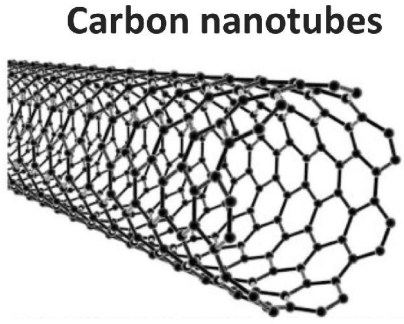
Fullerenes **2**



- Fullerenes are newly synthesised allotropes of carbon.
- Unlike graphite and diamond, these allotropes are discrete molecules such as C_{32}, C_{50}, C_{60}, C_{70}, C_{76} etc..

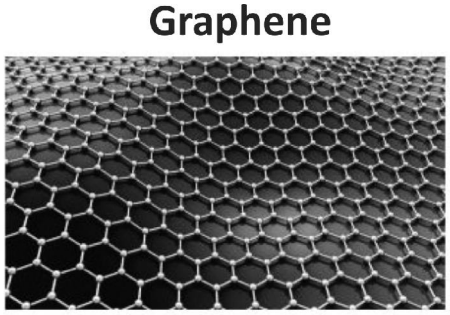
- These molecules have cage like structures as shown in the figure.
- The C_{60} molecules have a soccer ball like structure.
- This allotrope was named as Buckminster fullerene after the American architect Buckminster fuller.
- Because its structure reminded the framework of dome shaped halls designed by Fuller for large international exhibitions, it is called by the pet name Bucky Ball.
- A large family of fullerenes exists, starting at C_{20} and reaching up to C_{540}.
- It has a fused ring structure consists of 20 six membered rings and 12 five membered rings.
- Each carbon atom is sp^2 hybridised and forms three ó bonds & a delocalised ð bond giving aromatic character to these molecules.
- The C-C bond distance is 1.44 Å and C=C distance 1.38 Å.

Carbon nanotubes **2**



- Carbon nanotubes, another recently discovered allotropes, have graphite like tubes with fullerene ends.
- Along the axis, these nanotubes are stronger than steel and conduct electricity.
- These have many applications in nanoscale electronics, catalysis, polymers and medicine.

Graphene **1**

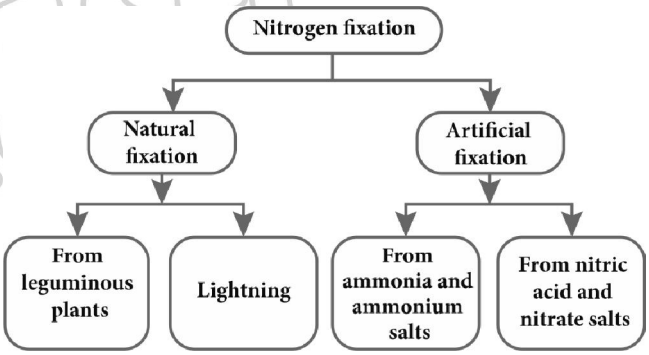


- Another allotrophic form of carbon is graphene.
- It has a single planar sheet of sp^2 hybridised carbon atoms that are densely packed in a honeycomb crystal lattice.

9) Explain in detail about fixation of nitrogen?

Nitrogen fixation **4**

- Nitrogen gets circulated in the air, soil and living things as the element itself or in the form of its compounds.
- Just as there is a circulation of carbon in nature so also there is a circulation of nitrogen.
- It is essential for the proper growth of all plants.
- The plants cannot make use of the elemental nitrogen from the air as such.
- The plants require soluble compounds of nitrogen.
- Thus, plants depend on other processes to supply them with nitrates.
- Any process that converts nitrogen in the air into a useful nitrogen compound is called **nitrogen fixation**.
- Fixation of nitrogen is carried out both naturally and by man.



- Method employed for fixation or bringing atmospheric nitrogen into combination:

Manufacture of ammonia (Haber's process) **3**

- A mixture of nitrogen and hydrogen in the ratio 1:3 under pressure (200-900 atm) is passed over a catalyst finely divided iron and molybdenum as promoter, heated to about 770K.
- $N_2 + 3H_2 \rightarrow 2NH_3$

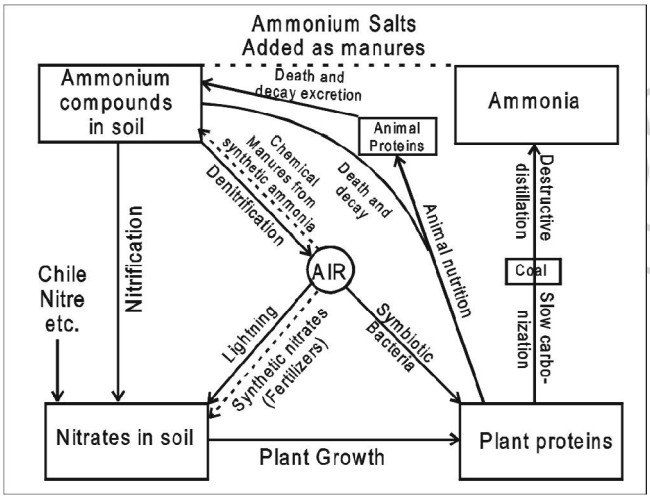
Nitrogen fixation in nature

- Due to electrical disturbances atmospheric nitrogen and oxygen combine to give nitric oxide which gets further oxidised to nitrogen dioxide.

- This reacts with rain water in the presence of excess of oxygen to produce nitric acid and is washed down to earth.
- Here it reacts with bases of the soil to give nitrates.
- In addition to this, certain bacteria living in the nodules on roots of leguminous plants e.g. pea, beans etc., convert nitrogen into nitrogenous compounds which can be directly assimilated by the plant.

Nitrogen cycle **3**

- There is a continual turnover of nitrogen between the atmosphere, the soil, the sea and living organisms.
- The nitrogen passes from atmosphere to plants and animals, converted into useful products like ammonia, nitric acid etc. and still its percentage in the atmosphere remains practically unchanged.
- This is due to the fact that combined nitrogen is constantly passing back to the atmosphere.
- This cycle of changes involved is known as nitrogen cycle.



Uses of nitrogen compounds **2**

- Liquid ammonia is used as solvent.
- Ammonia is used as a refrigerant in ice-plants.
- Ammonia is used in the manufacture of artificial silk, urea, manures, washing soda etc.
- Nitrous oxide mixed with oxygen is used as anaesthetic for minor operations in dentistry and surgery.
- Nitrous acid is used in the manufacture of azo-dyes.
- Nitric acid is used in the manufacture of fertilizers, explosives like TNT, GTN, etc.
- Nitric acid is used in the purification of gold and silver.
- Nitric acid is used in pickling of stainless steel.
- Nitric acid is used in the manufacture of perfumes, artificial silk, medicines etc.
- Liquid nitrogen is used as a refrigerant.

10) Explain the following.

a) Graphene and its applications

b) Catenation and Tetravalency.

a) Graphene and its applications

Graphene **3**

- Graphene is most recently produced allotrope of carbon which consists of honeycomb shaped hexagonal ring repeatedly arranged in a plane.
- Graphene is the thinnest compound known to man at one atom thick.
- It is the lightest material known (with 1 square metre weighing around 0.77 milligrams) and the strongest compound discovered (100-300 times stronger than steel).
- It is a best conductor of heat at room temperature.
- Layers of graphene are stacked on top of each other to form graphite, with an inter planar spacing of 0.335 nanometres.
- The separate layers of graphene in graphite are held together by Vander Waals forces.

Applications **3**

- Utilised to increase the strength of other materials.
- Graphene-enhanced composite materials can find applications in aerospace, building materials, mobile devices, and many other applications.
- Used to make heat-spreading solutions, such as heat sinks (a device or substance for absorbing excessive or unwanted heat).
- Utilized in batteries and super capacitors.
- Used to enhance fuel-cells.
- Integrated into “bionic” devices that would be implanted in living tissue.
- Used to make new, lightweight, and flexible solar panels
- Used in manufacturing very efficient, electrical conductors that are transparent, thin, flexible, and cheap.
- Anti-corrosion coatings and paints, efficient and precise sensors, faster and efficient electronics, flexible displays, faster DNA sequencing, drug delivery, and more.

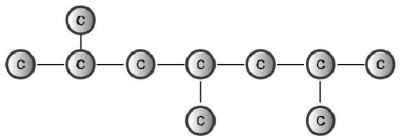
b) Catenation and Tetravalency

Catenation 3

- Catenation is binding of an element to itself or with other elements through covalent bonds to form open chain or closed chain compounds.
- Carbon is the most common element which undergoes catenation and forms long chain compounds.
- Carbon possesses maximum tendency for catenation i.e. Bond energy (kcal / mol) for catenation of C is maximum.

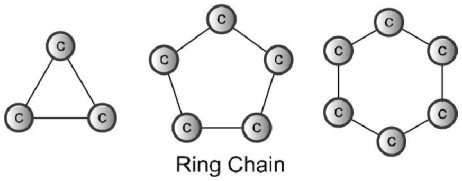
C-C,	Si-Si,	N-N,	P-P,	O-O,	S-S
85	54	39	50	35	54

- The stability or strength of bond decreases as the bond energy decreases. Hence the catenation order among the following is C > Si H" S>P>N>O.
- Carbon atom links repeatedly to itself through covalent bond to form linear chain, branched chain or ring structure.
- This property of carbon itself is the reason for the presence of large number of organic carbon compounds.
- So organic chemistry essentially deals with catenated carbon compounds.



Branched Chain

Linear Chain

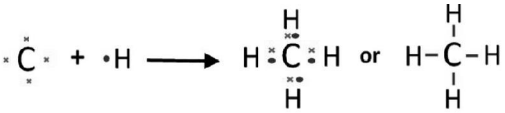


Ring Chain

- For example, starch and cellulose contain chains of hundreds of carbon atoms.
- Even plastics we use in our daily life are macro molecules of catenated carbon compounds.

Tetravalency 3

- Another versatile nature of carbon is its tetravalency.
- The shell electronic configuration of carbon is 2,4 (Atomic no: 6).
- It has four electrons in its outermost orbit.
- According to Octet Rule, carbon requires four electrons to attain nearest noble gas (Neon) electronic configuration.
- So carbon has the tendency to share its four electrons with other atoms to complete its octet.
- This is called its tetravalency.
- Thus, carbon can form four covalent bond with other elements.
- For example, in methane, carbon atom shares its four valence electrons with four hydrogen atoms to form four covalent bonds and hence tetravalent.



11) What are Agricultural chemistry? Explain its goals and applications?

Agricultural Chemistry 4

- Agricultural chemistry involves the application of chemical and biochemical knowledge to agricultural production, processing of raw materials into foods and beverages, and environmental monitoring and remediation.
- It deals with scientific relation between plants, animals, bacteria and environment.
- 40% of people are involving in agriculture.
- It is one of the world's employment sector.

a) Goals of agricultural chemistry 4

- Indian chemists and biochemists applied their knowledge and developed modernized agricultural practices which involve use of synthetic fertilizers, genetically modified crops, and equipments.
- It aims at producing sufficient nutritious food and feed the population in a sustainable way while being responsible stewards of our environment and ecosystem.
- Based on the issues and challenges in agricultural production, agricultural chemistry mainly focusses to achieve the following:
- Increase in crop yield and livestock
- Improvement of food quality
- Reducing cost of food production

b) Applications of Agricultural Chemistry 4

- Chemical principles and reactions are most widely used in agriculture in order to increase

yield, to protect crops from diseases and to simplify the practice of agriculture.

- Various applications are given below.

Soil Testing

- Crop lands may have different kinds of soil with varying pH.
- Soil pH is one of the main criteria to be considered for the selection of crop or remediation of soil.
- Soil testing involves determination of pH, porosity and texture.

Chemical Fertilizers

- Fertilizers are chemical compounds added to crop field for supplying essential micro and macro nutrients required for crop growth.
- Ammonium nitrate, calcium phosphate, urea, NPK (Nitrogen, Phosphorous and Potassium), etc. are some of the fertilizers.
- Depending on the nature of soil, these fertilizers are used separate or as mixtures.

Pesticides and Insecticides

- Crops are prone to diseases caused by pests and insects.
- Chemically synthesized pesticides and insecticides are used to solve these issues.
- Chlorinated hydrocarbons, organophosphates and carbamates are used as pesticides and insecticides.

12) Discuss the various methods of using pesticides?

General methods of pesticides **2**

- The pesticides are usually in the powedered, waxy or oily form. They cannot be applied conveniently as such. Hence they are formulated in a suitable form and applied. Some of the important general methods of pesticides are.

Dusts **2**

- The pesticide is mixed with a suitable powder and spraryed in the dry form on the crops. This method of applying a pesticide is called dusting. Dust sticks on the wet surfaces of the plant.
- Therefore, dusting is done early in the morning when the plant is wet with dew: The common pesticides like DDT and BHC are available as 5% or 10% dust.

Granules or pellets **2**

- The dusting method is not suitable for use when the weather is not calm. Dusts are carried by long distances by wind. Under such condition, sprinkling of toxic chemicals as granules is more suitable.
- When the granules are sprinkled on the crops, the toxicant is released by the moisture present on the plant surface Carbaryl (trade name – sevin) is available as 4% granule and aluminium phosphide is marketed in the form of tablet.

Wettable powders (WP) **2**

- Wettable powder is a powdered form of pesticides which yields a suspension when diluted with water. Pesticides like DDT and BHC are formulated as 50% WP (50% water + 50% pesticide powder). Suspensions of Wettable powder are more effective than dusts and granules.

Emulsifiable concentrates (EC) **2**

- Many of the synthetic organic pesticides are insoluble in water but soluble in organic solvents. The EC is prepared by mixing the pesticide and a volatile organic solvent with a small amount of emulsifying agent like soap.
- It is a clear solution which yields an emulsion when diluted with water. When sprayed, the solvent evaporates quickly leaving a deposit of toxicant on the target. It is the most convenient method of applying pesticides than the others.

Fumigation **2**

- The application of pest control materials in the gaseous state is called fumigation. The crystalline solids that evaporate slowly at room temperature are generally used as fumigants.
- Soil fumigants are used in horticulture, nurseries, green houses etc. To get maximum benefits, the treated soil may be covered with plastic sheets for several days.
- Fumigation is an effective method to destroy pests on food grains stored in ware houses.

Unit - 3

1) What is Ore? Explain the types of separation of Ore?

Ore **1.5**

- The mineral from which a metal can be readily and economically extracted on a large scale is said to be an ore.

For example **1.5**

- Clay (Al_2O_3. 2 SiO_2. 2 H_2O) and bauxite (Al_2O_3.2 H_2O) are the two minerals of aluminium, but aluminium can be profitably extracted only from bauxite.

- Hence, bauxite is an ore of aluminium and clay is its mineral.

Types of separation of an ore

- There are four major types of separation of ores based on the nature of the ore.
- The different kinds of ores of metals are given in Table.

Types of ores **3**

Oxide Ores	Carbonate Ores	Halide Ores	Sulphide Ores
Bauxite ($Al_2O_3.2H_2O$)	Marble ($CaCO_3$)	Cryolite(Na_3AlF_6)	Galena (PbS)
Cuprite(Cu_2O)	Magnesite ($MgCO_3$)	Fluorspar(CaF_2)	Iron pyrite (FeS_2)
Haematite (Fe_2O_3)	Siderite($FeCO_3$)	Rock salt (NaCl)	Zinc blende (ZnS)

- Concentration of the crushed ore is done mainly by the following methods:

i) Hydraulic (Gravity Separation) method

Principle **3**

- The difference in the densities or specific gravities of the ore and the gangue is the main principle behind this method.
- Oxide ores are purified by this method. e.g., Haematite Fe_2O_3 the ore of iron.
- Note: When the ore is heavier than the impurity, this method can be used.

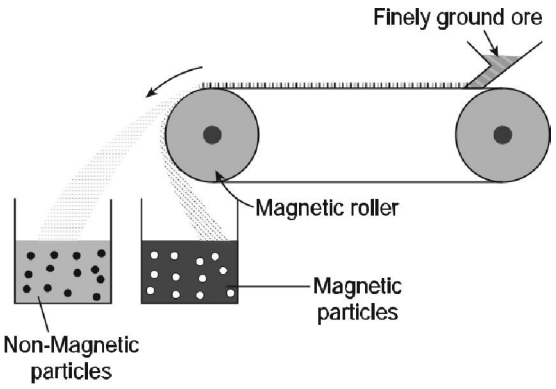
Method

- The ore is poured over a sloping, vibrating corrugated table with grooves and a jet of water is allowed to flow over it.
- The denser ore particles settle down in the grooves and lighter gangue particles are washed down by water.

ii) Magnetic separation method **3**

Principle

- The magnetic properties of the ores form the basis of separation.
- When either the ore or the gangue is magnetic, this method is employed. e.g., Tinstone SnO_2, the ore of tin.



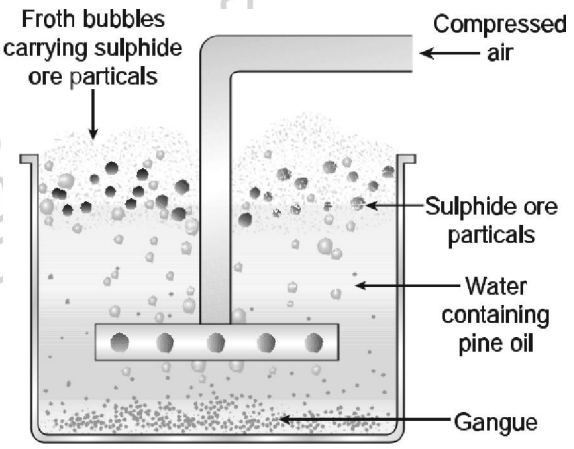
Method

- The crushed ore is placed over a conveyer belt which rotates around two metal wheels, one of which is magnetic.
- The magnetic particles are attracted to the magnetic wheel and fall separately apart from the non-magnetic particles.

Froth floatation

Principle

- This process depends on the preferential wettability of the ore with oil (pine oil) and the gangue particles by water.
- Lighter ores, such as sulphide ores, are concentrated by this method. e.g., Zinc blende (ZnS)



Froth floatation process for the concentration of sulphide ores.

- Note: When the impurity is heavier than the ore, this method can be used.

Method **2**

- The crushed ore is taken in a large tank containing pine oil and water and agitated with a current of compressed air
- The ore is wetted by the oil and gets separated from the gangue in the form of froth.
- Since the ore is lighter, it comes on the surface with the froth and the impurities are left behind. e.g., Zinc blende (ZnS).

Chemical method or Leaching 1

- This method is employed when the ore is in a very pure form.
- The ore is treated with a suitable reagent such that the ore is soluble in it but the impurities are not.
- The impurities are removed by filtration.
- The solution of the ore, i.e., the filtrate is treated with a suitable reagent which precipitates the ore.
- Example: Bauxite Al_2O_3. $2H_2O$ (the ore of aluminium)

2) Define alloys and mention the reason for alloying. List out its types and advantages?

Alloys: 4

- An alloy is a homogeneous mixture of two or more metals or of one or more metals with certain non-metallic elements.
- The properties of alloys are often different from those of its components. Pure gold is brittle to be used.
- The addition of small percentage of copper enhances its strength and utility.

Reasons for alloying 3

- To modify appearance and colour
- To modify chemical activity.
- To lower the melting point.
- To increase hardness and tensile strength.
- To increase resistance to electricity.

Method of making alloys

- By fusing the metals together. E.g. Brass is made by melting zinc and copper.
- By compressing finely divided metals. E.g. Wood metal: an alloy of lead, tin, bismuth and cadmium powder is a fusible alloy.

Alloys as solid solutions 4

- Alloys can be considered as solid solutions in which the metal with high concentration is solvent and other metals are solute.
- For example, brass is a solid solution of zinc (solute) in copper (solvent).

Types of Alloys

- Based on the presence of Iron, alloys can be classified into:

a. Ferrous alloys

- Contain Iron as a major component.
- A few examples of ferrous alloys are Stainless Steel, Nickel Steel etc.

b. Non-ferrous alloys

- These alloys do not contain Iron as a major component.
- For example, Aluminium alloy, Copper alloy etc.

Copper Alloys (Non- ferrous)	
Alloys	Uses
Brass (Cu, Zn)	Electrical fittings, medal, decorative items, hardware
Bronze (Cu, Sn)	Statues, coins, bells, gongs
Aluminium Alloys (Non- ferrous)	
Alloys	**Uses**
Duralumin (Al, Mg, Mn, Cu)	Aircrafts, tools, pressure cookers
Magnalium (Al, Mg)	Aircraft, scientific instruments
Iron Alloys (Ferrous)	
Alloys	**Uses**
Stainless steel (Fe,C, Ni,Cr)	Utensils, cutlery, automobile parts
Nickel steel (Fe,C,Ni)	Cables , aircraftparts, propeller

Advantages of alloys 4

- Alloys do not get corroded or get corroded to very less extent.
- They are harder and stronger than pure metals (Example: Gold is mixed with copper and it is harder than pure gold).
- They have less conductance than pure metals (Example: Copper is good conductor of heat and electricity where as brass and bronze are not good conductors).
- Some alloys have lower melting point than pure metals (Example: Solder is an alloy of lead and tin which has lower melting point than each of the metals).
- When metal is alloyed with mercury, it is called amalgam.
- These alloys are formed through metallic bonding with the electrostatic force of attraction between the electrons and the positively charged metal ions.
- Silver tin amalgam is used for dental filling.

3) Name three ores of zinc? How is zinc extracted from zinc blende? Write the importance of zinc carbonate?

Occurrence and principles of extraction of zinc

Zinc 2

- The ancient used an alloy of Zn and Cu not very different from brass without knowing its actual composition.

- Zinc has been known in our country for a long time and has been mentioned in Ayurvedic treatises as yashda.
- It is commonly called jast.

Occurrence 1

- Zinc does not occur in the native form since it is a reactive metal.
- However, in the combined state, zinc is widely distributed.

Ores 1

- The important ores of zinc are

i) Zinc blende, ZnS
ii) Calamine, $ZnCO_3$
iii) Zincite, ZnO

- The chief ore of Zinc is Zinc blende. In India large deposits of zinc blende occur in Zawar mines near Udaipur in Rajasthan.

Extraction of Zinc from Zinc blende 3

- The extraction of Zinc from Zinc blende involves the following steps.

1. Concentration

- The ore is crushed and then concentrated by froth-floatation process.

2. Roasting

- The concentrated ore is then roasted in the presence of excess of air at about 1200 K.

$2ZnS + 3O_2 \xrightarrow{\Delta} 2ZnO + 2SO_2$

3. Reduction

- Zinc oxide is mixed with powdered coke and heated to 1673 K in a fire clay retort, in which ZnO is reduced to zinc metal.

$ZnO + C \xrightarrow{1673K} Zn + CO$

Purification 1

- Zinc is purified by electrolytic refining.
- In this process, Impure Zinc is anode and cathode is of pure thin sheet of Zinc.
- The electrolyte is $ZnSO_4$ solution containing a little of dil.H_2SO_4. On passing electric current, pure zinc get deposited at the cathode.

Properties 2

Physical properties

- Zinc is a bluish white metal
- It is good conductor of heat and electricity.
- It is malleable and ductile.

Chemical properties

Action of air

- When heated in air at 773 K, it burns to form a white cloud of Zinc oxide which settles to form a wooly flock called philosopher's wool.

$2Zn + O_2 \xrightarrow{773K} 2ZnO$

Action of water

- Pure zinc does not react with water but impure zinc (Zn-Cu couple) decomposes steam quite readily evolving H_2 gas.

$Zn + H_2O$ (steam) $\rightarrow ZnO + H_2$

Action of dilute acids

- Pure zinc is not attacked by dilute acids. However, impure zinc reacts with dilute acids with the liberation of H_2.

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

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

Action of con.H_2SO_4

- Zinc reacts with hot con.H_2SO_4 forming $ZnSO_4$.

$Zn + 2H_2SO_4 \rightarrow ZnSO_4 + SO_2\uparrow + 2H_2O$

Action of con.HNO_3

- Zinc reacts with HNO_3 at various concentrations and it gives different products.

$4Zn + 10\ HNO_3$ (dil) $\rightarrow 4Zn(NO_3)_2 + N_2O + 5H_2O$
Nitrous oxide

$4\ Zn + 10\ HNO_3$ (very dilute) $\rightarrow 4\ Zn\ (NO_3)_2 + NH_4NO_3 + 3H_2O$ Ammonium nitrate

Action of alkalies 3

- Zinc dissolves in hot NaOH solution forming soluble zincate ion.

$Zn + 2NaOH + 2H_2O \rightarrow Na_2ZnO_2 + H_2O$
Sodium zincate

Uses of zinc

- It is widely used for galvanizing iron sheets.
- It is used in the extraction of gold and silver by the cyanide process.
- Zinc plates and rods are used in batteries and dry cells.
- Zinc dust and granulated zinc are used in laboratory as reducing agents.

Importance of Zinc carbonate ($ZnCO_3$) 2

- Zinc carbonate occurs in nature as calamine.
- It is used in making ointment for curing skin diseases.
- It is used in the preparation of cosmetics.
- It is used a pigment for rubber.

4) a) Explain common ion effect with an example?
b) Explain Buffer solution with an example?
c) Discuss about Henderson - Hasselbakh equation?

a) Explain common ion effect with an example.

Common Ion Effect 5

- When a salt of a weak acid is added to the acid itself, the dissociation of the weak acid is suppressed further.

- For example, the addition of sodium acetate to acetic acid solution leads to the suppression in the dissociation of acetic acid which is already weakly dissociated.
- In this case, CH_3COOH and CH_3COONa have the common ion, CH_3COO^-
- Acetic acid is a weak acid. It is not completely dissociated in aqueous solution and hence the following equilibrium exists.

  $CH_3COOH(aq) \rightleftharpoons H^+(aq)+CH_3COO\ (aq)$
- However, the added salt, sodium acetate, completely dissociates to produce Na^+ and CH_3COO^- ion.

  $CH_3COONa(aq) \rightarrow Na^+(aq) + CH_3COO(aq)$
- Hence, the overall concentration of CH_3COO^- is increased, and the acid dissociation equilibrium is disturbed.
- We know from Le chatelier's principle that when a stress is applied to a system at equilibrium, the system adjusts itself to nullify the effect produced by that stress.
- So, inorder to maintain the equilibrium, the excess CH_3COO^- ions combines with H^+ ions to produce much more unionized CH_3COOH i.e, the equilibrium will shift towards the left. In other words, the dissociation of CH_3COOH is suppressed.
- Thus, the dissociation of a weak acid (CH_3COOH) is suppressed in the presence of a salt (CH_3COONa) containing an ion common to the weak electrolyte.
- It is called the common ion effect.

b) Explain Buffer solution with an example.

Buffer Solution **5**

- Our blood maintains a constant pH, irrespective of a number of cellular acid – base reactions.
- Is it possible to maintain a constant hydronium ion concentration in such reactions due to buffer action.
- Buffer is a solution which consists of a mixture of a weak acid and its conjugate base (or) a weak base and its conjugate acid
- This buffer solution resists drastic changes in its pH upon addition of a small quantities of acids (or) bases, and this ability is called buffer action.
- The buffer containing carbonic acid (H_2CO_3) and its conjugate base HCO_3^- is present in our blood.
- There are two types of buffer solutions.
- **Acidic buffer solution :** a solution containing a weak acid and its salt.
- Example : solution containing acetic acid and sodium acetate
- **Basic buffer solution :** a solution containing a weak base and its salt.
- Example : Solution containing NH_4OH and NH_4Cl

c) Discuss about Henderson - Hasselbalch equation **5**

Henderson equation

- The pH of an acid buffer can be calculated from the dissociation constant, K_a, of the weak acid and the concentrations of the acid and the salt used.
- The dissociation expression of the weak acid, HA, may be represented as

  $HA \rightleftharpoons H^+ + A^-$ and

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

- The weak acid is only slightly dissociated and its dissociation is further depressed by the addition of the salt ($Na^+ A^-$) which provides A^- ions(Common ion effect).
- As a result the equilibrium concentration of the unionised acid is nearly equal to the initial concentration of the acid.
- The equilibrium concentration $[A^-]$ is presumed to be equal to the initial concentration of the salt added since it is completely dissociated.
- Thus we can write the equation (1) as

$$[H^+] = K_a \times \frac{[acid]}{[base]} \quad \text{.....(2)}$$

- Where [acid] is the initial concentration of the added acid and [salt] that of the salt used.
- Taking negative logs of both sides of the equation (2), we have

$$-\log[H^+] = -\log K_a - \log \frac{[acid]}{[salt]} \quad \text{..... (3)}$$

- But $-\log [H^+] = pH$ and $-\log K_a = pK_a$
- Thus from (3) we have

$$pH = pK_a - \log \frac{[acid]}{[salt]} = pKa + \log \frac{[salt]}{[acid]}$$

- Hence, $pH = pK_a + \log$
- This relationship is called the Henderson-Hasselbalch equation or simply Henderson equation.

- In a similar way, the Henderson-Hasselbalch equation for a basic buffer can be derived.
- This can be stated as : $pOH = pK_b + \log \frac{[salt]}{[base]}$

5) Define acid, base and salt? List out its uses?

a) Acids **3**

- The term acid is derived from the Latin word 'acidus' which means sour.
- Thus, the chemical compounds which have sour taste are generally called as acids.
- Swedish chemist Svante Arrhenius proposed a theory on acids.
- According to him, an acid is a substance which furnishes H^+ ions or H_3O^+ ions in aqueous solution.
- All acids contain one or more replaceable hydrogen atoms in their molecules and when dissolved in water they release H+ ions.
- For example, Hydrochloric acid (HCl), Sulphuric acid (H_2SO_4) and Nitric acid (HNO_3) release hydrogen ions (H^+) when dissolved in water.

  Hydrochloric acid (HCl) $\rightarrow$ Hydrogen ion(H^+) + Chloride ion (Cl^-)

  Sulphuric acid (H_2SO_4) $\rightarrow$ Hydrogen ion ($2H^+$) + Sulphate ion (SO_4^{2-})
- Thus, acids are defined as the chemical substances which release hydrogen ions when dissolved in water.
- All acids essentially contain one or more hydrogens.
- But all the hydrogen containing substances are not acids.
- For example, methane (CH_4) and ammonia (NH_3) also contain hydrogen.
- But they do not produce H^+ ions in aqueous solution.

b) Bases **3**

- We use soaps for bathing as well as washing.
- Soaps are slippery in nature due to the presence of 'base'.
- Bases are chemical substances that are corrosive and bitter in taste.
- A lot of bleaches, soaps, detergents, toothpaste, etc., contain bases.
- In contrast to acids which release hydrogen ions in water, bases release hydroxide ions in water.
- Thus, the chemical substances that release hydroxide ions when dissolved in water are called as bases.
- Examples: Sodium hydroxide (NaOH) and Potassium hydroxide (KOH).

  Sodium hydroxide (NaOH) Sodium ion (Na^+) + Hydroxide ion (OH^-)

  Potassium hydroxide (KOH) Potassium ion (K^+) + Hydroxide ion (OH^-)
- Water soluble bases are called Alkalis.
- Bases like sodium hydroxide, potassium hydroxide, calcium hydroxide and ammonium hydroxide are highly soluble in water and hence they are called alkalis.
- Certain chemical substances which do not release hydroxide ions when dissolved in water also behave as bases.
- Examples: Sodium carbonate, Sodium bicarbonate, Calcium carbonate etc.
- Sodium carbonate (Na_2CO_3) is commercially called as washing soda.Similarly sodium bicarbonate ($NaHCO_3$) is commercially called as baking soda. Caustic soda is sodium hydroxide (NaOH) and caustic potash is potassium hydroxide (KOH)

c) Salts **3**

- Salts are the products of the reaction between acids and bases.
- Salts produce positive ions and negative ions when dissolved in water.

  Acid + Base $\rightarrow$ Salt + Water

Types of Salts

Normal Salts:

- A normal salt is obtained by complete neutralization of an acid by a base.

  $NaOH + HCl \rightarrow NaCl + H_2O$

Acid Salts:

- It is derived from the partial replacement of hydrogen ions of an acid by a metal.
- When a calculated amount of a base is added to a polybasic acid, acid salt is obtained.

  $NaOH + H_2SO_4 \rightarrow NaHSO_4 + H_2O$

Basic Salts:

- Basic salts are formed by the partial replacement of hydroxide ions of a diacidic or triacidic base with an acid radical.

  $Pb(OH)_2 + HCl \rightarrow Pb(OH)Cl + H_2O$

Double Salts:

- Double salts are formed by the combination of the saturated solution of two simple salts in equimolar ratio followed by crystallization.
- For example, potash alum is a mixture of potassium sulphate and aluminium sulphate. $KAl(SO_4)_2 \cdot 12H_2O$

d) Uses of Acids **2**

- Hydrochloric acid present in our stomach helps in the digestion of food materials.
- Vinegar (acetic acid) is used to preserve food materials.
- Benzoic acid is also used to preserve food materials like pickles.
- Sodium or potassium salts of higher fatty acids are used to make washing and bathing soaps.
- Sulphuric acid is called the king of chemicals because it is used in the preparation of many other compounds. It is used in car batteries also.
- Sulphuric acid is an effective dehydrating agent.
- Sulphuric acid is used in various industries to make detergents, paints, fertilizers and many more chemicals.
- Hydrochloric acid, nitric acid and sulphuric acid are important laboratory reagents.
- Cells of all living organisms contain the fundamental nuclear material called nucleic acids.
- Animals have deoxy ribo nucleic acid (DNA) whereas plants contain ribo nucleic acid (RNA)
- Hydrochloric acid is used as a cleansing agent in toilets.
- Citric acid is used in the preparation of effervescent salts and as a food preservative.
- Nitric acid is used in the manufacture of fertilizers, dyes, paints and drugs.
- Oxalic acid is used to clean iron and manganese deposits from quartz crystals. It is also used as bleach for wood and removing black stains.
- Carbonic acid is used in aerated drinks.
- Tartaric acid is a constituent of baking powder

e) Uses of Bases **2**

- Potassium hydroxide is used to make bathing soaps.
- Sodium hydroxide is used to make washing soaps.
- Sodium hydroxide is also used in paper industries, textile industries and in the preparation of medicines.
- Calcium hydroxide is used for white washing.
- Aluminum hydroxide and magnesium hydroxides are used in antacids to cure acidity problems.
- Ammonium hydroxide is used to manufacture fertilizers, nylon, plastics and rubber.
- Magnesium hydroxide is used as a medicine for stomach disorder.
- Ammonium hydroxide is used to remove grease stains from cloths.

f) Uses of Salts **2**

Common Salt (Sodium Chloride - NaCl)

- It is used in our daily food and used as a preservative.

Washing Soda (Sodium Carbonate-Na_2CO_3)

- It is used in softening hard water.
- It is used in glass, soap and paper industries.

Baking Soda (Sodium bicarbonate -$NaHCO_3$)

- It is used in making of baking powder which is a mixture of baking soda and tartaric acid.
- It is used in soda-acid fire extinguishers.
- Baking powder is used to make cakes and bread, soft and spongy.
- It neutralizes excess acid in the stomach and provides relief.

Bleaching powder (Calcium Oxychloride - $CaOCl_2$)

- It is used as disinfectant.
- It is used in textile industry for bleaching cotton and linen.

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6) $Zn(s) + Cu^{2+}(aq)\ Zn^{2}(aq) + Cu(s)$. Give the oxidation and reduction half cells reactions for the above reaction and write the galvanic cell set up?

Electrochemical Cell **2**

- Electrochemical cell is a device which converts chemical energy into electrical energy and vice versa.
- It consists of two separate electrodes which are in contact with an electrolyte solution.
- Electrochemical cells are mainly classified into the following two types.

1. Galvanic Cell (Voltaic cell)

- It is a device in which a spontaneous chemical reaction generates an electric current
- i.e., it converts chemical energy into electrical energy.
- It is commonly known as a battery.

2. Electrolytic cell

- It is a device in which an electric current from an external source drives a nonspontaneous reaction i.e., it converts electrical energy into chemical energy.

Galvanic cell **2**

- When a zinc metal strip is placed in a copper sulphate solution, the blue colour of the solution fades and the copper is deposited on the zinc strip as red – brown crust due to the following spontaneous chemical reaction.

  $Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$
- The energy produced in the above reaction is lost to the surroundings as heat.
- In the above redox reaction, Zinc is oxidised to Zn^{2+}ions and the Cu^{2+} ions are reduced to metallic copper.
- The half reactions are represented as below.

  $Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$ (oxidation)

  $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ (reduction)
- The separation of half reaction is the basis for the construction of Daniel cell. It consists of two half cells.

Oxidation half cell **2**

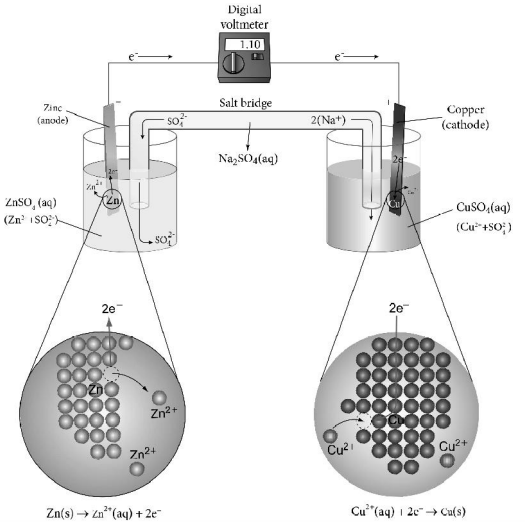
- A metallic zinc strip that dips into an aqueous solution of zinc sulphate taken in a beaker, as shown in Figure.

Reduction half cell

- A copper strip that dips into an aqueous solution of copper sulphate taken in a beaker, as shown in Figure.

Joining the half cells

- The zinc and copper strips are externally connected using a wire through a switch (k) and a load (example: volt meter).
- The electrolytic solution present in the cathodic and anodic compartment are connected using an inverted U tube containing agar-agar gel mixed with an inert electrolytes such as KCl, Na_2SO_4 etc.,
- The ions of inert electrolyte do not react with other ions present in the half cells and they are not either oxidised (or) reduced at the electrodes.
- The solution in the salt bridge cannot get poured out, but through which the ions can move into (or) out of the half cells.
- When the switch (k) closes the circuit, the electrons flows from zinc strip to copper strip.
- This is due to the following redox reactions which are taking place at the respective electrodes.



Anodic oxidation **1.5**

- The electrode at which the oxidation occurs is called the anode.
- In Daniel cell, the oxidation take place at zinc electrode.
- i.e., zinc is oxidised to Zn^{2+}ions by loosing its electrons.
- The Zn^{2+} ions enter the solution and the electrons enter the zinc metal, then flow through the external wire and then enter the copper strip.
- Electrons are liberated at zinc electrode and hence it is negative (- ve).

  $Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$ (loss of electron-oxidation)

Cathodic reduction **1.5**

- As discussed earlier, the electrons flow through the circuit from zinc to copper, where the Cu^{2+} ions in the solution accept the electrons, get reduced to copper and the same get deposited on the electrode.
- Here, the electrons are consumed and hence it is positive (+ve).

  $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ (gain of electron-reduction)

Salt bridge **2**

- The electrolytes present in two half cells are connected using a salt bridge.
- We have learnt that the anodic oxidation of zinc electrodes results in the increase in concentration of Zn^{2+} in solution. i.e., the

solution contains more number of Zn^{2+} ions as compared to SO_4^{2-} and hence the solution in the anodic compartment would become positively charged.

- Similarly, the solution in the cathodic compartment would become negatively charged as the Cu^{2+} ions are reduced to copper i.e., the cathodic solution contain more number of SO_4^{2-} ions compared to Cu^{2+}.
- To maintain the electrical neutrality in both the compartments, the non reactive anions Cl^- (from KCl taken in the salt bridge) move from the salt bridge and enter into the anodic compartment, at the same time some of the K^+ ions move from the salt bridge into the cathodic compartment.

Completion of circuit

- Electrons flow from the negatively charged zinc anode into the positively charged copper cathode through the external wire, at the same time, anions move towards anode and cations are move towards the cathode compartment. This completes the circuit.

Consumption of Electrodes **2**

- As the Daniel cell operates, the mass of zinc electrode gradually decreases while the mass of the copper electrode increases and hence the cell will function until the entire metallic zinc electrode is converted in to Zn^{2+} or the entire Cu^{2+} ions are converted in to metallic copper.
- Unlike Daniel cell, in certain cases, the reactants (or) products cannot serve as electrodes and in such cases inert electrode such as graphite (or) platinum is used which conducts current in the external circuit.

Galvanic cell notation **1**

- The galvanic cell is represented by a cell diagram, for example, Daniel cell is represented as

  Zn (s)| Zn^{2+} (aq) || Cu^{2+} (aq) | Cu (s)
- In the above notation, a single vertical bar () represents a phase boundary and the double vertical bar () represents the salt bridge.
- The anode half cell is written on the left side of the salt bridge and the cathode half cell on the right side.
- The anode and cathode are written on the extreme left and extreme right, respectively.

Example **1**

- The net redox reaction of a galvanic cell is given below

  2 Cr(s) + 3Cu $^{2+}$ (aq) $\rightarrow$ $2Cr^{3+}$(aq) + 3Cu(s)
- Write the half reactions and describe the cell using cell notation.
- Anodic oxidation 2Cr (s) $\rightarrow$ $2Cr^{3+}$ (aq) + $6e^-$
- Cathodic reduction : $3Cu^{2+}$ (aq) + $6e^-$ $\rightarrow$ 3Cu(s)
- Cell Notation is Cr (s)| Cr^{3+} (aq) || Cu^{2+} (aq)| Cu(s)

7) a) Explain about classification of organic compounds?

b) Discuss about various classes of organic compounds and their uses in our daily life?

c) What are the uses of ethanol and ethanoic acid?

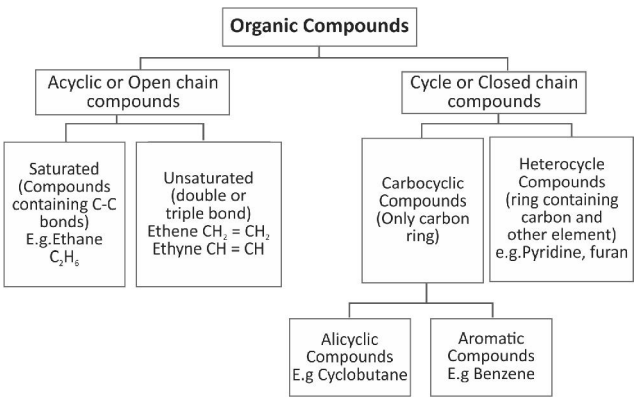
a) Explain about classification of organic compounds **5**

Organic compounds

- The unique nature of carbon, such as catenation, tetravalency and multiple bonding, enables it to combine with itself or other elements like hydrogen, oxygen, nitrogen,sulphur etc., and hence form large number of compounds.
- All these compounds are made of covalent bonds.
- These compounds are called organic compounds.

I. Classification of organic compounds based on the pattern of Carbon chain

- Organic chemistry is the chemistry of catenated carbon compounds.
- The carbon atoms present in organic compounds are linked with each other through covalent bonds and thus exist as chains.
- By this way, organic compounds are classified into two types as follows:



- Flow chart depicts the classification of organic compounds based on the pattern of carbon arrangements and their bonding in organic compounds

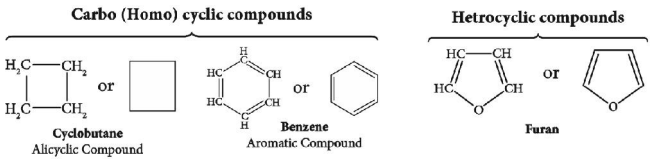
Acyclic or Open chain compounds

- These are the compounds in which the carbon atoms are linked in a linear pattern to form the chain.
- If all the carbon atoms in the chain are connected by single bonds, the compound is called as **saturated**.
- If one or more double bonds or triple bonds exist between the carbon atoms, then the compound is said to **unsaturated.**

CH_3-CH_2-CH_3	CH_3-CH=CH_2
Propane	**Propene**
Saturated compound	Unsaturated compound

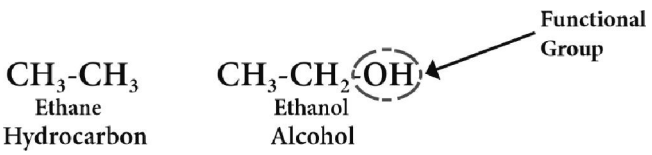
Cyclic Compounds

- Organic compounds in which the chain of carbon atoms is closed or cyclic are called cyclic compounds.
- If the chain contains only carbon atoms, such compounds are called **carbocyclic (Homocyclic)** compounds.
- If the chain contains carbon and other atoms like oxygen, nitrogen, sulphur, etc., these compounds are called **heterocyclic compounds**.
- Carbocyclic compounds are further subdivided into **alicyclic** and **aromatic** compounds.
- Alicyclic compounds contain one or more carbocyclic rings which may be saturated or unsaturated whereas aromatic compounds contain one or more benzene rings (ring containing alternate double bonds between carbon atoms).



II. Classification of organic compounds based on functional groups

- The structural frameworks of organic compounds are made of carbon and hydrogen, which are relatively less reactive.
- But, the presence of some other atoms or group of atoms makes the compounds more reactive and thus determines the chemical properties of the compound.
- These groups are called functional groups.
- A functional group is an atom or group of atoms in a molecule, which gives its characteristic chemical properties.
- The chemical properties of an organic compound depend on its functional group whereas its physical properties rely on remaining part of the structure.
- Carbon to carbon multiple bonds (C=C, C C) also are considered as functional groups as many of the properties are influenced by these bonds. Other functional groups include, –OH, –CHO, –COOH, etc.
- For example, ethane is a hydrocarbon having molecular formula C_2H_6.
- If one of its hydrogen is replaced by –OH group, you will get an alcohol.
- Leaving the functional group, the rest of the structure is represented by 'R'.
- Thus an alcohol is represented by 'R-OH'



- A series of compounds containing the same functional group is called a class of organic compounds.
- Table shows various classes or families of organic compounds and their functional groups:

Classes of organic compounds based on functional group

Class of the compound	Functional group	CommonFormula	Examples
Alcohol	–OH	R-OH	Ethanol, CH_3CH_2OH
Aldehyde		R-CHO	Acetaldehyde, CH_3CHO
Ketone		R–CO-R	Acetone, CH_3COCH_3
Carboxylic acid		R-COOH	Acetic acid, CH_3COOH

b) Discuss about various classes of organic compounds and their uses in our daily life.

Organic compounds in daily life **5**

- Organic compounds are inseparable in human life.
- They are used by mankind or associated at all stages of life right from one's birth to death.
- Various classes of organic compounds and their uses in our daily life as follows:

1. Hydrocarbons

- Fuels like LPG, Petrol, Kerosene.
- Raw materials for various important synthetic materials.
- Polymeric materials like tyre, plastic containers.

2. Alcohols

- As a solvent and an antiseptic agent.
- Raw materials for various important synthetic materials.

3. Aldehydes

- Formaldehyde as a disinfectant.
- Raw materials for synthetic materials.

4. Ketones

- As a solvent.
- Stain Remover.

5. Ethers

- Anaesthetic agents.
- Pain Killer.

6. Esters

- All the cooking oils and lipids contain esters.

c) What are the uses of ethanol and ethanoic acid **5**

I. Ethanol

- Ethanol is commonly known as alcohol.
- All alcoholic beverages and some cough syrups contain ethanol.

Ethanol is used

- in medical wipes, as an antiseptic.
- as an anti-freeze in automobile radiators.
- for effectively killing micro organisms like bacteria, fungi, etc., by including it in many hand sanitizers.
- as an antiseptic to sterilize wounds in hospitals.
- as a solvent for drugs, oils, fats, perfumes, dyes, etc.
- in the preparation of methylated spirit (mixture of 95% of ethanol and 5% of methanol) rectified spirit (mixture of 95.5% of ethanol and 4.5% of water), power alcohol (mixture of petrol and ethanol) and denatured spirit (ethanol mixed with pyridine).
- to enhance the flavour of food extracts, for example vanilla extract; a common food flavour, which is made by processing vanilla beans in a solution of ethanol and water.

II. Ethanoic acid (CH_3COOH)

- Ethanoic acid or acetic acid is one of the most important members of the carboxylic acid family.

Uses of ethanoic acid

- Acetic acid, in lower concentration, (vinegar) is used as a food additive, a flavoring agent and a preservative.

Ethanoic acid is used

- in the manufacture of plastic.
- in making dyes, pigments and paint.
- in printing on fabrics.
- as a laboratory reagent.
- for coagulating rubber from latex.
- in the production of pharmaceuticals.

8) Define Carbohydrates? Mention its classification and importance?

Contraception **5**

Carbohydrates

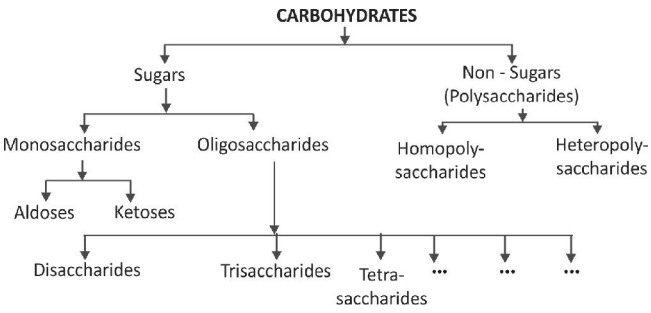
- Carbohydrates are the most abundant organic compounds in every living organism.
- They are also known as saccharides (derived from Greek word 'sakcharon' which means sugar) as many of them are sweet.
- They are considered as hydrates of carbon, containing hydrogen and oxygen in the same ratio as in water.
- Chemically, they are defined as polyhydroxy aldehydes or ketones with a general formula $C_n(H_2O)_n$.
- Some common examples are glucose (monosaccharide), sucrose (disaccharide) and starch (polysaccharide).
- Carbohydrates are synthesised by green leaves during photo synthesis, a complex process in which sun light provides the energy to convert carbon dioxide and water into glucose and oxygen.
- Glucose is then converted into other carbohydrates and is consumed by animals.

$6CO_2 + 6\ H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

Classification **5**

- Carbohydrates may be classified into two broad groups.

1. Sugars
2. Non-sugars or polysaccharides.



1. Sugars

- Sugars are sweet crystalline substances and soluble in water.

a) Monosaccharides

- Monosaccharides are carbohydrates that cannot be hydrolysed further and are also called simple sugars.
- Monosaccharides have general formula $C_n(H_2O)_n$.
- While there are many monosaccharides known only about 20 of them occur in nature.
- Some common examples are glucose, fructose, ribose, erythrose
- Monosaccharides are further classified based on the functional group present (aldoses or ketoses) and the number of carbon present in the chain (trioses, tetroses, pentoses, hexoses etc...).
- If the carbonyl group is an aldehyde, the sugar is an aldose .
- If the carbonyl group is a ketone, the sugar is a ketose.
- The most common monosaccharides have three to eight carbon atoms.

Different types of monosaccharides

No. of carbon atoms in the chain	Functional group present	Type of sugar	Example
3	Aldehyde	Aldotriose	Glyceraldehyde
3	Ketone	Ketotriose	Dihydroxy acetone
4	Aldehyde	Aldotetrose	Erythrose
4	Ketone	Ketotetrose	Erythrulose
5	Aldehyde	Aldopentose	Ribose
5	Ketone	Ketopentose	Ribulose
6	Aldehyde	Aldohexose	Glucose
6	Ketone	Ketohexose	Fructose

Glucose

- Glucose is a simple sugar which serves as a major energy source for us.
- It is the most important and most abundant sugar.
- It is present in honey, sweet fruits such as grapes and mangoes etc...
- Human blood contains about 100 mg/dL of glucose, hence it is also known as blood sugar.
- In the combined form it is present in sucrose, starch, cellulose etc.,

Fructose

- Fructose is another commonly known monosaccharide having the same molecular formula as glucose.
- It is levorotatory and a ketohexose.
- It is present abundantly in fruits and hence it is also called as fruit sugar.

b) Oligosaccharides

- Oligosaccharides are sugars that yield two to ten monosaccharide molecules on hydrolysis and are thus again classified into various groups depending upon the number of monosaccharide units formed on hydrolysis

Disaccharides

- Disaccharides are sugars that yield two molecules of monosaccharides on hydrolysis.
- This reaction is usually catalysed by dilute acid or enzyme.
- Disaccharides have general formula $C_n(H_2O)_{n-1}$.
- In disaccharides two monosaccharides are linked by oxide linkage called 'glycosidic linkage', which is formed by the reaction of the anomeric carbon of one monosaccharide reacts with a hydroxyl group of another monosaccharide.
- Example: Sucrose, Lactose, Maltose

Sucrose

- Sucrose, commonly known as table sugar is the most abundant disaccharide.
- It is obtained mainly from the juice of sugar cane and sugar beets.
- Insects such as honey bees have the enzyme called invertases that catalyzes the hydrolysis of sucrose to a glucose and fructose mixture.
- Honey in fact, is primarily a mixture of glucose, fructose and sucrose.
- On hydrolysis sucrose yields equal amount of glucose and fructose units.

  Sucrose $\rightarrow$ Glucose + Fructose

Lactose

- Lactose is a disaccharide found in milk of mammals and hence it is referred to as milk sugar.
- On hydrolysis, it yields galactose and glucose.

Maltose

- Maltose derives its name from malt from which it is extracted.
- It is commonly called as malt sugar.
- Malt from sprouting barley is the major source of maltose.
- Maltose is produced during digestion of starch by the enzyme -amylase.

2. Non-sugars (or) Polysaccharides

- Polysaccharides consist of large number of monosaccharide units bonded together by glycosidic bonds and are the most common form of carbohydrates.
- Since, they do not have sweet taste polysaccharides are called as non-sugars.
- They form linear and branched chain molecules.
- Polysaccharides are classified into two types, namely, homopolysaccharides and heteropolysaccharides depending upon the constituent monosaccharides.
- Homopolysaccharides are composed of only one type of monosaccharides while the heteropolysaccharides are composed of more than one.

- Example: starch, cellulose and glycogen (homopolysaccharides); hyaluronic acid and heparin (heteropolysaccharides).

a) Starch

- Starch is used for energy storage in plants. Potatoes, corn, wheat and rice are the rich sources of starch.
- It is a polymer of glucose in which glucose molecules are lined by a(1,4) glycosidic bonds.
- Starch can be separated into two fractions namely, water soluble amylose and water insoluble amylopectin.
- Starch contains about 20 % of amylose and about 80% of amylocpectin.

b) Cellulose

- Cellulose is the major constituent of plant cell walls.
- Cotton is almost pure cellulose.
- On hydrolysis cellulose yields D-glucose molecules.
- Cellulose is a straight chain polysaccharide.
- The glucose molecules are linked by â(1,4)glycosidic bond
- Cellulose is used extensively in the manufacturing paper, cellulose fibres, rayon explosive, (Gun cotton – Nitrated ester of cellulose) and so on.
- Human cannot use cellulose as food because our digestive systems do not contain the necessary enzymes (glycosidases or cellulases) that can hydrolyse the cellulose

c) Glycogen

- Glycogen is the storage polysaccharide of animals. It is present in the liver and muscles of animals.
- Glycogen is also called as animal starch. On hydrolysis it gives glucose molecules.
- Structurally, glycogen resembles amylopectin with more branching.
- In glycogen the branching occurs every 8-14 glucose units opposed to 24-30 units in amylopectin.
- The excessive glucose in the body is stored in the form of glycogen.

Importance of carbohydrates **5**

- Carbohydrates, widely distributed in plants and animals, act mainly as energy sources and structural polymers.
- Carbohydrate is stored in the body as glycogen and in plant as starch.
- Carbohydrates such as cellulose which is the primary components of plant cell wall, is used to make paper, furniture (wood) and cloths (cotton)
- Simple sugar glucose serves as an instant source of energy.
- Ribose sugars are one of the components of nucleic acids.
- Modified carbohydrates such as hyaluronate (glycosaminoglycans) act as shock absorber and lubricant.