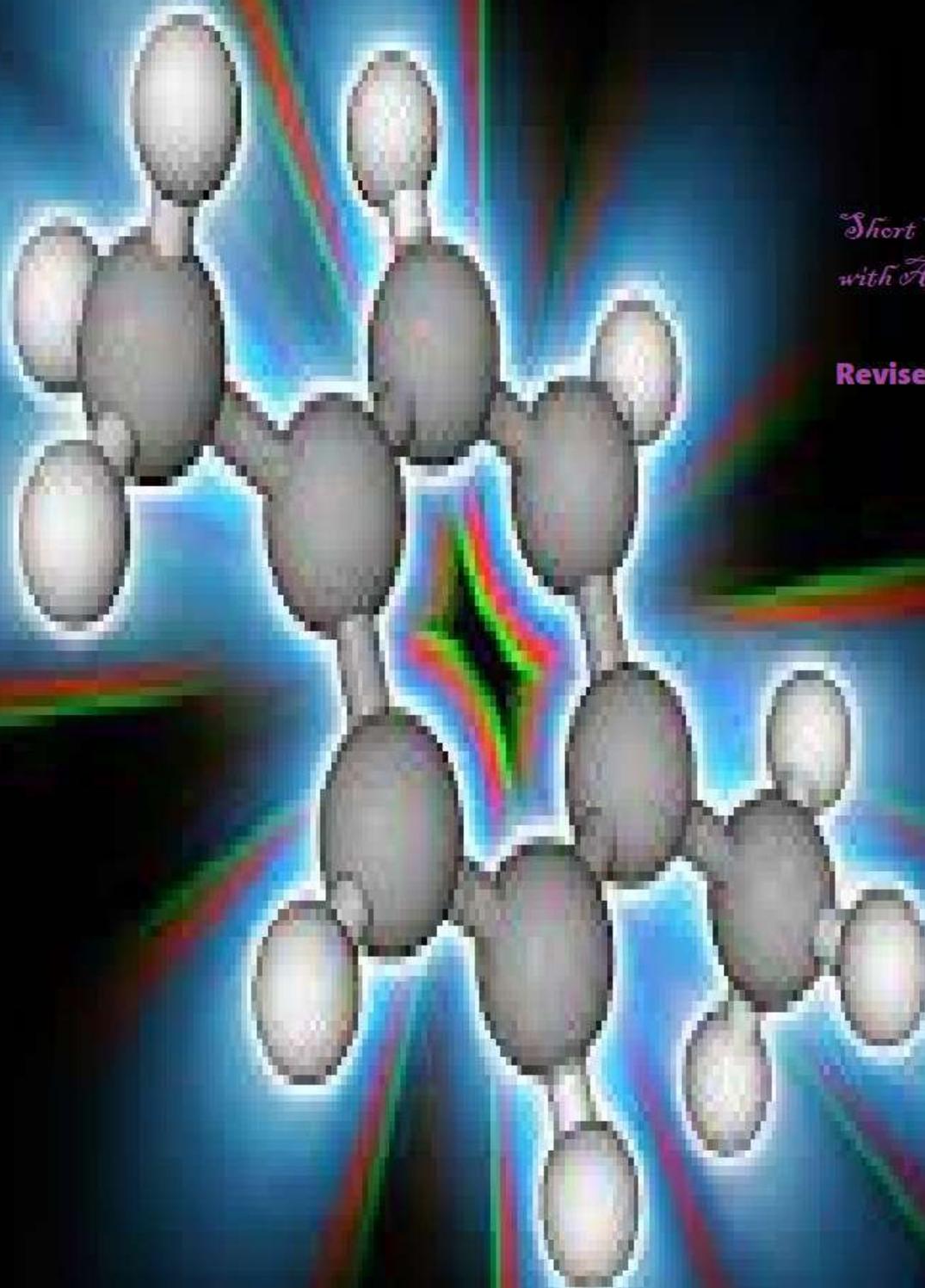


SECOND YEAR CHEMISTRY

*Short Questions
with Answers*

Revised Nov, 2022



Chapter#1
Periodic Classification of Elements and Periodicity

1. Define periodic table.

Ans: The periodic table provides a basic framework to study the periodic behaviour of physical and chemical properties of elements as well as their compounds.

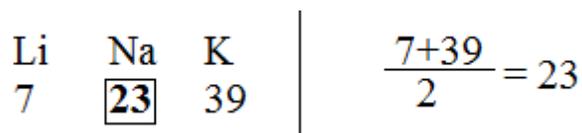
2. What is the contribution of Al-Razi in the field of chemistry?

Ans: Al-Razi classified the substances on the basis of their physical and chemical properties.

3. What are Dobereiner's triads?

Ans: Dobereiner, a German chemist in 1829, arranged the known elements in a group called Triads, as each contained three elements with similar properties. According to Dobereiner's Law of Triads,

“If the atomic mass of 1st and 3rd element is known, then the atomic mass of 2nd (middle) element can be calculated by taking the average of other two elements”. For example,



4. What are Newland's Octaves?

Ans: Newland, who was an English chemist, in 1864, classified 62 elements, known at that time, in increasing order of their atomic masses. He noticed that *every eighth element had some properties in common with the first one*. The principle on which this classification is based was called the Law of Octaves.

5. Define Mendeleev's and modern periodic law.

Ans: Mendeleev' Periodic law:

“If the elements are arranged in ascending order of their atomic masses, their

chemical properties repeat in a periodic manner”.

Modern periodic law:

“If the elements are arranged in ascending order of their atomic numbers, their chemical properties repeat in a periodic manner”.

6. What are the drawbacks in Mendeleev’s periodic table? OR Give two defects of Mendeleev’s periodic table.

Ans: Following are the drawbacks in Mendeleev’s periodic table:

1. The elements were arranged in increasing order of their atomic masses.
2. Another confusion in Mendeleev’s table was that elements like Be, Mg, Ca, Sr, Ba and Zn, Cd, Hg were placed in a single vertical group, while according to their properties they belonged to two different categories. The same was true for so many other elements placed in the same vertical group.

7. What are the improvements in Mendeleev’s periodic table?

Ans: Following are the improvements made in Mendeleev’s periodic table:

1. After the discovery of atomic number by Moseley in 1911, it was noticed that elements could be classified more satisfactorily by using their atomic numbers rather than their atomic masses.
2. The periodic table was improved by arranging the elements in ascending order of their atomic numbers instead of their atomic masses.
3. Another improvement was the addition of an extra group (group VIIIA) at the extreme right of the periodic table. This group contains noble gases, which had not been discovered in Mendeleev’s time.
4. In modern periodic table, the confusion of placing elements with different properties in same group was removed by dividing the elements in two types of vertical groups, A and

B. In modern periodic table, Be, Mg, Ca, Sr and Ba are placed in group IIA and Zn, Cd, Hg in group IIB.

8. *Zn, Cd, Hg were placed along with alkaline earth metals in Mendeleev's periodic table. How this confusion was removed in Modern periodic table?*

Ans: In modern periodic table, the confusion of placing elements with different properties in same group was removed by dividing the elements in two types of vertical groups, A and B. In modern periodic table, Be, Mg, Ca, Sr and Ba are placed in group IIA and Zn, Cd, Hg in group IIB.

9. *Define groups and periods.*

Ans: Groups

Elements with similar properties are placed in vertical columns called Groups. There are eight groups, which are usually numbered by Roman numerals I to VIII.

Points to remember (not part of definition)

Each group is divided into two sub-groups designated as A and B subgroups. The sub-groups, containing the representative or normal elements are labeled as A subgroups, whereas B subgroup contain less typical elements, called transition elements and are arranged in the centre of the periodic table.

Periods

The horizontal rows of the periodic table are called Periods. There are seven periods in the periodic table.

10. *Which period is the shortest one in the periodic table?*

Ans: The period 1 is the shortest one in the periodic table. It contains only two elements, hydrogen and helium.

11. Tell about short periods in the periodic table.

Ans: The periods 2 and 3 contain eight elements each and are called short periods. All the elements in these periods are representative elements and belong to A subgroup. In these periods, every eighth element resembles in properties with the first element. Lithium and beryllium in the 2nd period resemble in most of their properties with sodium and magnesium of the 3rd period, respectively. Similarly, boron and aluminium both show oxidation state of +3, fluorine in 2nd period has close resemblances with chlorine of 3rd period.

Elements of second period: Li, Be, B, C, N, O, F, Ne

Elements of third period: Na, Mg, Al, Si, P, S, Cl, Ar

12. Tell about long periods in the periodic table.

Ans: The periods 4 and 5 are called long periods. Each long period consists of eighteen elements. Out of these, eight are representative elements belonging to A subgroup similar to second and third periods. Whereas the other ten elements, placed in the centre of the table belong to B subgroups and are known as transition elements. In these periods, the repetition of properties among the elements occurs after 18 elements. As after ${}_{19}\text{K}$ (having atomic number 19) the next element with similar properties is ${}_{37}\text{Rb}$. The period 6 is also a long period, which contains thirty-two elements. In this period there are eight representative elements, ten transition elements and a new set of fourteen elements called Lanthanides as they start after ${}_{57}\text{La}$. Lanthanides have remarkably similar properties and are usually shown separately at the bottom of the periodic table.

Elements of 4th period: K, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, Ge, As, Se, Br, Kr

Elements of 5th period: Rb, Sr, Y, Zr, Nb, Mo, Tc, Ru, Rh, Pd, Ag, Cd, In, Sn, Sb, Te, I, Xe

Elements of 6th period: Cs, Ba, La, Hf, Ta, W, Re, Os, Ir, Pt, Au, Hg, Tl, Pb, Bi, Po, At, Rn

In sixth period Lanthanides: La (57)-Lu (71)

13. Which period is called incomplete in the periodic table?

Ans: The period 7 is incomplete so far. It contains only two normal elements $_{87}\text{Fr}$ and $_{88}\text{Ra}$, ten transition elements and fourteen inner transition elements. The inner transition elements of this period are called Actinides, as they follow $_{89}\text{Ac}$ - $_{103}\text{Lr}$. The actinides are also shown at the bottom of the periodic table under the Lanthanides.

14. What are rare earth elements?

Ans: Lanthanides and actinides are called rare earth elements as they are found in a very small amount in the earth's crust.

15. Tell about blocks in the periodic table.

Ans:

- IA and IIA subgroups are called s-block elements because their valence electrons are available in s orbital.
- The elements of IIIA to VIIIA subgroups (except He) are known as p-block elements as their valence electrons are present in p orbital.
- Similarly in transition elements, electrons in d-orbital are responsible for their valency hence they are called d-block elements.
- For Lanthanides and Actinides valence electrons are present in f- orbital hence these elements are called f-block elements.

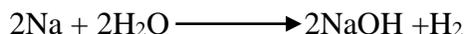
16. How the classification of elements in different blocks helps in understanding their chemistry?

Ans: The classification in blocks (s, p, d, f) is based upon the valence orbital of the element involved in chemical bonding. So this classification is quite useful in understanding the chemical

properties of elements, especially, the concept of valency as oxidation state.

17. What are alkali metals? Why they are called so?

Ans: Group IA elements are called alkali metals because of their property to form strong alkalies with water.



18. What are alkaline earth metals? Why they are called so?

Ans: Group IIA elements are called alkaline earth metals because of their presence in the earth's crust and alkaline character.

19. Why halogens are called so?

Ans: Group VIIA elements are called halogens because of their salt forming properties when halogens are treated with metals.

20. Why noble gases are called so?

Ans: The gases of group VIIIA are least reactive as their outermost shells are complete (ns^2np^6). They cannot gain, lose or share electrons. That is why, they are called noble gases.

21. Write name and symbol of an element from s block that has zero oxidation state. Also write its electronic configuration.

Ans: Helium (He) is the element from s block that has zero oxidation state. The electronic configuration is $1s^2$.

22. Discuss the position of metals, non-metals and metalloids in the periodic table.

Ans: The elements on the left hand side, in the centre and at the bottom of the periodic table are metals, while the non-metals are in the upper right corner of the table. Some elements, especially lower members of groups, III A, IVA and VA have properties of both metals as well as non-metals. These elements are called semi-metals or metalloids. In the periodic table elements of

groups IVA to VIIIA, at the top right hand corner above the stepped-line, are non-metals. The elements just under the “steps” such as Si, As, and Te are the metalloids. All the remaining elements, except hydrogen, are metals.

23. What are transition elements?

Ans: Transition elements may be defined as those elements which have partially filled d or f-subshells in atomic state or in any of their commonly occurring oxidation states.

The d-block and the f-block elements are called transition elements because they are located between the s and p-block elements and their properties are in transition between the metallic elements of the s-block and nonmetallic elements of the p-block.

24. d and f-block elements are called transition elements. Why?

Ans: The d-block and the f-block elements are called transition elements because they are located between the s and p-block elements and their properties are in transition between the metallic elements of the s-block and non-metallic elements of the p-block.

25. What are typical and non-typical transition elements?

Ans: The elements of group IIB and group IIIB are referred to as non-typical transition elements as some of their properties are like representative elements and the elements in the remaining transition series are called typical transition elements.

26. What are inner transition elements and outer transition elements?

Ans: The f-block elements i.e. lanthanides and actinides are called inner transition elements and the d-block elements are called outer transition elements.

27. What are coinage metals?

Ans: The elements of group IB i.e. Cu, Ag, Au are called coinage metals as they are used in making coins.

28. Discuss position of hydrogen with respect to Group IA.

Ans: Position of hydrogen with respect to IA is discussed below:

Similarities

1. Like alkali metals hydrogen atom has one electron in 1s sub-shell, which it can lose to form H^+
2. Both hydrogen and alkali metals have a strong tendency to combine with electronegative elements such as halogens.
3. Similar to alkali metals hydrogen also forms ionic compounds, which dissociate in water.

Dissimilarities

1. Hydrogen is a nonmetal in true sense. It does not lose electron as easily as most of the alkali metals do.
2. Unlike alkali metals molecular hydrogen exists in open atmosphere.

29. Discuss position of hydrogen with respect to Group VIIA.

Ans: Position of hydrogen with respect to VIIA is discussed below:

Similarities

1. Hydrogen is a gas like most of the halogens and is stable in diatomic form such as F_2 , Cl_2 and Br_2 .
2. As required by halogens, hydrogen also needs one electron to complete its outermost shell.
3. By accepting one electron hydrogen forms H^- (Hydride ion) similar to F^- , Cl^- and Br^- .
4. Both hydrogen and halogens form stable ionic compounds with alkali metals.

Dissimilarities

1. By losing its only electron, hydrogen forms H^+ but halogens do not form positive ions.

2. Combining with oxygen, hydrogen forms very stable oxides while halogens lack this property.

30. Discuss position of hydrogen with respect to IVA Group.

Ans: Position of hydrogen with respect to IVA is discussed below:

Similarities

1. Valence shell of hydrogen is half filled like those of group IVA elements.
2. Both, hydrogen and group IV elements combine with other elements through covalent bonding.
3. Like carbon, hydrogen also possesses remarkable reducing properties.



Dissimilarities

1. Carbon and silicon form long chain compounds, when their atoms combine with each other, while hydrogen does not form such compounds.
2. Similarly, carbon can simultaneously form bonds with more than one elements, whereas, hydrogen due to having only one electron can combine with only one element at a time.

31. Discuss reducing properties of hydrogen with respect to IVA.

Ans: Like carbon, hydrogen also possesses remarkable reducing properties.



32. Define halides. Give examples.

Ans: Halides are the binary compounds which halogens form with other elements. For example, NaCl, KBr, NaI.

33. How are halides classified?

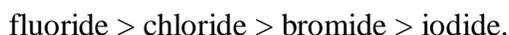
Ans: Halides can be classified into two general classes: ionic and covalent. In between the two, there is another class of halides in which the halogen atom acts as a bridge between the two atoms of the other element. Such halides are termed as “Polymeric” halides.

34. How are ionic halides formed? Give their properties.

Ans: Strongly electropositive elements, having greater electronegativity difference with halogen atom, form ionic halides. The halides of group IA are considered purely ionic compounds, which are high melting point solids. Such halides have three-dimensional lattices consisting of discrete ions.

35. Which ionic halides have the highest melting point and why?

Ans: Among the pure ionic compounds, the fluorides have the highest lattice energies due to the small size of fluoride ion. Thus, for ionic halides, the fluorides have the highest melting and boiling points which decrease in the order:



36. Which elements give polymeric halides and what are their properties?

Ans: Less electropositive elements, such as Be, Ga and Al form polymeric halides having partly ionic bonding with layer or chain lattices.

37. What is the trend of halides from left to right in the periodic table?

Ans: On moving across the periodic table from left to right, the electronegativity difference reduces and the trend shifts towards covalent halides. Ionic halides are formed by elements on the right side of the periodic table (IA and IIA). For example, in 3rd period:

- i. NaCl and MgCl₂ are ionic halide.
- ii. AlCl₃ is polymeric halide.
- iii. SiCl₄, PCl₃, S₂Cl₂ are covalent in nature.

38. What are the properties of covalent halides?

Ans: As the intermolecular forces in covalent halide molecules are weak van der Waal's forces so they are often gases, liquids or low melting point solids. Physical properties of covalent halides are influenced by the size and polarizability of the halogen atom. Iodides, as being the largest and more polarizable ions, possess the strongest van der Waal's forces and have higher melting and boiling points than those of other covalent halides.

39. What is the trend of halides from top to bottom in the periodic table?

Ans: In general, for a metal the order of decreasing ionic character of the halides is:

fluoride > chloride > bromide > iodide.

40. AlF_3 has higher melting point than AlI_3 . Why?

Ans: AlF_3 is purely ionic compound having melting point 1290°C and fairly a good conductor, whereas AlI_3 is predominantly covalent with melting point 198°C and electrically a non-conductor.

41. Why $PbCl_2$ is ionic but $PbCl_4$ is fairly covalent compound?

Ans: When a metal forms more than one halide, the halides in which metal has lower oxidation state tends to be ionic while that in higher oxidation state is covalent. Similarly, high polarizing power of Pb^{+4} as compared to Pb^{+2} makes $PbCl_2$ mainly ionic, but, $PbCl_4$ fairly covalent.

42. How oxidation state tells about ionic or covalent nature of halides?

Ans: In case of an element forming more than one halides the metal halide in its lower oxidation state tends to be ionic, while that in the higher oxidation state is covalent. For example, $PbCl_2$ is mainly ionic and $PbCl_4$ is fairly covalent. This can again be explained by the high polarizing power of Pb^{4+} as compared to that of Pb^{2+} .

43. What are hydrides?

Ans: The binary compounds of hydrogen with other elements are called hydrides. For example, NaH, H₂O, H₂S.

44. What are hydrides? What is the trend of boiling points of hydrides of group VIA down the group?

Ans: The binary compounds of hydrogen with other elements are called hydrides. For example, NaH, H₂O, H₂S. The boiling point of hydrides of group VIA increases down the group except H₂O which is due to hydrogen bonding and has higher boiling point than might be expected.

Group VIA (Hydrides)	Boiling point (°C)
H ₂ O	100
H ₂ S	-60.3
H ₂ Se	-42
H ₂ Te	-2

45. How hydrides are classified?

Ans: Hydrides may be broadly classified into three classes: ionic, covalent and intermediate.

46. Why alkali metals give ionic hydrides?

Ans: Alkali metals are more electropositive than hydrogen. They have strong tendency to lose electron and form a uni-positive ion. This electron is accepted by hydrogen to form a hydride ion (H⁻). These cations and anions then combine to form ionic bond. That's why alkali metals give ionic hydrides. For example, Na⁺H⁻ and K⁺H⁻.

47. Which elements form ionic hydrides and what are their properties?

Ans: The elements of group IA and the heavier members of group IIA form ionic hydrides, which contain H⁻ (Hydride) ion. These hydrides are crystalline solid compounds, with high melting and boiling points, which conduct electricity in molten state.

48. What is the trend of hydrides from left to right in the periodic table?

Ans: The elements on the left side of the periodic table (IA and IIA) form ionic hydrides. The

tendency towards covalent character increases by moving from left to right in the periodic table. Hydrides of beryllium and magnesium represent the class of intermediate hydrides. Their properties are in between the ionic and covalent hydrides.

49. What are the properties of covalent hydrides?

Ans: The covalent hydrides are usually gases or volatile liquids. They are non-conductors and dissolve in organic solvents. Their bond energies depend on the size and the electronegativity of the element. Stability of covalent hydrides increases from left to right in a period and decreases from top to bottom in a group.

50. The boiling point of covalent hydrides generally increases except the first members of group VA-VIIA which have higher boiling point than the other group members. Why?

Ans: The boiling points of covalent hydrides generally increase on descending a group except the hydrides like H_2O , HF and NH_3 which, due to hydrogen bonding, have higher boiling points than might be expected.

51. Define oxides. Give examples.

Ans: The compounds which oxygen forms with other elements are called oxides. For example, P_2O_5 , Na_2O , CO_2 .

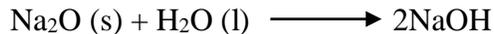
52. How are oxides classified?

Ans: Oxides can be classified in more than one ways: based upon the type of bonding they have as well as their acidic or basic character. On the basis of acidic and basic character they are categorized as acidic, basic and amphoteric oxides.

53. What are basic oxides?

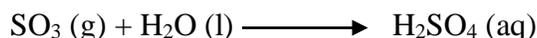
Ans: Metals form basic oxides like IA and IIA. When oxides of metals are dissolved in water they give bases.

For example:



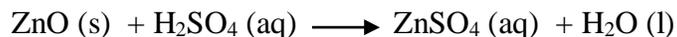
54. What are acidic oxides?

Ans: Non-metals give acidic oxides like C, N, P and S. When oxides of non-metals are dissolved in water they form acids. For example:



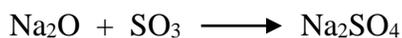
55. What are amphoteric oxides?

Ans: The oxides having both acidic and basic properties are called amphoteric oxides. Oxides of relatively less electropositive elements, such as BeO, Al₂O₃, Bi₂O₃ and ZnO are amphoteric and behave as acids towards strong bases and as bases towards strong acids.



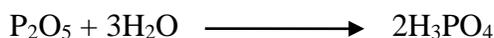
56. What happens when acidic and basic oxides combine with each other?

Ans: Basic oxides and acidic oxides react with one another to give salts e.g,



57. Although both sodium and phosphorus are present in the same period of the periodic table yet their oxides are different in nature, Na₂O is basic while P₂O₅ is acidic in character. Justify.

Ans: Sodium is a metal while phosphorus is a non-metal. Metals give basic oxides while non-metals give acidic oxides.



58. What is the trend of oxides in the periodic table?

Ans: In a given period, the oxides progress from strongly basic through weakly basic, amphoteric, and weakly acidic to strongly acidic, e.g. Na_2O , MgO , Al_2O_3 , P_4O_{10} , SO_3 , Cl_2O_7 . The basicity of main group metal oxides increases on descending a group of the periodic table, (e.g. $\text{BeO} < \text{MgO} < \text{CaO} < \text{SrO} < \text{BaO}$), though the reverse trend is observed in the transition metal oxides.

59. What is the effect of oxidation state of metal on nature of oxide?

Ans: The oxidation state of the metal also affects the acid/base character of its oxide. The acidity increases with increasing oxidation state (e.g. the acidity of $\text{MnO} < \text{Mn}_2\text{O}_3 < \text{MnO}_2 < \text{Mn}_2\text{O}_7$).

60. Define hydration energy. Give an example.

Ans: The hydration energy is the heat absorbed or evolved when one mole of gaseous ions dissolve in water to give an infinitely dilute solution. For example, when one mole of gaseous hydrogen ions is dissolved in water to give an infinitely dilute solution and a large amount of heat is liberated:

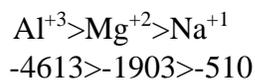


61. On which factor does hydration energy depends?

Ans: Hydration energies highly depend upon charge to size ratio of the ions. For a given set of ions, for example of group IA, charge to size ratio decreases from top to bottom in a group, the hydration energy also decreases in the same fashion. On the contrary, the hydration energy increases significantly by moving from left to right in a period as the charge to size ratio increases, as found in the metal ions of third period.

62. Hydration energies of ions are in the following order. $\text{Al}^{+3} > \text{Mg}^{+2} > \text{Na}^{+1}$. Justify it.

Ans: Hydration energy depends upon the charge to size ratio, greater the charge to size ratio greater the hydration energy. Hence, in the given order ($\text{Al}^{+3} > \text{Mg}^{+2} > \text{Na}^{+1}$), Al^{+3} has greater charge to size ratio than Mg^{+2} and Na^{+1} . That's why, the hydration energies are in this order:



63. What is the trend of electrical conductance in the periodic table?

Ans: The electrical conductance of metals in groups IA and IIA, generally increases from top to bottom. Metals of group IB, which are known as coinage metals, have extraordinary high values of electrical conductance. Non-metals especially of groups VIA and VIIA show such low electrical conductance that they can be considered as non-conductors. In the series of transition metals, the values of electrical conductance vary so abruptly that no general trend can be assigned to them. The lower elements of group IVA, tin and lead, are fairly good conductors and their values of electrical conductivity are comparable with those of their counterparts in group IA.

64. Why metallic character increases from top to bottom in a group of metal?

Ans: Metallic character increases from top to bottom in a group of metal because atomic size increases, shielding effect increases and effective nuclear charge decreases from top to bottom in a group. As a result, the removal of electrons from the outermost shell becomes easier as hold of nucleus on the outermost shell electrons decreases. Therefore, metallic character increases from top to bottom in a group of metals.

65. Why do metals conduct electricity? OR Why the metals are good conductors?

Ans: Metals are good conductors of heat and electricity due to the presence of free moving electrons. These free electrons act as carriers of heat and electricity from one end of the metal to the other. Greater the number of free moving electrons greater is the electrical conductance.

66. Why graphite is a conductor whereas diamond is a non-conductor?

Ans: Carbon, in the form of diamond is non-conductor because all of its valence electrons are

tetrahedrally bound and unable to move freely, while in the form of graphite, carbon is fairly a good conductor because one of its four valence electrons is relatively free to move.

67. Define oxidation state.

Ans: The oxidation state of an atom in a compound is defined as the charge with the sign +ve or -ve, which it would carry in the compound. For example Na^{+1} , Cl^{-1} , F^{-1} .

68. How the oxidation state is linked with group number?

Ans: The oxidation state of a typical element is directly or indirectly related to the group number to which the element belongs in the periodic table. The elements of group IA to IVA have the same oxidation states as their group numbers are. Just as B, Al and Ga belong to group IIIA, hence, they always show oxidation state of +3. So, for the elements of these groups, the oxidation state is same as the number of electrons present in the valence shells of the elements.

69. When the oxidation state is not same as group number?

Ans: For the elements of group VA, the oxidation states are either the number of electrons present in the valence shell (which is same as their group number) or the number of vacancies available in these shells. For example, N, P, As and Sb frequently show +3 as well as +5 oxidation states. Elements of group VIA show almost similar behaviour. In H_2SO_4 , sulphur shows the oxidation state of +6, which is the number of electrons in its outermost shell whereas its oxidation state is -2 in H_2S , which is the number of vacancies in the shell. In group VIIA elements oxidation state is mostly -1, which is again the number of vacancies in their outermost shells. Group VIIIA elements, which are also called zero group elements, usually show zero oxidation state because there is no vacancy in their outermost shells.

70. Oxidation states usually remain same in a group. Why? OR The oxidation states vary in a period but remain almost constant in a group. Justify.

Ans: The number of electrons in the outermost shells goes on changing in period from left to right, so oxidation states go on changing but, the number of electrons in the outermost shell remains same in a group so the oxidation states remain the same. The process of un- pairing of electrons may happen in a group and oxidation states may change, especially, in case of groups of transition elements.

71. Why the oxidation states of noble gases are usually zero?

Ans: The oxidation state of an element is directly or indirectly related to the number of its valence electrons or the number of vacancies available in its valence shell. In case of noble gases, their outermost shells are completely filled with electrons and no vacancy is available in their outermost shells (ns^2np^6). Thus, these gases usually show zero oxidation state. That's why they are often called zero group elements.

72. Why transition elements show variable oxidation state?

Ans: Transition elements, which are shown in B sub-groups of the periodic table, also show the oxidation states equal to their group number as it can be seen for Cu(I), Zn(II), V(V), Cr(VI) and Mn (VII). But due to greater number of valence electrons available in partly filled d-orbitals these elements usually show more than one oxidation states in their compounds.

73. Why melting point and boiling point increases up to the middle of the periodic table and then decreases as we move from left to right?

Ans: Across the short periods, the melting and boiling points of elements increase with the number of valence electrons up to group IVA and then decrease up to the noble gases. Since carbon has the maximum number of binding electrons, thus, it has a very high melting point in diamond in which each carbon is bound to four other carbon atoms. In general, the elements which exist as giant covalent structures have very high melting points.

An important change occurs when we move from group IVA to groups VA, VIA, VIIA as the lighter elements of these groups exist as small, covalent molecules, rather than as three dimensional lattices. For instance, nitrogen, oxygen and fluorine exist as individual molecules which have very weak intermolecular forces between them. Consequently, their melting and boiling points are extremely low.

74. Why IA elements have lower melting point than IIA elements?

Ans: The melting points of group IA elements are low because each atom in them provides only one electron to form a bond with other atom. Melting points of group IIA elements are considerably higher than those of group IA elements because each atom in them provides two binding electrons.

75. Explain the variation in melting points along the short periods.

Ans: Melting points in short periods increase up to the middle and then decrease.

- i. Increase in melting point is due to decrease in atomic size and increase in inter-atomic forces.
- ii. After group IV-A lighter elements of these groups exist as small, discrete, covalent molecules and have weak inter-molecular forces as a result of which melting points also decrease.

76. What is the trend of melting and boiling point down the group in the periodic table?

Ans: The melting and boiling points of IA and IIA group elements decreases from top to bottom due to the increase in their atomic sizes. The binding forces present between large sized atoms are relatively weaker as compared to those between smaller atoms. For elements of group VIIA, which exist in the form of molecules, the melting and boiling points increase down the group. This is because large molecules exert stronger force of attraction due to their higher polarizabilities.

77. Why the melting and boiling points of halogens increase down the group?

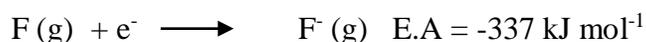
Ans: For elements of group VIIA, which exist in the form of molecules, the melting and boiling points increase down the group. This is because large molecules exert stronger force of attraction due to their higher polarizabilities.

78. What is the trend of metallic and non-metallic character in the periodic table?

Ans: Metallic character increases from top to bottom in a given group of elements as the tendency to lose electrons increases from top to bottom because atomic size increases, effective nuclear charge decreases and shielding effect increases. Therefore, hold of nucleus on outer shell electrons decreases and it becomes easier to remove electrons from the outermost shell. On the contrary, it decreases from left to right across a period as the tendency to gain electrons increases from left to right, shielding effect remains constant, effective nuclear charge increases and atomic size decreases.

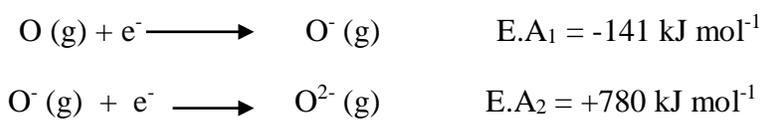
79. Define electron affinity. Write an example.

Ans: The electron affinity is the energy released or absorbed, when an electron is added to a gaseous atom to form a negative ion. For example,



80. Why the second value of ionization energy is shown with a positive sign while the first value is shown with a negative sign?

Ans: Energy is usually released when electronegative elements absorb the first electron and electron affinity in such cases is expressed in negative figures as in the case of halogens. When a second electron is added to a uni-negative ion, the incoming electron is repelled by the already present electron and energy is absorbed in this process.



81. What is the trend of electron affinity in the periodic table?

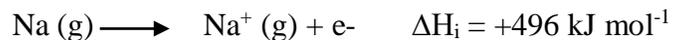
Ans: Electron affinity increases from left to right in periods of the periodic table because effective nuclear charge increases, shielding effect remains constant, size of atom decreases so hold of nucleus on outermost shell electrons increases.

Electron affinity decreases from top to bottom in the periodic table because effective nuclear charge decreases, shielding effect increases, size of atom increases so hold of nucleus on outermost shell electrons decreases.

82. Define ionization energy.

Ans: The ionization energy of an element is the minimum quantity of energy which is required to remove an electron from the outermost shell of its isolated gaseous atom in its ground state.

For example,



83. What is the trend of ionization energy in the periodic table? OR Why ionization energy decreases down the group and increases along a period?

Ans: Ionization energy decreases from top to bottom in a group because shielding effect increases, effective nuclear charge decreases and size of atom increases so less energy is required to remove electron from the outermost shell as the hold of nucleus on the outer shell electron decreases. Ionization energy increases from left to right in a period as the shielding effect remains constant, effective nuclear charge increases and size of atom decreases so more energy is required to remove electron from the outermost shell as the hold of nucleus on the outer shell electron increases.

84. Define atomic radius.

Ans: Half of the distance between the centers of two bonded atoms is considered to be the radius

of the atom.

85. What is the trend of atomic radius in the periodic table?

Ans: Atomic radius decreases from left to right in periods of the periodic table as the shielding effect remains constant and effective nuclear charge increases so hold of nucleus on outermost shell electrons increases.

Atomic radius increases from top to bottom in a group because shielding effect increases and effective nuclear charge decreases so hold of nucleus on outermost shell electrons decreases. The trend of ionic radius is same.

86. Define Lanthanide contraction.

Ans: The lanthanide contraction is the greater-than-expected decrease in ionic radii of the elements of lanthanide series from atomic number 57, lanthanum, to 71, lutetium, which results in smaller than otherwise expected ionic radii for the subsequent elements starting with hafnium 72. It is due to the involvement of f sub-shells.

OR

The gradual or progressive decrease in the atomic size of the elements in the lanthanide series is significant and is called lanthanide contraction. Same decrease is observed in actinide series. This is due to poor shielding effect of f sub-shell which is being gradually filled along the series.

87. Lanthanide contraction controls the atomic sizes of elements of 6th and 7th periods.

Justify.

Ans: In Lanthanide and Actinide series there is a gradual decrease in the atomic size from left to right due to increased nuclear charge. The slow reduction in atomic size in both these series is called Lanthanide contraction. This contraction controls the size of 6th and 7th period elements.

88. Why size of cation is smaller than the parent atom?

Ans: The removal of electrons causes an imbalance in proton-electron ratio. Due to the greater attraction of the nuclear charge, the remaining electrons of the ion are drawn closer to the nucleus. A positive ion is always smaller than the neutral atom from which it is derived. The radius of Na is 157pm and the radius of Na^+ is 95pm.

89. Why size of anion is larger than the parent atom?

Ans: A negative ion is always bigger than its parent atom. The reason is that addition of one or more electrons in the shell of a neutral atom enhances repulsion between the electrons causing expansion of the shell. Thus, the radius of fluorine atom is 72pm and that of the fluoride ion (F^-) is 136pm.

90. What are isoelectronic species?

Ans: Ions with the same electronic configuration are called isoelectronic species. For example, Na^+ (10 electrons), Ne (10 electrons), Mg^{2+} (10 electrons), O^{2-} (10 electrons), N^{3-} (10 electrons), etc.

Chapter#2
s-Block Elements

1. What are alkali metals? Why are they called so?

Ans: The group IA elements i.e. Li, Na, K, Rb, Cs, Fr are called alkali metals. The name alkali came from Arabic which means 'The Ashes'. The Arabs used this term for these metals because they found that the ashes of plants were composed chiefly of sodium and potassium.

2. What are s-block elements?

Ans: The s-block elements are the metals in Group IA and Group IIA of the periodic table. They are called the s-block elements because s-orbitals are being filled in their outer most shells.

3. What are alkaline earth metals?

Ans: The alkaline-earth metals are beryllium, magnesium, calcium, strontium, barium and radium. They are called alkaline-earth because they produce alkalies in water and are widely distributed in earth's crust.

4. Mention the names and formulae of important minerals of alkali metals.

Ans: Lithium

Spodumene $\text{LiAl}(\text{SiO}_3)_2$

Sodium

Rock salt (Halite) NaCl

Chile salt petre NaNO_3

Natron $\text{Na}_2\text{CO}_3 \cdot \text{H}_2\text{O}$

Trona $\text{Na}_2\text{CO}_3 \cdot 2\text{NaHCO}_3 \cdot 2\text{H}_2\text{O}$

Borax $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$

Potassium

Carnallite $\text{KCl} \cdot \text{MgCl}_2 \cdot 6\text{H}_2\text{O}$

Sylvite KCl

Alunite (Alum Stone) $\text{K}_2\text{SO}_4 \cdot \text{Al}_2(\text{SO}_4)_3 \cdot 4\text{Al}(\text{OH})_3$

5. Give formulae of halite and natron.

Ans:

Halite NaCl

Natron $\text{Na}_2\text{CO}_3 \cdot \text{H}_2\text{O}$

6. Write any four points mentioning peculiar behaviour of lithium.

Ans: Following are the four points highlighting peculiar behaviour of lithium:

1. Lithium is much harder and lighter than the other alkali metals.
2. The lithium salts of anions with high charge density are generally less soluble in water than those of the other alkali metals, e.g. LiOH , LiF , Li_3PO_4 , Li_2CO_3 .
3. Lithium forms stable complex compounds, although complex formation generally is not a property of alkali metals. One of the stable complexes formed by lithium is $[\text{Li}(\text{NH}_3)_4]^+$
4. Lithium reacts very slowly with water, while other alkali metals react violently.

7. Write any four points mentioning peculiar behaviour of beryllium.

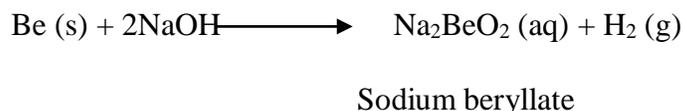
Ans: Following are the four points highlighting peculiar behaviour of beryllium:

1. Beryllium metal is almost as hard as iron and hard enough to scratch glass. The other alkaline earth metals are much softer than beryllium but still harder than the alkali metals.
2. The melting and boiling points of beryllium are higher than other alkaline earth metals.
3. As reducing agents, the group IIA metals are all powerful enough to reduce water, at least in principle. However, with water, beryllium forms insoluble oxide coating that protects it from further attack.
4. Beryllium in particular is quite resistant towards complete oxidation, even by acids, because of its

BeO coating.

8. Give the reaction of Be with NaOH.

Ans: Beryllium is the only member of its group which reacts with alkalis to give hydrogen. The other members do not react with alkalis.



9. Why alkali metals are good reducing agents?

Ans: Since alkali metals have got low ionization energies, so they are strong reducing agents. They are highly electropositive. They react readily with halogens giving alkali metal halides.

10. How alkali metals react with oxygen?

Ans: They react with oxygen and the surface is tarnished due to the oxides formed. Only lithium burns in air to form the normal oxide, Li_2O (white solid).



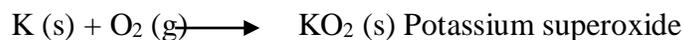
The exposed metals are oxidized almost immediately by oxygen in air, and in the presence of moisture. The oxides formed react with CO_2 in the atmosphere to form carbonates.



Sodium will undergo a similar reaction, but only if the supply of oxygen is limited. In the presence of excess of oxygen, sodium forms the pale yellow peroxide.



Potassium, rubidium and caesium react with oxygen to form superoxides (orange yellow). Caesium explodes spontaneously when it is in contact with air or oxygen.



11. How alkali metals react with water?

Ans: Very rapid reactions occur when alkali metals react with water. A small piece of sodium

(potassium or lithium) floated on water reacts vigorously to liberate hydrogen and produce metal hydroxide. The reaction is highly exothermic. The energy produced by the reaction may even ignite the hydrogen.



The reaction becomes increasingly vigorous from lithium to caesium. Potassium, rubidium and caesium are so highly reactive that they react with ice even at -100°C .

12. How alkali metals react with hydrogen?

Ans: Alkali metals form ionic hydrides with hydrogen.



Rubidium and caesium react violently with hydrogen at room temperature. The other three metals require elevated temperature in order to form the hydride.

13. How alkali metal hydrides react with water?

Ans: Lithium and sodium hydrides are useful sources of hydrogen when treated with water.



Due to the presence of hydride ion (H^-), the ionic hydrides are used as powerful reducing agents.

14. How lithium reacts with nitrogen and carbon?

Ans: Lithium is the only Group IA metal that combines with nitrogen and carbon to form nitride and carbide, respectively.



15. How alkali metals react with halogens?

Ans: Alkali metals react easily with halogens to give halides. Lithium and sodium, for example, react slowly with chlorine at room temperature. Molten sodium burns with a brilliant yellow flame

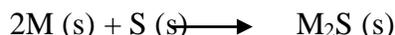
in a chlorine atmosphere to form sodium chloride.



Potassium, rubidium and caesium react vigorously with all the halogens, forming metal halides.

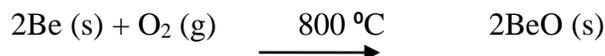
16. How alkali metals react with sulphur?

Ans: All alkali metals form their sulphides when treated with molten sulphur. The general reaction is:

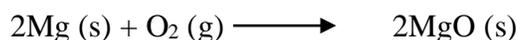


17. How alkaline-earth metals react with oxygen?

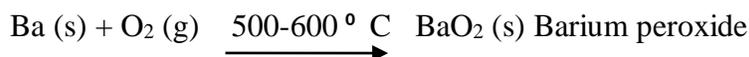
Ans: The alkaline-earth metals burn in oxygen to form oxides or in the case of barium, the peroxide. Beryllium is the least reactive metal in the group. It is resistant to complete oxidation and stable in air at ordinary temperature but oxidizes rapidly at about 800 °C. Therefore beryllium is not tarnished by atmospheric attack but the metal soon loses the silvery appearance.



When exposed to air magnesium quickly becomes coated with the layer of MgO. This layer protects the surface from further corrosion at ordinary temperature.

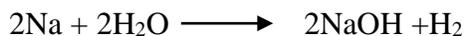


When magnesium is burnt in air a small amount of nitride is also formed along with magnesium oxide: When barium is heated in air or oxygen at 500 – 600°C, its peroxide is formed.



18. What are alkali metals? Why are they called so?

Ans: Group IA elements are called alkali metals because of their property to form strong alkalies with water.



19. What are alkaline earth metals? Why are they called so?

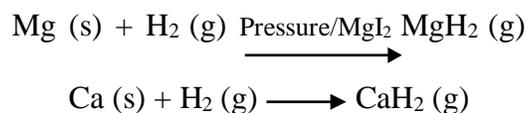
Ans: Group IIA elements are called alkaline earth metals because of their presence in the earth's crust and alkaline character.

20. Why alkali and alkaline earth metals are the most reactive elements of the periodic table?

Ans: Since ionization energies of alkali and alkaline earth metals are very low and they have large atomic sizes, therefore, they are the most reactive elements of the periodic table.

21. How alkaline-earth metals react with hydrogen?

Ans: Hydrides are produced by treating the molten alkaline earth metals with hydrogen, usually under high pressures. Magnesium reacts with hydrogen at high pressure and in the presence of a catalyst (MgI_2) forming magnesium hydride.



22. How alkaline earth metals react with nitrogen? What are the products of hydrolysis of their nitrides?

Ans: All Group II-A elements react with nitrogen on heating giving nitrides. For example, magnesium reacts with nitrogen to give magnesium nitride.

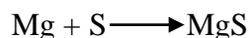


The nitrides hydrolyze vigorously when treated with water, giving ammonia and the respective hydroxides.



23. How alkaline earth metals react with sulphur?

Ans: With sulphur, magnesium gives magnesium sulphide, MgS . The other Group II-A metals also react similarly.



24. How alkaline earth metals react with halogens?

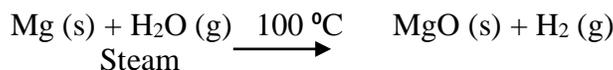
Ans: All group II-A elements react directly with halogens giving halides of the type MX_2 e.g.



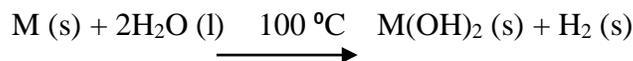
25. How alkaline earth metals react with water?

Ans: Magnesium is more reactive than beryllium, even though it is not attacked by cold water.

Magnesium reacts slowly with boiling water and quite rapidly with steam to liberate hydrogen.

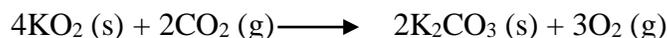


Beryllium does not react with water even at red hot temperature but remaining alkaline earth metals produce hydroxides with water.



26. Why KO_2 is used in breathing equipment by mountaineers?

Ans: Potassium superoxide (KO_2) has a very interesting use in breathing equipments for mountaineers and in space craft. It has the ability to absorb carbon dioxide while giving out oxygen at the same time.



27. What is the trend of solubility of alkaline earth metal oxides in water?

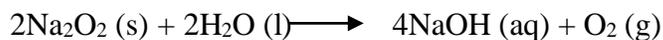
Ans: The solubility of alkaline earth metal oxides in water increases down the group. BeO and MgO are insoluble but CaO , SrO and BaO are soluble and react with water to form the corresponding hydroxides.

28. What is the trend of basic character of oxides of alkaline earth metals?

Ans: The basic character of the oxides of alkaline earth metals increases down the group. The tendency for group IIA oxides to form alkaline solution is relatively less than that of alkali metals.

29. The reaction of an alkali metal oxide with water is an acid-base reaction and not an oxidation reduction reaction. Justify.

Ans: The reaction of an alkali metal oxide with water is an acid-base reaction and not an oxidation reduction reaction since no element undergoes a change in its oxidation number. The reaction simply involves the decomposition of water molecule by an oxide ion.



30. Justify that BeO is amphoteric in nature.

Ans: BeO is amphoteric in nature since it reacts with both acids and bases.



Sodium beryllate

31. What is the effect of heat on alkali and alkaline earth metal hydroxides?

Ans: Alkali metal hydroxides are stable to heat except LiOH, while alkaline earth metal hydroxides like Mg(OH)₂ and Ca(OH)₂ decompose on heating.

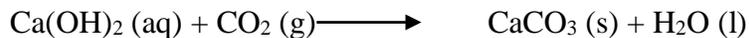


32. What is lime water and milk of magnesia?

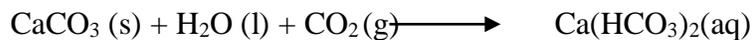
Ans: A saturated solution of Ca(OH)₂ in water is called lime water and is used as a test for CO₂. A suspension of Mg(OH)₂ in water is called milk of magnesia and it is used for the treatment of acidity in stomach.

33. Why lime water turns milky by passing CO₂ gas but becomes clear with excess of CO₂?

Ans: Lime water turns milky by passing CO₂ gas due to formation of insoluble CaCO₃



On further addition of CO_2 insoluble CaCO_3 changes into soluble $\text{Ca(HCO}_3)_2$



34. What is the trend of solubility of alkaline earth metal hydroxides?

Ans: The solubility of alkaline earth metal hydroxides in water increases down the group. Be(OH)_2 is quite insoluble. Mg(OH)_2 is sparingly soluble while Ba(OH)_2 is more soluble. This increase in solubility is due to low lattice energy of hydroxides which is, in turn, due to higher ionic size.

35. Tell about stability of alkali metal carbonates and their solubility in water.

Ans: The carbonates of alkali metals are all soluble in water and are stable towards heat except Li_2CO_3 which is not only insoluble but also decompose on heating to lithium oxide. The decomposition is made easy because the electrostatic attraction in converting from carbonate to oxide is considerable.

36. Why is it difficult to decompose potassium carbonate?

Ans: In case of large cation like K^+ in K_2CO_3 , the gain in electrostatic attraction is relatively much less and the decomposition is difficult.

37. What is washing soda?

Ans: At temperature below 35.2°C , Na_2CO_3 crystallizes out from water as $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$, which is called washing soda.

38. Why the solution of sodium carbonate in water is basic in nature?

Ans: The solution of Na_2CO_3 in water is basic due to hydrolysis of carbonate ion.



NaOH is a strong base and H_2CO_3 is a weak acid. So the solution is alkaline in nature.

39. Solution of Na_2O in water is alkaline. Justify the statement.

Ans: When Na_2O is dissolved in water, it produces NaOH which is a strong alkali. Hence, solution of Na_2O in water is alkaline.



40. What is the action of litmus with aqueous solution of Na_2CO_3 ?

Ans: The aqueous solution of Na_2CO_3 is alkaline due to formation of strong alkali NaOH and it turns litmus solution red.



41. Mention the trend of solubility of alkaline earth metal carbonates.

Ans: Unlike the alkali metal carbonates, the alkaline earth metal carbonates are only very slightly soluble in water, with the solubility decreasing down the group. They also decompose on heating and the ease of decomposition decreases down the group.



42. What is the relation between ease of decomposition and size of ion?

Ans: The ease of decomposition can be related to the size of the metal ion, the smaller the ion, the more is the lattice energy of the resulting oxide and hence higher the stability of the product.

43. Tell about the solubility of nitrates of both alkali and alkaline earth metals.

Ans: Nitrates of both alkali and alkaline-earth metals are soluble in water.

44. What is the effect of heat on nitrates of alkali and alkaline earth metals?

Ans: Nitrates of Li , Mg , Ca and Ba decompose on heating to give O_2 , NO_2 and the metallic oxide, whereas, nitrates of Na and K decompose to give different products.



45. Prove that decomposition of lithium nitrate gives different products than nitrates of other alkali metals?

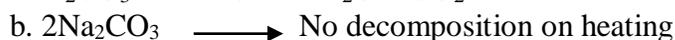
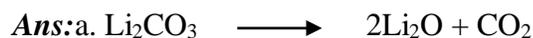
Ans: Decomposition of lithium nitrate gives different products than nitrates of other alkali metals as shown below:



46. What happens when:

a. Li_2CO_3 is heated

b. Na_2CO_3 is heated



47. How Plaster of Paris is prepared? OR How gypsum is converted into Plaster of Paris?

Ans: Calcium sulphate occurs in nature as gypsum $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$. When it is heated above 100°C , it loses three quarters of its water of crystallization, giving a white powder called Plaster of Paris.



48. Tell about solubility of alkali and alkaline earth metal sulphates.

Ans: All the alkali metals give sulphates and they are all soluble in water. The solubilities of sulphates of alkaline earth metals gradually decrease down the group. BeSO_4 and MgSO_4 are fairly soluble in water. CaSO_4 is slightly soluble, while SrSO_4 and BaSO_4 are almost insoluble.

49. What are the advantages of Down's cell?

Ans: Following are the advantages of Down's cell:

(a) The metallic fog is not produced.

(b) Liquid sodium can easily be collected at 600°C .

(c) Material of the cell is not attacked by the products formed during the electrolysis.

50. What are the problems faced and their solutions during the working of Nelson's

cell/diaphragm cell?

Ans: We can face two major problems during the working of the cell.

1. Chlorine produced can react with hydroxide ions in cold giving hypochlorite ions.



2. Hydroxide ions may be attracted towards anode, where they can be discharged releasing oxygen gas. This oxygen gas may contaminate the chlorine and renders it impure.

The first problem is solved by using asbestos diaphragm. This keeps the two solutions separate while allowing sodium ions to move towards the cathode. This movement of ions keeps the current following through the external current.

The second problem is solved keeping the level of brine in anode compartment slightly higher. This keeps the direction of flow of liquid toward the cathode and thus prevents the possibility of hydroxides ions to reach the anode.

51. What is the role of gypsum in plant growth?

Ans: Gypsum is applied to the soil as a source of calcium and sulphur. The calcium supplied by gypsum in fertilizers is of importance in crop production in area where soils are subject to extensive leaching.

52. What is the role of sulphur in plant growth?

Ans: Sulphur has been recognized as an essential constituent of plants. For centuries, sulphur compounds had been applied to soils because of their observed beneficial effect on plant growth. Aside from serving as a constituent of protein and various other compounds in plants, sulphur has an influence on chlorophyll development in plant leaves. Although not a constituent of chlorophyll, plants deficient in sulphur exhibit a pale green colour. The root systems of several plants have been observed to be greatly enlarged by the application of sulphur. It has been reported that good crops are produced by the application of sulphur containing materials such as gypsum.

53. What is dead burnt gypsum?

Ans: Gypsum must not be heated too strongly as the anhydrous salt is then formed which absorbs water slowly. Such plaster is called 'Dead burnt'.

54. What are the uses of Plaster of Paris?

Ans: Following are the uses of Plaster of Paris:

1. Plaster of Paris is used for making plaster walls, casts of statuary, coins, etc.
2. It is used in surgery, Plaster of Paris bandages are used for holding in place fractured bones after they have been set.

55. Mention the varieties of Plaster of Paris.

Ans: Following are the varieties of Plaster of Paris:

(1) Cement Plaster

It is Plaster of Paris to which usually glue or other oils have been added as retarders to prolong the time of setting.

(2) Hard Finish Plasters

These are made by the calcination of the anhydrous sulphate with alum or borax. These plasters are set very slowly but give a hard finish. When mixed with wood pulp and allowed to set in the form of boards, it forms a material, much used in the construction of buildings as wall boards and partitions.

Gypsum is also used as filler in paper industries.

56. Why 2% gypsum is added in cement?

Ans: About 2% of gypsum is added during grinding of cement clinkers which prevents the cement from hardening too rapidly. It increases the setting time of cement.

57. How acidic soil is treated?

Ans: Large quantities of calcium oxide are used in agriculture for neutralizing acidic soils. It has been found that application of lime (CaO) to acidic soils increases the amount of readily soluble

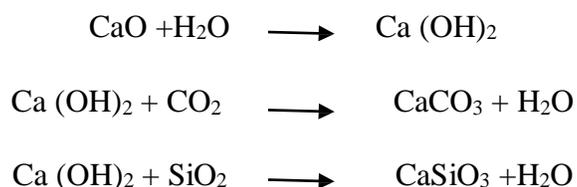
phosphorus.

58. What is the role of calcium in plant growth?

Ans: The presence of calcium is essential for the normal development of plants. The quantity of calcium required by different plants varies considerably. An adequate supply of calcium appears to stimulate the development of root hairs and, in fact, the entire root system. Calcium is also necessary for normal leave development and tends to accumulate in leaves as well as in bark. An adequate supply of calcium is also essential for the optimum activity of microorganisms that produce nitrates. The effect of calcium on the supply of available phosphorus in the soil is of special significance. Soils containing sufficient calcium are slightly alkaline in nature. When a deficiency of calcium exists various substances such as aluminium and manganese may accumulate in plants in harmful concentrations.

59. What is lime mortar?

Ans: Ordinary mortar, also called lime mortar, is prepared by mixing freshly prepared slaked lime (one volume) with sand (three or four volumes) and water to form a thick paste. This material when placed between the stones and bricks hardens or sets, thus binding the blocks firmly together. The equations for the chemical reactions which take place when mortar hardens are:



60. What is white-wash?

Ans: A suspension of the calcium hydroxide is called milk of lime and is used as a white-wash.

61. How lime and sand are used to make glass?

Ans: The ability of lime to react with sand at high temperature forming calcium silicate (CaSiO_3) serves as an important basis for glass manufacture. Lime is added in sand and on heating gets

converted to calcium silicate. Addition of lime in glass increases the hardness and chemical durability of glass.

Chapter#3
Group IIIA and Group IVA Elements

1. Name the ores of boron. (Formulae of individual ores can be asked)

Ans: Following are the ores of boron:

Borax or Tincal $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$

Colemanite $\text{Ca}_2\text{B}_6\text{O}_{11} \cdot 5\text{H}_2\text{O}$

Orthoboric Acid H_3BO_3

2. Name the ores of aluminium. (Formulae of individual ores can be asked)

Ans: Following are the ores of aluminium:

Feldspar KAlSi_3O_8 or $\text{K}_2\text{O} \cdot \text{Al}_2\text{O}_3 \cdot 6\text{SiO}_2$

Mica (Muscovite) $\text{KH}_2\text{Al}_3(\text{SiO}_4)_3$

Kaolin (Clay) $\text{H}_2\text{Al}_2(\text{SiO}_4)_2 \cdot \text{H}_2\text{O}$ or $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O}$

Corundum Al_2O_3

Emerald AlF_2SiO_4

Gibbsite $(\text{Al}_2\text{O}_3 \cdot 3\text{H}_2\text{O})$ or $\text{Al}(\text{OH})_3$

Bauxite $\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$

Cryolite Na_3AlF_6

Diaspore $\text{Al}_2\text{O}_3 \cdot \text{H}_2\text{O}$ or $\text{AlO}(\text{OH})$

3. Why boron shows different behaviour as compared to rest of the group members?

Ans: The difference in the properties of boron and those of the other members of the series is mainly due to the large difference in their sizes and ionization energies.

4. Write any four points mentioning peculiar behaviour of boron.

Ans: Following are the points mentioning peculiar behaviour of boron:

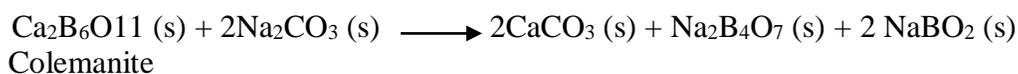
1. Boron is the only element in Group IIIA which is non-metallic in behaviour
2. It is the only element with less than four electrons in the outermost shell which is not a metal
3. Boron always uses all the three of its valence electrons for bonding purposes and its common oxidation states are + 3 and -3
4. One of the outstanding features of the chemistry of boron is its ability to form molecular addition compounds

5. Mention the methods of preparation of borax.

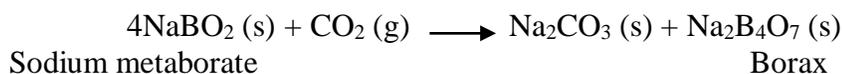
Ans: 1. Formally borax was manufactured by treating a hot solution of boric acid with the proper amount of soda ash.



2. Now-a-days borax is almost exclusively obtained from calcium borate. Finely powdered colemanite is boiled with Na_2CO_3 solution, when CaCO_3 precipitates out and a mixture of borax and sodium metaborate is formed.



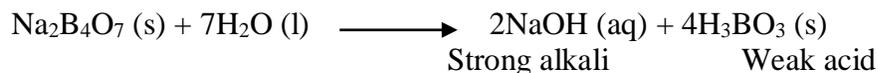
The clear solution from the top is taken off and is then allowed to crystallize, when crystals of borax separate out. To get more borax, CO_2 is blown through the mother-liquor, the sodium metaborate is decomposed into borax, which separates out in the form of fine crystals.



3. Borax may also be obtained from tincal ($\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$) by treating tincal with water and subsequently evaporating the clear solution, when crystals of borax separate out.

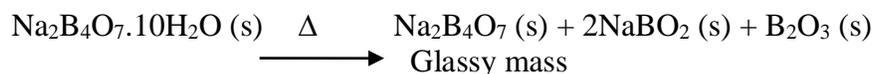
6. Why is the aqueous solution of borax alkaline in nature?

Ans: The aqueous solution of borax is alkaline in nature due to the formation of sodium hydroxide which is a strong base along with boric acid which is a weak acid. The overall solution is alkaline in nature due to the presence of a strong base.



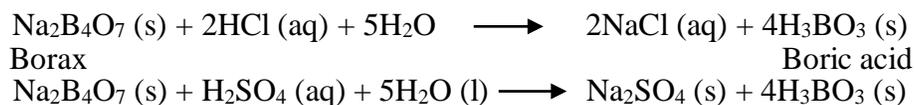
7. What is the effect of heat on borax?

Ans: When heated, borax loses water and swells up into a white porous mass due to the expulsion of water: on further heating it melts into a clear transparent glass, which dissolves many metallic oxides forming coloured beads. This reaction forms the basis of borax bead test.



8. How borax reacts with HCl and H₂SO₄?

Ans:



9. How borax reacts with ammonium chloride?

Ans:

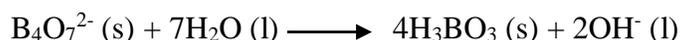


10. How borax is ionized?

Ans: Borax when dissolved in water ionizes as:



Hydrolysis of $\text{B}_4\text{O}_7^{2-}$ occurs as follows:



So, a strong alkali (NaOH) is formed which is highly ionized. On the other hand, boric acid (H_3BO_3) is ionized to a little extent, because it is a weak acid. Hence, solution of borax as a whole is alkaline in nature.

11. Give chemistry of borax bead test.

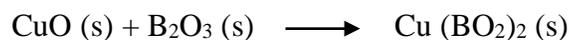
Ans: Prepare a loop at the end of a platinum wire. Heat the wire and take a little powdered borax on the hot loop. Heat again, borax first swells up and then melts into colourless, glasslike bead on the loop. Now put a few grains of the substance, under examination, on the beads and re-heat it first in the oxidizing flame and then in the reducing flame.

Chemistry of the Borax-bead Test:

Borax, when fused, is decomposed into sodium metaborate and boric anhydride.



The metallic oxide formed from the substance, under examination, combines with B_2O_3 giving the coloured metallic borates. With cupric oxide, the beads are coloured blue in the oxidizing flame because cupric borates are blue in colour.



12. Give uses of borax OR Give any two uses of borax OR Give any four uses of borax.

Ans: Following are the uses of borax:

1. It is used to prepare borate glass, which is heat resistant.
2. It is used in softening of water.
3. It is employed in borax bead test, for the detection of metallic cations.
4. It is used in metallurgical operations.
5. It is used as a flux in welding and in metallurgy.
6. It is employed in making washing powders.
7. It is used in leather industry for tanning and dyeing.

8. It is used in cosmetics, soaps, textiles, paints, medicine, match industry and as a preservative.

13. Name the important boric acids.

Ans: Following are the names and formulae of different boric acids:

(i) Orthoboric Acid, H_3BO_3

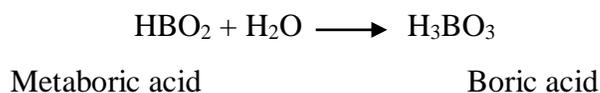
(ii) Metaboric Acid, HBO_2

(iii) Tetraboric Acid, $H_2B_4O_7$

(iv) Pyroboric Acid, $H_6B_4O_9$

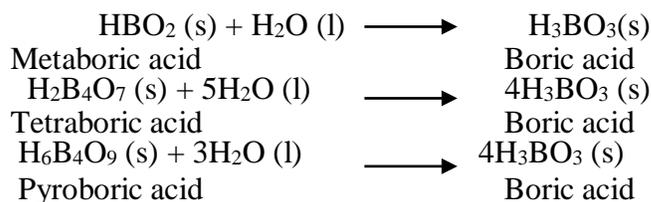
14. What is boric acid?

Ans: Boric acid (H_3BO_3) is a white lustrous crystalline solid having a soft soapy touch, which is very slightly soluble in cold water but, fairly soluble in hot water. It is formed when water is added into metaboric acid (HBO_2)



15. What are the products of hydrolysis of different boric acids?

Ans: The product of hydrolysis of all the boric acids is orthoboric acid, being the most stable one.

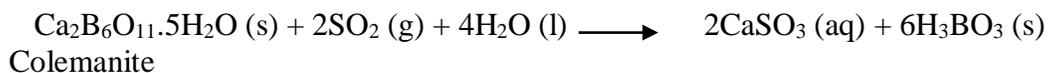


16. How is boric acid prepared on commercial level?

Ans: From Colemanite

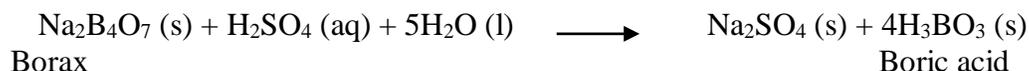
On commercial scale, boric acid is prepared from a natural calcium borate called colemanite ($Ca_2B_6O_{11} \cdot 5H_2O$) by suspending it in boiling water while, sulphur dioxide is passed through it.

Boric acid crystallizes out from the solution while, the other product CaSO_3 remains in the solution.



From Borax

A hot concentrated solution of borax is treated with a calculated quantity of conc. H_2SO_4 . On cooling, crystals of boric acid formed separate out.



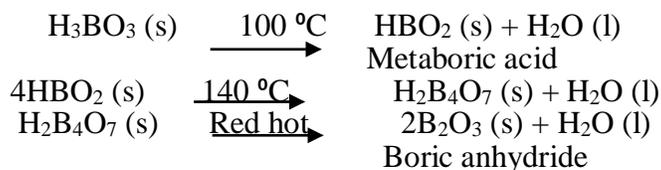
17. How boric acid reacts with ethanol?

Ans: It reacts with ethyl alcohol forming ethyl borate.



18. What is the effect of heat on boric acid?

Ans: When heated strongly, it swells to frothy mass losing water molecules. It is first converted into metaboric acid, then to tetra boric acid and finally to boric anhydride.



19. How is the boric acid ionized? OR Show that H_3BO_3 is a monobasic acid.

Ans: It is a very weak acid and ionizes to a very limited extent mainly as a monobasic acid.



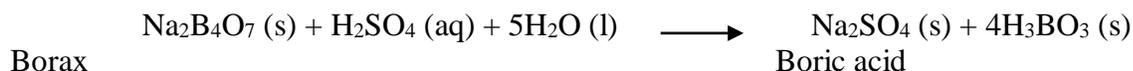
It releases only one H^+ ion in solution. From this it can be easily evident that H_3BO_3 is a monobasic acid.

20. How boric acid reacts with sodium hydroxide? OR How will you convert boric acid into borax and vice versa?

Ans: Boric acid is partially neutralized by caustic soda to give borax.

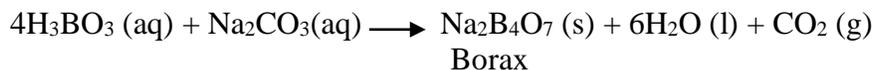


A hot concentrated solution of borax is treated with a calculated quantity of conc. H_2SO_4 . On cooling, crystals of boric acid formed separate out.



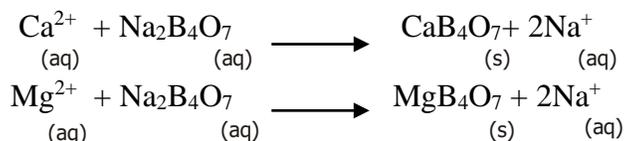
21. How boric acid reacts with soda ash (Na_2CO_3)?

Ans: When boric acid is neutralized by soda ash (Na_2CO_3), borax is obtained.



22. How does borax serve as a water softening agent?

Ans: Hardness in water is because of Ca^{2+} and Mg^{2+} . Borax has ability to remove Ca^{2+} and Mg^{2+} ions from water as calcium tetra-borate and magnesium tetra-borate and hence borax can be used as a water softening agent.



23. What are the uses of boric acid?

Ans: Following are the uses of boric acid:

1. Boric acid is used in medicines as an antiseptic, e.g. dusting powder, boric ointment and boric solution is used as an eye-wash.
2. It is used in pottery as a glaze because borate glazes are more fusible than silicate glazes and possess a higher coefficient of expansion.
3. It is also used in candle industry for stiffening of wicks.

24. Give reaction of aluminium with air.

Ans: When a piece of aluminium sheet is exposed to moist air it acquires a thin, continuous coating of aluminium oxide, which prevents further attack on the metal by atmospheric oxygen and water under normal conditions. Because of this aluminium sheets are said to be corrosion-free. However, if the aluminium powder is heated to 800°C and above, the metal will react with air to form aluminium oxide, Al₂O₃, and aluminium nitride, AlN. The reaction is accompanied by the evolution of heat and intense white light. This property of aluminium is made use of in flash light photography.

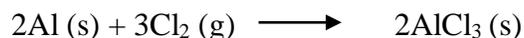


25. Why is aluminium not found as a free element?

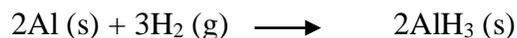
Ans: Aluminium does not exist in free state because it is a highly reactive metal. It is third most abundant element of earth crust and mostly found in the form of alumino-silicates.

26. How aluminium reacts with non-metals?

Ans: Heated aluminium combines with the halogens, sulphur, nitrogen, phosphorus and carbon, accompanied by the evolution of heat.



Aluminium on heating with hydrogen forms aluminium hydride.

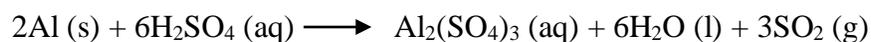


27. Give reactions of aluminium with acids and alkalies.

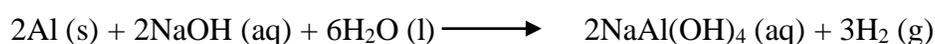
Ans: Aluminium is amphoteric. It dissolves in both acids and bases with the liberation of hydrogen gas. Aluminium reacts slowly with dilute acid and more rapidly with concentrated hydrochloric acid to displace hydrogen.



Aluminium does not react with dilute sulphuric acid. However, it is oxidized by hot concentrated sulphuric acid to liberate sulphur dioxide gas.



Aluminium does not react with nitric acid at any concentration, probably because of the formation of protective layer of aluminium oxide. The acid is said to render the aluminium passive. Nitric acid is, therefore, frequently transported in aluminium containers. Aluminium dissolves in both sodium and potassium hydroxides to form a soluble aluminate, with the evolution of hydrogen.



28. Give uses of aluminium OR Give any four uses of aluminium.

Ans: 1. Aluminium is very-light (nearly three times less dense than iron) but possesses high tensile strength. These properties account for its extensive use in the transport industries, in the construction of aircrafts, ships and cars.

2. It is an excellent conductor of both electricity and heat. Thus, it is used as heat exchanger in chemical, oil and other industries. Heavy duty electrical cables are made of aluminium metal.

3. Aluminium is an excellent reflector of radiant energy. For this reason, it is commonly used to insulate buildings. Aluminium foil is also used to jam radar.

4. It is non-magnetic and is thus used in navigational equipment.

5. It is a good reducing agent and can thus be used for this purpose in the chemical and steel industries.

6. It is non-toxic and can be used for making food and brewing equipments and in packaging.

7. Aluminium readily forms alloys with other metals like copper, magnesium, nickel and zinc.

8. At homes, aluminium is found in the form of cooking utensils, window frames and kitchen foil.

9. Aluminium is used for making petrol and milk storage tanks because it reflects heat and prevents them of being over heated in the sun.

29. How Al finds its uses in metallurgy and photoflash bulbs?

Ans:

Use in metallurgy

Aluminum being highly reactive is used in the extraction of chromium and manganese from their oxides. Al reduces oxides of these metals.



Use in photoflash bulbs

Photoflash bulbs are made up of glass containing a thin filament or foil of Aluminum. Bulb is filled with oxygen at low pressure. The foil is ignited using electricity. Oxygen atmosphere increases the brilliance of the flash.

30. Mention the peculiar behaviour of carbon.

Ans: Carbon differs from the remaining members of Group IV-A in the following respects:

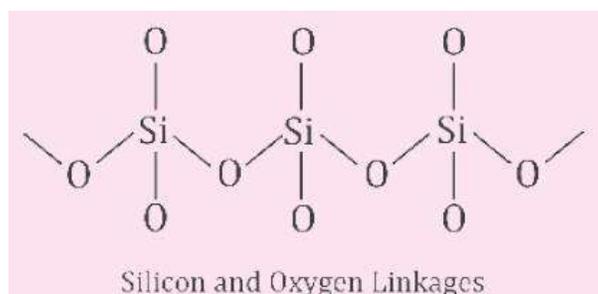
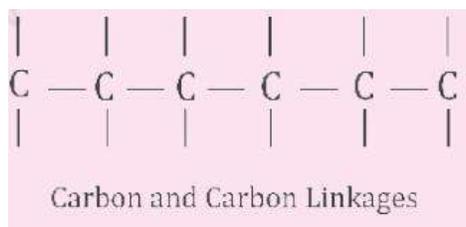
1. Carbon and silicon are nonmetals while the other members of the family are metalloids or metals.
2. Catenation or self linkage. Carbon has a tendency to form long chains of identical atoms. The type of linkage of identical atoms with each other is called catenation or self-linkage. The property of catenation decreases on moving down the group from carbon to lead.

31. How are carbon and silicon different from rest of the group members? OR Mention points of similarity between carbon and silicon.

Ans: Carbon and silicon are the only non-metals in Group IVA. Carbon has the peculiar property of forming long carbon chains, silicon forms long chains of alternating silicon and oxygen atoms.

1. Carbon and silicon both form acidic oxides, whereas the oxides of germanium, tin and lead are amphoteric in nature.

2. Both carbon and silicon form covalent bonds. Their oxides are acidic and both form hydrides and chlorides.



32. What is inert pair effect?

Ans: The pair of valence electrons that do not readily take part in chemical combination is termed as inert pair. The inert pair effect is most marked in the element of highest atomic mass, namely lead.

33. Mention the common properties of group IVA elements.

Ans:

1. All the elements of this group show a valency of four.
2. All of them form hydrides, MH_4
3. They form tetrachlorides, MCl_4
4. They also form the dioxides, MO_2

34. How does carbon exist in nature?

Ans: Carbon occurs naturally in the two states. One is crystalline (graphite, diamond) form and the other is amorphous (coal, charcoal) form.

Limestone (calcite)

$CaCO_3$

Dolomite $\text{MgCO}_3 \cdot \text{CaCO}_3$

Magnesite MgCO_3

35. Name the ores of silicon. (Formulae of individual ores can be asked)

Ans: Following are the ores of silicon:

Analcite (a zeolite) $\text{NaAl}(\text{SiO}_3)_2 \cdot \text{H}_2\text{O}$

Asbestos $\text{CaMg}_3(\text{SiO}_3)_4$

Kaolin (pottery clay) $\text{H}_2\text{Al}_2(\text{SiO}_4)_2 \cdot \text{H}_2\text{O}$ or $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O}$

Zircon ZrSiO_4

Talc (or soapstone) $\text{H}_2\text{Mg}_3(\text{SiO}_3)_4$

36. Name the oxides of carbon.

Ans: Three oxides of carbon are known:

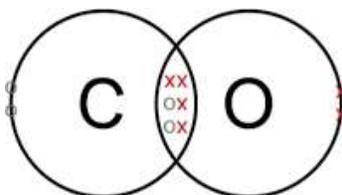
(i) Carbon monoxide, CO

(ii) Carbon dioxide, CO_2

(iii) Carbon suboxide, C_3O_2

37. Tell about the structure of carbon monoxide.

Ans: Carbon monoxide is diatomic molecule having triple bond between the two atoms. It is very slightly polar. The electronic structure of carbon monoxide can be represented as



It is usually written as:



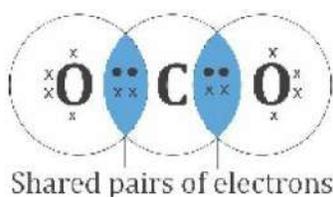
It might appear from the above structure that the molecule should have a large dipole moment, but

in fact the molecule has a small dipole moment (0.112D).



38. Tell about the structure of carbon dioxide OR How CO₂ is non-polar?

Ans: Carbon dioxide exists in the gaseous state as linear molecules. The observed C-O bond distance is 115 pm. Solid CO₂ has a face-centered cubic structure. Being linear its dipole moment is zero.



39. How CO₂ is acidic in nature?

Ans: Carbon dioxide is a non-metal oxide so when it is dissolved in water it changes into carbonic acid. Hence, it is acidic in nature.



40. Mention the properties of vitreous silica.

Ans: Vitreous silica possesses the following interesting and useful properties.

1. High transparency to light.
2. Very refractory, does not soften below 1500 to 1600°C.
3. Very low thermal expansion.
4. Excellent insulator.
5. Hard, brittle and elastic.
6. Insoluble in water and inert toward many reagents.
7. It is resistant towards all acids except HF.

41. Both carbon and silicon have four electrons in their valence shells and both also form four

covalent bonds. So, why should there be a big difference between CO_2 and SiO_2 ? OR Why CO_2 is a gas while SiO_2 is a solid?

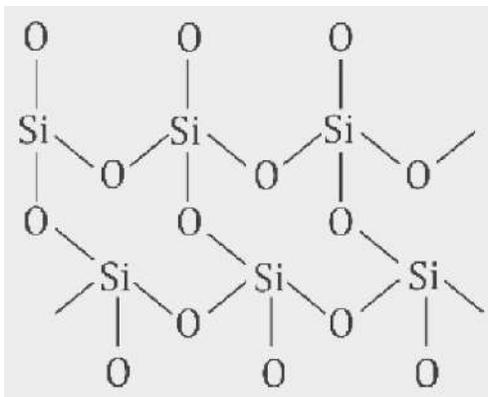
Ans: Silicon atoms are much larger than carbon atoms and thus tend to surround themselves with more oxygen neighbours; silicon forms only single bonds to oxygen atoms whereas carbon may form double bonds. Carbon, in fact, forms double bonds to each of the two oxygen atoms to produce a small, symmetrical, linear molecule CO_2 , which is volatile and reasonably reactive.

42. Tell about the structure of silicon dioxide.

Ans: The silicon atom can be approached closely by four oxygen atoms and forms a single bond to each at tetrahedral angles. This structure can be continued in three dimensions to produce a continuous giant silicon oxygen network extending out to give the massive silicon dioxide crystal. In the interior of the silica network every silicon atom is bonded tetrahedrally to four oxygen atoms and every oxygen atom is bonded to two silicon atoms. The overall ratio of silicon to oxygen atoms is 1:2 and the simplest formula for silica therefore is SiO_2 .

The silicon oxygen bonds are strong and keep the atoms firmly in place. It is not the molecular formula for silica but the whole chunk of silica must be considered to be essentially one molecule. The atoms of silicon and oxygen at the surface of the chunk do not have all their valence forces satisfied, as is shown by the high surface activity of silica.

The regular tetrahedral arrangement of four oxygen atoms around each silicon persists in each crystalline form but the Si-O-Si bond angles and the rotation about each Si-O bond are different in the different polymorphic species.



43. What is silica glass?

Ans: When crystalline silica is heated sufficiently it melts to give a viscous liquid having a random structure, presumably with the silicon atoms still on the average close to four oxygen atoms and the oxygen atoms close to two silicon atoms. When this liquid silica is cooled it does not crystallize readily, but usually it under supercools tremendously and eventually becomes rigid without having undergone orientation into a regular crystal pattern. This rigid, highly under super cooled liquid is called vitreous silica or silica glass.

44. What are silicates?

Ans: The compounds derived from silicic acids are termed as silicates. For example, sodium silicate, aluminium silicate, talc or soapstone and asbestos.

45. How sodium silicate is prepared?

Ans: This is sodium salt of metasilicic acid H_2SiO_3 It is known as water glass or soluble glass. It is prepared by fusing sodium carbonate with pure sand. The process is carried out in a furnace called reverberatory furnace.



46. Mention the uses of sodium silicate.

Ans: Following are the uses of sodium silicate:

1. It is used as a filler for soap in soap industry.

2. It is used in textile as a fire proof.
3. It is used as furniture polish.
4. It is also used in calico printing.

47. What is chemical garden?

Ans: When crystals of soluble coloured salts like nickel chloride, ferrous sulphate, copper sulphate or cobalt nitrate, etc. are placed in a solution of sodium silicate, they produce a very beautiful growth, like plant, which is called chemical garden.

48. How is aluminium silicate obtained? OR How weathering phenomenon converts potassium feldspar into clay?

Ans: Many important silicate rocks contain aluminium. The weathering of these rocks results in the disintegration of the complex silicates which they contain. The boiling and freezing of water in the rocks, and the chemical action of water and carbon dioxide convert these compounds into potassium carbonate, sand and clay. The following reaction explains the weathering of potassium feldspar.



49. What is glazing?

Ans: Stoneware is usually glazed to give it a less porous surface by throwing salt upon the articles while they are hot. This treatment produces sodium aluminate and sodium aluminium silicate, which melt readily and cover the entire surface. When the article cools, the covering solidifies, producing a compact, smooth, waterproof surface.

50. Borate glazes are better than silicate glazes. Explain.

Ans: Borate glazes are used in potteries which are more fusible than silicate glazes and possess higher co-efficient of expansion. In this way, borate glazes are better than silicate glazes.

51. What is China ware?

Ans: China wares are made from a mixture of kaolin, bone ash, and feldspar; the mixture fuses when heated and fills the pores between the grains of kaolin.

52. What is talc or soapstone?

Ans: The magnesium silicate, $Mg_3H_2(SiO_3)_4$, is commonly known as talc or soapstone. It is physically greasy to touch. Therefore it is used in making cosmetics. It is also used in making household articles.

53. What is asbestos?

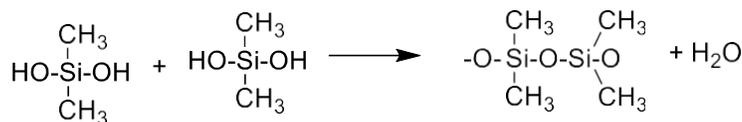
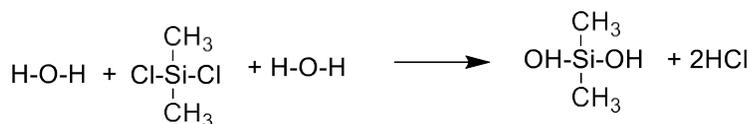
Ans: Asbestos is hydrated calcium magnesium silicate $CaMg_3(SiO_3)_4$. It is commonly used in making incombustible fabrics and hardboard, etc.

54. How acidic soil is treated?

Ans: Large quantities of calcium oxide are used in agriculture for neutralizing acidic soils.

55. What are silicones?

Ans: If a compound of silicon containing chlorine atoms and methyl groups, $SiCl_2(CH_3)_2$, is allowed to react with water, hydrogen chloride (HCl) comes out, and the silicon atoms join together through oxygen atoms.



Such a compound is called a silicone; this one is a methyl silicone. Other alkyl groups may also be substituted for the methyl groups and the molecular chain can be made of various lengths.

56. Why silicone oil is preferred over ordinary lubricant?

Ans: If the temperature is dropped from 100°C to 0°C the viscosity of petroleum oil may increase about one hundred folds, whereas that of silicone oil will increase less than four folds. In the presence of air or oxygen at temperature as high as 300°C, silicone oils remain free from acid formation, oxidation and similar phenomena, which frequently limit the usefulness of petroleum products and other synthetic organic liquids.

57. Mention any four uses of silicones OR Mention any two uses of silicones.

Ans:1. Some of the methyl silicones are oily liquids and they become more viscous as the chain length increases. They are used as lubricants, either incorporated in greases or as oils, in bearings, gears, etc. They are also used in hydraulic brakes and other hydraulic systems.

2. The outstanding physical attribute of silicone oil is its very small change in viscosity with change in temperature, compared with the behaviour of other oils of similar viscosity. If the temperature is dropped from 100°C to 0°C the viscosity of petroleum oil may increase about one hundred folds, whereas that of silicone oil will increase less than four folds. In the presence of air or oxygen at temperature as high as 300°C, silicone oils remain free from acid formation, oxidation and similar phenomena, which frequently limit the usefulness of petroleum products and other synthetic organic liquids.

3. Methyl silicones of high molecular mass resemble rubber and are used in making rubber like tubing and sheets.

4. Silicone molecules can be made in such a way that bridges, or cross linkages bind one long molecule to another at several points along the chain. These compounds have resinous properties and are extensively used in electrical insulation.

5. Another interesting and important application of silicones is their use in the treatment of various surfaces to make them water repellent. A silicone film covers the surface and repels water like a grease film. Much of the leak of electricity through the moisture film on ceramic electrical

insulators can be prevented by a silicone film; cloth, plastics, asbestos, glass, leather, and paper, even filter paper and blotting paper become strongly water repellent when covered with a silicone film.

58. What are semiconductors? Give examples.

Ans: A semiconductor is a substance that has different resistances to the passages of an electric current under different circumstances. Semiconductors include the elements germanium, selenium and silicon, and the compounds lead sulphide, silicon carbide, cadmium sulphide, lead telluride, gallium arsenide and indium antimonide.

59. What is the effect of increase of temperature on semiconductors?

Ans: In semiconductors flow of electricity increases by increasing temperature because as the temperature increases the number of free moving electrons increase in case of semiconductors, thereby, increasing the flow of electricity.

60. Name the lead compounds used in paints.

Ans: Following are the lead compounds used in paints:

- i. Lead suboxide Pb_2O
- ii. Lead Monoxide (Litharge, Massicot) PbO
- iii. Triplumbic Tetraoxide, (red lead, minium), Pb_3O_4
- iv. Lead Dioxide, PbO_2
- v. White Lead $2PbCO_3.Pb(OH)_2$
- vi. Lead Chromate ($PbCrO_4$)

61. Tell about lead chromate. Give uses.

Ans: It is used as a pigment under the name of chrome yellow. Orange or red basic lead chromates are formed when lead chromate is boiled with dilute alkali hydroxide and are used as pigments. The stable yellow modification of lead chromate is monoclinic. Mixture of lead chromate with lead

sulphate or barium sulphate is also used as yellow pigments.

62. Tell about white lead. Give uses.

Ans: Basic lead carbonate $2\text{PbCO}_3 \cdot \text{Pb(OH)}_2$ is an amorphous white pigment. It mixes readily with linseed oil and has a good covering power. If improperly prepared, it becomes crystalline and its covering power is reduced. White lead is not suitable for use as a good pigment since it is darkened by the hydrogen sulphide which is frequently present in the atmosphere.

63. Tell about lead dioxide. Give uses.

Ans: When red lead is treated with concentrated nitric acid, it is decomposed into lead nitrate and lead dioxide.



Lead dioxide is a reddish brown powder. It is not very soluble in water, but it does dissolve in alkaline water to yield soluble plumbates. It is not affected by dilute acids.

64. Tell about triplumbic tetraoxide. Give uses.

Ans: When lead is heated in air at about 340°C , it absorbs oxygen and forms a bright scarlet crystalline powder of red lead or minium.



It decomposes at 470°C



Red lead is used for a variety of purposes. Its principal uses are in the manufacture of storage batteries, as a pigment in paints applied to steel and iron to retard corrosion, and as an ingredient in the manufacture of flint glass, matches and ceramic glazes.

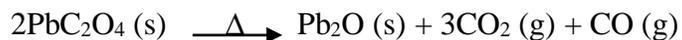
65. Tell about lead monoxide. Give uses.

Ans: Litharge varies in colour from pale yellow to reddish yellow, possibly owing to the existence

of two forms, a rhombic (yellow) and a tetragonal (red). It is slightly soluble in water. It is usually used in preparing flint glass and paints. If litharge is boiled with water and olive oil, lead oleate which is a sticky adhesive mass is formed and glycerin passes into solution. Litharge is used in preparing oils and varnishes and in the manufacturing of flint glass.

66. Tell about lead suboxide. Give uses.

Ans: It is black powder, obtained on heating plumbous oxalate in the absence of air.



Pb_2O is decomposed by heat into Pb and PbO . Other than pigment it is also used in the manufacture of lead storage batteries.

Chapter#4

Group VA and Group VIA Elements

1. Name the members of VA group.

Ans: Nitrogen (N), Phosphorus (P), Arsenic (As), Antimony (Sb), Bismuth (Bi)

2. Why phosphorus can make three and five covalent bonds?

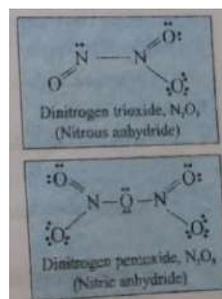
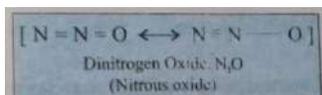
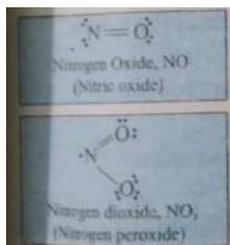
Ans: In phosphorus one of the 3s electrons can be promoted to a vacant 3d orbital giving 5 unpaired electrons in the valence shell. Phosphorus can thus make three or five covalent bonds. Indeed three and five are the common valencies of the group VA elements.

3. Why the elements of VIA other than oxygen show more than two oxidation states?

Ans: Except oxygen the other members of the group show a co-valency of +2, +4, and +6, for example, SCl_2 , SCl_4 , SCl_6 . +2 oxidation state is shown due to 2 unpaired electrons in the p-orbitals. +4 oxidation state is shown when 1 electron from p-orbital is promoted to the next vacant d-orbital, while +6 oxidation state is shown when another electron from s-orbital is also promoted to the next vacant d-orbital.

4. Name the oxides of nitrogen.

Ans: Nitrogen forms several oxides with oxygen. Common oxides of nitrogen are N_2O , NO and NO_2 . It also forms N_2O_3 and N_2O_5 .



5. How dinitrogen oxide is prepared? OR Give any two methods of preparation of N_2O .

Ans: 1. Dinitrogen oxide can be prepared by the action of dil. HNO_3 , on metallic zinc.



2. It is usually prepared by heating ammonium nitrate to about $200^\circ C$.



6. How sulphur and phosphorus are burnt using dinitrogen oxide?

Ans: It is not combustible but resembles oxygen in rekindling a glowing splinter. Similarly, it supports combustion of burning substances, such as sulphur, phosphorus, etc. are taken in the cylinder containing this gas.



7. How is dinitrogen oxide reduced?

Ans: When N_2O is passed over red hot copper, it is reduced to nitrogen.

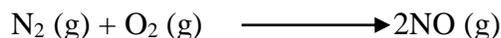


8. How is nitrogen oxide prepared? OR Give any two methods of preparation of NO .

Ans: 1. Nitrogen oxide can be prepared by the action of dil HNO_3 on copper.

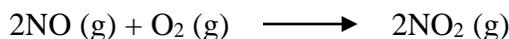


2. It can also be prepared by passing air through an electric arc.



9. How nitrogen oxide reacts with oxygen?

Ans: With oxygen, it forms reddish brown nitrogen dioxide.



10. How nitrogen oxide decomposes?

Ans: It decomposes into N₂ and O₂ at about 1000°C and supports combustion.



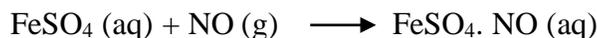
11. How nitrogen oxide reacts with chlorine?

Ans: It forms nitrosyl chloride and nitrosyl bromide with chlorine and bromine, respectively in the presence of charcoal.



12. What is ring test? or Describe "Ring test" for the confirmation of the presence of nitrates in solution.

Ans: Nitrogen oxide forms a brown coloured addition compound with FeSO₄. This test is used to confirm the presence of nitrates (Ring Test).



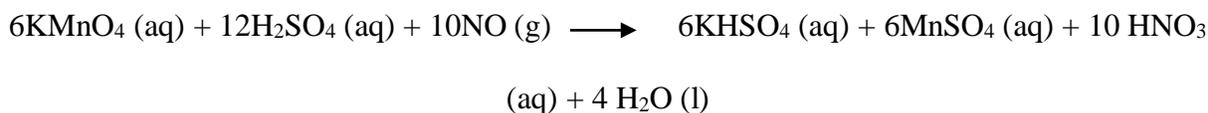
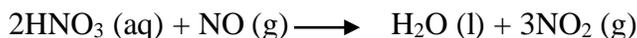
13. Give reaction of nitrogen oxide with reducing agents OR How NO is reduced?

Ans: With reducing agents, it is reduced to nitrous oxide or nitrogen.



14. Give reaction of nitrogen oxide with oxidizing agents OR How NO is oxidized?

Ans: Oxidizing agents can oxidize NO to NO₂ or HNO₃.

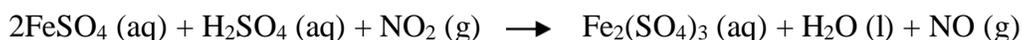


15. How is nitrogen dioxide prepared? OR How NO₂ is prepared from i. Lead nitrate ii. copper nitrate?



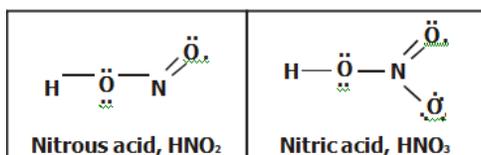
20. How nitrogen dioxide acts as an oxidizing agent?

Ans: It is a strong oxidizing agent and oxidizes H_2S to sulphur, ferrous sulphate to ferric sulphate and KI to I_2 .



21. Name the oxyacids of nitrogen.

Ans: There are two important oxyacids of nitrogen, nitrous acid and nitric acid.

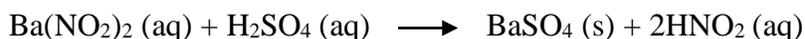


22. How nitrous acid is prepared?

Ans: 1. It can be prepared by dissolving dinitrogen trioxide in water at 0°C .



2. Pure nitrous acid solution can be prepared by reaction between ice cold barium nitrite solution and ice cold dilute sulphuric acid.



23. How is nitrous acid decomposed?

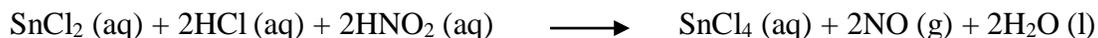
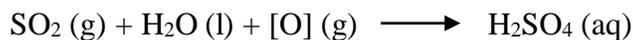
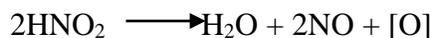
Ans: It begins to decompose almost as soon as it is formed even at ordinary temperature.



24. How nitrous acid acts as an oxidizing agent?

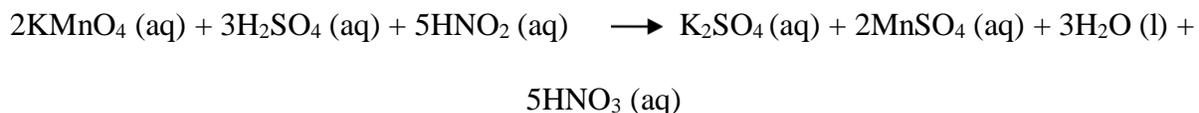
Ans: It acts as an oxidizing agent and oxidizes HI, SO_2 and SnCl_2 into I_2 , H_2SO_4 and SnCl_4 ,

respectively.



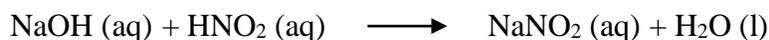
25. Give reaction of nitrous acid with acidified KMnO_4 and bromine water. OR How nitrous acid acts as a reducing agent?

Ans: Nitrous acid decolourizes acidified KMnO_4 and bromine water. It readily gets oxidized to nitric acid, so it also behaves as a reducing agent.



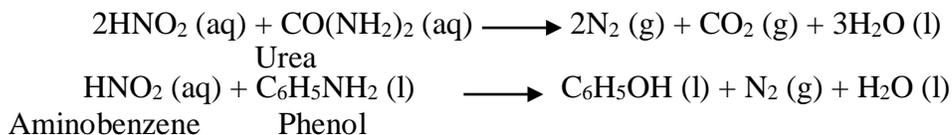
26. How nitrous acid reacts with alkalies?

Ans: As an acid it reacts with alkalies producing salts.



27. How nitrous acid reacts with organic compounds?

Ans: It also reacts with organic compounds containing NH_2 group and produces nitrogen.



28. How is nitric acid prepared?

Ans: In the laboratory, nitric acid is prepared by heating potassium nitrate crystals with concentrated sulphuric acid.



29. Which steps are involved in Birkeland and Eyde's process?

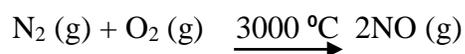
Ans: Following steps are involved in Birkeland and Eyde's process:

1. Formation of nitric oxide
2. Formation of nitrogen dioxide
3. Formation of nitrous acid
4. Formation of nitric acid

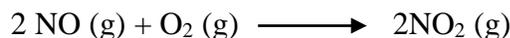
30. Give the reactions involved in Birkeland and Eyde's process.

Ans: Following reactions are involved in Birkeland and Eyde's process:

1. Formation of nitric oxide



2. Formation of nitrogen dioxide



3. Formation of nitrous acid



4. Formation of nitric acid



31. How is nitric acid decomposed?

Ans: Nitric acid is decomposed in the presence of light even at ordinary temperature.



32. Mention reaction of nitric acid with bases.

(All These reactions can come as separate short questions also. Learn any two reactions as answer to this)

Ans: It is a very strong acid. It exhibits all the usual general properties of acids in all reactions

where its oxidizing properties are not shown. It reacts in normal way with basic oxides, hydroxides and carbonates forming respective salts.



33. Mention action of nitric acid as an oxidizing agent. (Mention any four reactions for answer to short question. All reactions mentioned can come as separate short question)

Ans: (i) It acts as a strong oxidizing agent due to the ease with which it is decomposed.



(ii) It oxidizes non-metals to their corresponding oxides.



(iii) Metalloids like arsenic and antimony can be oxidized to their corresponding acids.



34. How nitric acid reacts with metals?

(All These reactions can come as separate short questions also. Learn any four reactions as answer to this)

Ans: Nitric acid behaves differently with different metals.

(a) Gold, platinum, iridium and titanium do not react.

(b) Iron, cobalt, nickel, chromium, aluminium are rendered passive by acid due to the formation of a film of their oxides over them .

(c) Tungsten and uranium are changed into their oxides.

(d) Magnesium, calcium and manganese give hydrogen with dilute nitric acid.



(e) Copper and lead give nitric oxide with dilute acid and nitrogen dioxide with concentrated acid.



(f) Mercury gives mercurous nitrate and nitric oxide with dilute nitric acid.



With concentrated acid, it gives mercuric nitrate and NO_2



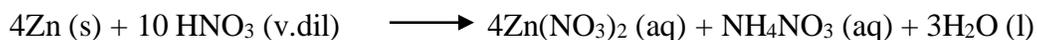
(g) Silver reacts with nitric acid to give silver nitrate and nitric oxide



(h) Dilute nitric acid gives ammonium nitrate, when it reacts with tin. With concentrated acid meta-stannic acid is produced.

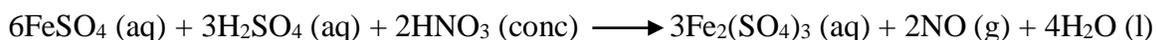


(i) Zinc gives different products depending upon the concentration of acid and temperature. Very dilute nitric acid gives NH_4NO_3 . Moderately dilute nitric acid gives nitrous oxide while concentrated nitric acid gives NO_2 .



35. How nitric acid reacts with reducing agents?

Ans: Reducing agents like FeSO_4 , H_2S and HI are converted to $\text{Fe}_2(\text{SO}_4)_3$, S and I_2 , respectively, when they react with conc. HNO_3



36. What is meant by fuming nitric acid?

Ans: Concentrated HNO_3 is a colourless volatile liquid and it fumes strongly in air to evolve NO_2 gas. Therefore, mixture of $\text{HNO}_3 + \text{NO}_2$ is called fuming nitric acid.

37. What is aqua regia? OR How aqua regia dissolves gold?

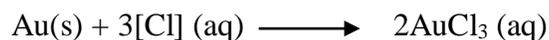
Ans: When one volume of concentrated HNO_3 is mixed with 3 volumes of concentrated HCl , aqua regia is formed. It is employed to dissolve gold and platinum.



NOCl formed is decomposed giving NO and Cl_2



This liberated chlorine gas converts noble metals such as gold and platinum into their water soluble chlorides.



38. Give the names of four elements which do not react with nitric acid.

Ans: Gold, platinum, iridium and titanium do not react as they are noble metals and are not

oxidized by nitric acid.

39. What are the uses of nitric acid?

Ans: It is used:

1. for making varnishes and organic dyes.
2. in the manufacture of explosives.
3. in the manufacture of nitrogen fertilizers.
4. as a laboratory reagent.

40. Name the minerals of phosphorus.

Ans: The two ores of phosphorus are impure $\text{Ca}_3(\text{PO}_4)_2$ and apatite $\text{Ca}_5\text{F}(\text{PO}_4)_3$.

41. Name three allotropic forms of phosphorus.

Ans: The three allotropes of phosphorus are:

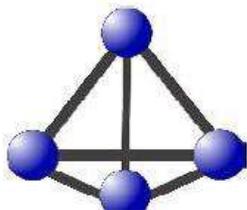
Whitephosphorus

Red phosphorus

Black phosphorus

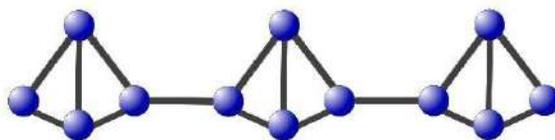
42. What are the characteristics of white phosphorus?

Ans: White phosphorus is a very reactive, poisonous, volatile, waxy, yellowish white substance, which is soluble in benzene and carbon disulphide. It exists in the form of tetraatomic molecules (P_4) which have a tetrahedral structure. It boils at 280°C to P_4 vapours which dissociate above 700°C to form P_2 molecules.



43. What are the characteristics of red phosphorus?

Ans: Red phosphorus is much less reactive and less poisonous than white phosphorus. It is prepared by heating white phosphorus in the presence of a little iodine or sulphur as a catalyst up to 250 °C in vacuum. The tetra-atomic molecules of red phosphorus combine to form macromolecules.

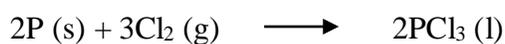


44. What are the characteristics of black phosphorus?

Ans: Black phosphorus is the third form which is most stable under ordinary conditions. Black phosphorus is prepared by heating red phosphorus to high temperature and pressure.

45. How phosphorus trichloride is prepared? OR Give any two methods of preparation of PCl_3 .

Ans: 1. It is usually prepared by melting white phosphorus in a retort in an inert atmosphere of CO_2 and current of dried chlorine is passed over it. The vapours of PCl_3 are collected in a flask kept in an ice-bath.



2. It may also be prepared by the action of phosphorus with thionyl chloride.



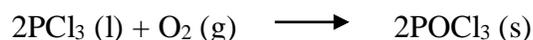
46. How phosphorus trichloride reacts with chlorine?

Ans: It combines with chlorine to form phosphorus pentachloride.



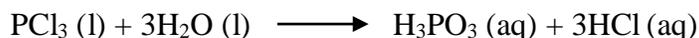
47. How phosphorus trichloride reacts with oxygen?

Ans: It combines with atmospheric oxygen slowly to form phosphorus oxychloride.



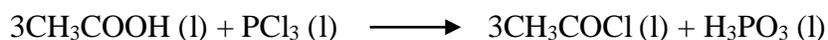
48. How phosphorus trichloride reacts with water?

Ans: It is soluble in organic solvents, but readily reacts with water to form phosphorus acid.



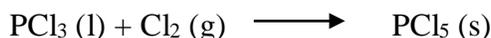
49. How phosphorus trichloride reacts with alcohol and carboxylic acid?

Ans: It reacts with alcohols and carboxylic acids forming the respective chloro derivatives and H_3PO_3 .

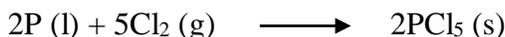


50. How phosphorus pentachloride is prepared?

Ans: 1. By passing dry chlorine through phosphorus trichloride.



2. It may also be prepared by passing dry chlorine in a well cooled solution of phosphorus in carbon disulphide



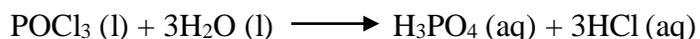
51. How phosphorus pentachloride is decomposed on heating?

Ans: It decomposes on heating producing PCl_3 and chlorine.



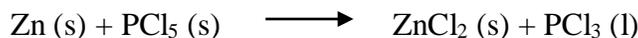
52. How phosphorus pentachloride reacts with water?

Ans: It gets decomposed by water forming phosphorus oxychloride which further reacts with water to produce orthophosphoric acid.



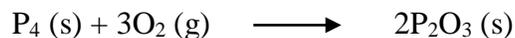
53. How phosphorus pentachloride reacts with metals?

Ans: It converts metals into their chlorides.



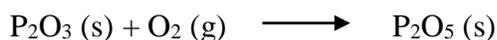
54. How phosphorus trioxide is prepared?

Ans: P_2O_3 can be prepared by burning white phosphorus in a limited supply of air.



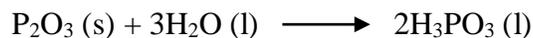
55. How phosphorus trioxide reacts with air?

Ans: When heated in the presence of air or oxygen, it is converted into phosphorus pentoxide.

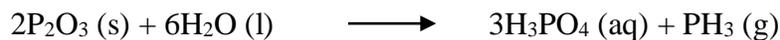


56. How phosphorus trioxide reacts with cold water?

Ans: It reacts with cold water to give phosphorus acid.

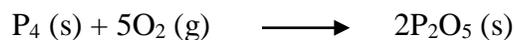


With hot water, it forms phosphine and phosphoric acid.



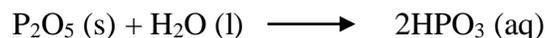
57. How phosphorus pentoxide is prepared in lab?

Ans: It is prepared by burning phosphorus in excess of dry air.

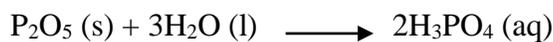


58. How phosphorus pentoxide reacts with water? OR How P_2O_5 reacts with hot and cold water?

Ans: With cold water phosphorus pentoxide forms metaphosphoric acid.

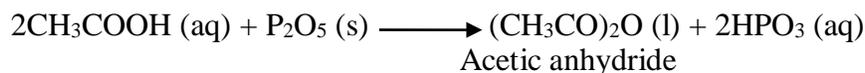
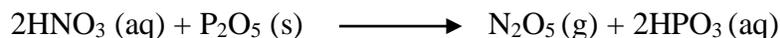


With hot water, it forms orthophosphoric acid



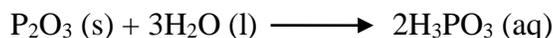
59. What is the role of phosphorus pentoxide as a dehydrating agent? OR P_2O_5 is a powerful dehydrating agent. Prove giving example.

Ans: It is a powerful dehydrating agent, thus, with HNO_3 , H_2SO_4 , CH_3COOH and C_2H_5OH , it gives N_2O_5 , SO_3 , $(CH_3CO)_2O$ and C_2H_4 , respectively.

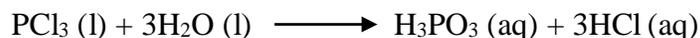


60. How is phosphorus acid prepared?

Ans: It is prepared by dissolving phosphorus trioxide in cold water.



It is also obtained by the hydrolysis of phosphorus trichloride.



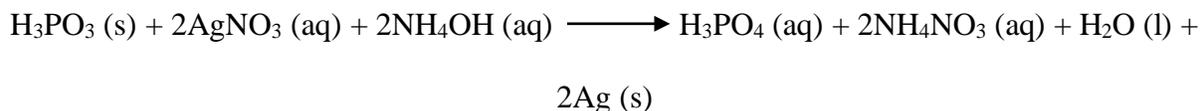
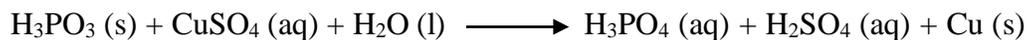
61. How phosphorus acid is decomposed?

Ans: It decomposes into phosphine and orthophosphoric acid on heating.



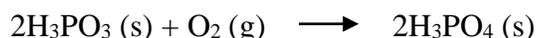
62. Phosphorus trioxide acts as a reducing agent. Justify.

Ans: It is a powerful reducing agent and reduces $CuSO_4$, $AgNO_3$, etc. to the metallic state.



63. How does phosphorus acid react with oxygen?

Ans: It reacts with oxygen to form orthophosphoric acid.



64. How phosphorus acid is reduced?

Ans: Nascent hydrogen produced by Zn/HCl reduces H_3PO_3 to phosphine



65. How is orthophosphoric acid prepared? (For short question learn any two methods well)

Ans: 1. It is prepared by dissolving phosphorus pentoxide in hot water.



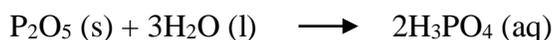
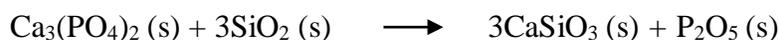
2. It is also obtained by heating red phosphorus with concentrated HNO_3 .



3. Hydrolysis of phosphorus pentachloride also gives orthophosphoric acid.

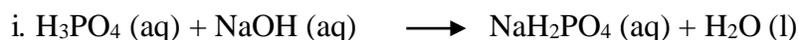


4. On large scale, it can be prepared by heating a mixture of phosphorite (bone ash) and sand in an electric furnace. The phosphorus pentoxide formed is treated with hot water to obtain phosphoric acid.



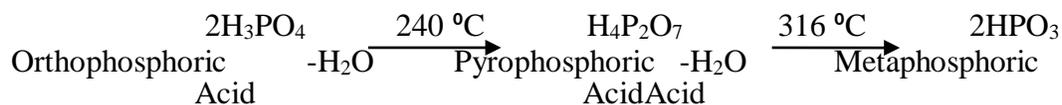
66. Prove that phosphoric acid is a tribasic acid.

Ans: It is a weak tribasic acid. It reacts with NaOH to give three series of salts.



67. What is the effect of heat on phosphoric acid?

Ans: On heating, it loses water and converted into pyro and metaphosphoric acid.



68. Name the elements of group VI A. Why are they called chalcogens?

Ans: The group VIA of the periodic table consists of oxygen, sulphur, selenium, tellurium and polonium. These elements are called chalcogens from the Greek for “copper giver”, because they are often found in copper ores.

69. Name the ores of sulphur (Formulae of individual ores can be asked separately)

Ans: Following are the ores of sulphur:

Sulphides, e.g. galena (PbS), Zinc blende (ZnS), cinnabar (HgS), stibnite (Sb₂S₃), copper pyrite (Cu₂S.Fe₂S₃), iron pyrite (FeS₂), etc. Some important sulphates are also found in nature, e.g. gypsum (CaSO₄), heavy spar (BaSO₄)

70. Mention the similarities of oxygen and sulphur.

(Mention any four as answer to short question)

- Ans:**
1. Both oxygen and sulphur have same outer electronic configuration of ns²p⁴.
 2. Both oxygen and sulphur are usually divalent.
 3. Both oxygen and sulphur exhibit allotropic forms.
 4. Both have polyatomic molecules. Oxygen has diatomic O₂, while sulphur has S₂ and S₈ molecules.
 5. Both combine with metals in the form of O⁻² and S⁻² with oxidation state -2.
 6. Both combine with non-metals and form covalent compounds, e.g. H₂O and H₂S, CO₂ and CS₂, etc.
 7. Both are typical non-metals.
 8. Both are found in free and combined states on earth.

71. Mention the differences between oxygen and sulphur. (For short learn any four differences)

Ans:

Oxygen	Sulphur
1. There are two allotropic forms of oxygen O ₂ and O ₃	1. There are three allotropic forms of sulphur, rhombic, monoclinic and plastic
2. It is gas at ordinary temperature	2. It is solid at ordinary temperature
3. Oxygen is sparingly soluble in water	3. Sulphur is not soluble in water
4. Oxygen helps in combustion	4. Sulphur is itself combustible
5. It is paramagnetic in nature	5. It is diamagnetic in nature
6. It does not react with water	6. When steam is passed through boiling sulphur a little hydrogen sulphide and sulphur dioxide are formed
7. It does not react with acids	7. It is readily oxidized by conc. Sulphuric acid or nitric acid
8. It does not react with alkalis	8. It reacts with alkali solution and forms sulphides and thiosulphates
9. It shows -2 oxidation state	9. It shows oxidation states of -2, +2, +4 and +6

72. Mention the principle of contact process.

Ans: SO₂ obtained by burning sulphur or iron pyrites is oxidized to SO₃ in the presence of V₂O₅ which acts as a catalyst. The best yield of SO₃ can be obtained by using excess of oxygen or air

and keeping the temperature between 400-500°C. SO₃ formed is absorbed in concentrated H₂SO₄ and “Oleum” (H₂S₂O₇) formed can be converted to sulphuric acid of any strength by mixing adequate quantities of water.

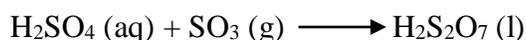
73. Name the stages of contact process.

Ans: Following are the steps/stages in contact process:

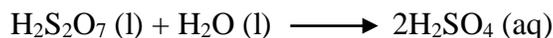
- a. Sulphur burner
- b. Purifying unit
 - i. Dust remover
 - ii. Cooling Pipes
 - iii. Scrubbers
 - iv. Drying Tower
 - v. Arsenic Purifier
 - vi. Testing box
 - vii. Contact tower

74. Why SO₃ is dissolved in sulphuric acid and not in water?

Ans: When SO₃ is dissolved in 98% H₂SO₄, we obtain Pyrosulphuric acid or (Oleum).



Oleum can be converted to sulphuric acid of any required concentration by adding water.



If SO₃ is dissolved in water directly, a highly exothermic reaction occurs in which heat energy is released and it vaporizes sulphuric acid to make mist or fog. This fog does not condense easily.

75. Give the advantages of contact process for the manufacture of sulphuric acid.

Ans: Solid catalyst V₂O₅ is used and nitrogen oxide impurities are not present. Sulphuric acid is

produced up to 100% in this process.

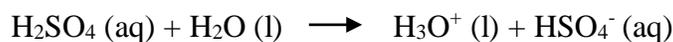
76. Tell about the stability of sulphuric acid

Ans: It is stable at ordinary temperature but on strong heating it dissociates into SO_3 and H_2O .



77. Prove that sulphuric acid is a strong acid.

Ans: It is a strong acid. In an aqueous solution it completely ionizes to give hydrogen, hydrogen sulphate and sulphate ions. The dissociation takes place in two steps.



78. Mention the reaction of sulphuric acid with alkalis.

Ans:



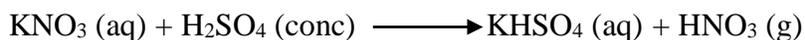
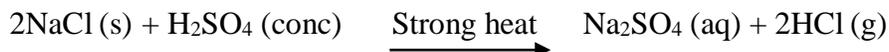
79. How sulphuric acid reacts with carbonates and bicarbonates?

Ans:



80. How sulphuric acid reacts with salts?

Ans:

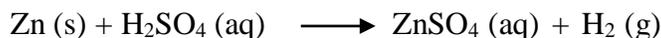
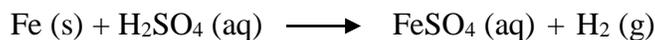


81. How sulphuric acid reacts with metals?

(These reactions can come separately as individual short questions. Mention any four as

answer to this question)

Ans: (a) Cold dilute acid reacts with almost all metals to produce hydrogen gas and sulphate salts.



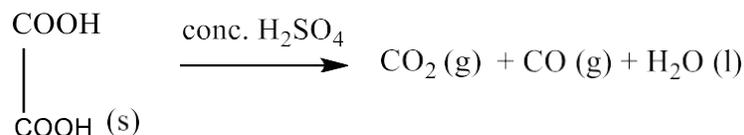
(b) Cold concentrated H_2SO_4 does not react with most of the metals like Cu, Ag, Hg, Pb, Au.

(c) With certain metals hot concentrated sulphuric acid gives metal sulphates, water and SO_2 .



82. How sulphuric acid acts as a dehydrating agent?

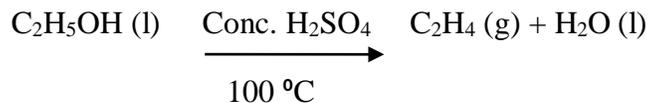
Ans: (i) With oxalic acid it forms CO_2 and CO.



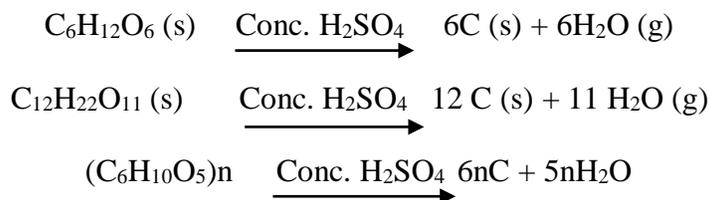
(ii) With formic acid, CO is formed.



(iii) With ethyl alcohol it forms ethylene.

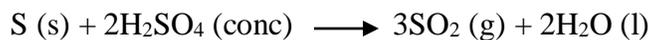


(iv) With wood, paper, sugar and starch it forms carbon and water.



83. How sulphuric acid acts as an oxidizing agent?

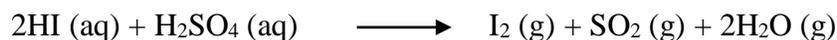
Ans: (i) It oxidizes C and S giving CO₂ and SO₂, respectively.



(ii) H₂S is oxidized to S.

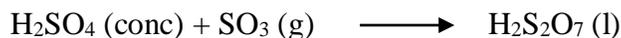


(iii) Reactions of H₂SO₄ with HBr and HI produces bromine and iodine respectively.



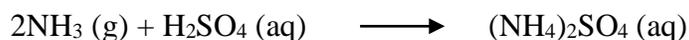
84. How sulphuric acid reacts with gases.

Ans: (i) It absorbs SO₃ and forms oleum



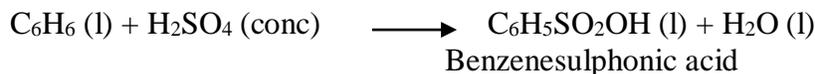
85. How sulphuric acid reacts with ammonia?

Ans: It reacts with ammonia forming ammonium sulphate.



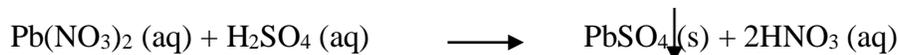
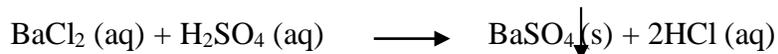
86. How sulphuric acid reacts with benzene?

Ans: Benzene sulphonic acid is produced when H₂SO₄ reacts with benzene.



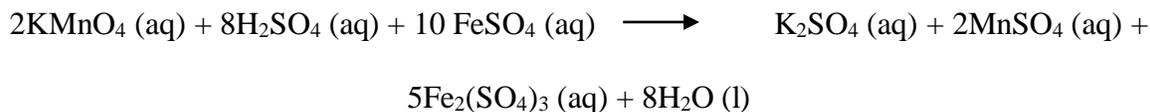
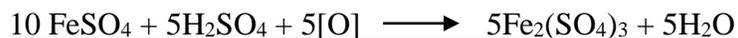
87. Give precipitation reactions of sulphuric acid.

Ans: White precipitates are produced when H₂SO₄ reacts with solutions of BaCl₂, Pb(NO₃)₂ and Sr(NO₃)₂.



88. How sulphuric acid reacts with oxidizing agents?

Ans: It reacts with oxidizing agents like KMnO_4 and $\text{K}_2\text{Cr}_2\text{O}_7$ to liberate oxygen which may oxidize other compounds.



89. Mention uses of sulphuric acid.

Ans: It is used

1. In the manufacture of fertilizers like ammonium sulphate and calcium superphosphate.
2. In refining of petroleum to remove nitrogen and sulphur compounds.
3. In the manufacture of HCl , H_3PO_4 , HNO_3 and sulphates.
4. In the manufacture of many chemicals, dyes, drugs, plastics, disinfectants, paints, explosives, synthetic fibers, etc.
5. In electrical batteries and storage cells.
6. As a dehydrating agent for drying gases.
7. As a laboratory reagent.
8. In textile, iron, steel, leather and paper industries.

90. Justify that sulphuric acid is king of chemicals.

Ans: Sulphuric acid is called king of chemicals because of its direct and indirect applications in manufacture of many chemicals including fertilizers. It dissolves its own compounds. It replaces salts from weaker acids. It is ideal to call sulphuric acid asking of chemicals. It acts as an oxidizing and dehydrating agent for a variety of compounds.

91. Mention physical properties of sulphuric acid OR Mention any four physical properties of

sulphuric acid.

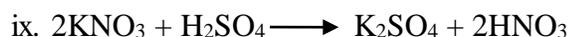
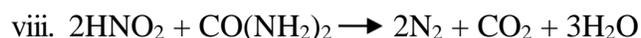
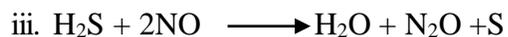
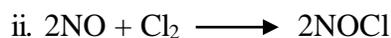
(In case of short question mention any four properties)

Ans: Following are the physical properties of sulphuric acid:

1. Pure sulphuric acid is a colourless oily liquid without an odour.
2. Its specific gravity is 1.834 at 18°C. 3. It freezes at 10.5°C.
4. Its boiling point is 338°C.
5. It dissolves in water liberating a lot of heat which raises the temperature of the mixture up to 120°C. H₂SO₄ should always be poured in water in a thin stream to avoid any accident.
6. Pure acid is a nonconductor of electricity but the addition of a little water makes it a good conductor.
7. It is extremely corrosive to skin and causes very serious burns to all the tissues.

92. Complete and balance the following equations.

Ans:



Chapter#5

The Halogens and the Noble Gases

1. Name the members of VIIA group. Why are they called halogens?

Ans: The elements fluorine (F), chlorine (Cl), bromine (Br), iodine (I) and astatine (At) are called halogens. These elements are called the halogens from Greek hals, “salt” and gennan, “to form or generate”, because they are literally the salt formers.

2. Name the ores of fluorine and chlorine (Formulae of individual ores can come as short question)

Ans: Following are the ores of fluorine and chlorine:

Fluorine

Fluorospars	CaF_2
Cryolite	Na_3AlF_6
Fluoroapatite	$\text{Ca}_5(\text{PO}_4)_3\text{F}$

Bromine

Brine wells, sea water, NaBr, KBr, MgBr_2

Chlorine

Halite	NaCl (Sea beds, brine wells, sea water)
Carnallite	$\text{KCl} \cdot \text{MgCl}_2 \cdot 6\text{H}_2\text{O}$

Iodine

NaIO_3 , NaIO_4 , deposits in Chile brine wells

3. How fluorine shows peculiar behaviour?

Ans: Following are the points of peculiar behaviour of fluorine:

1. Small size of F atom and of F⁻ ion.
2. High first ionization energy and electronegativity.
3. Low dissociation energy of F₂ molecule as compared to Cl₂ and Br₂.
4. Restriction of the valence shell to an octet.
5. Direct combination with inert gases.

4. What are the factors on which oxidizing power of halogens depends?

Ans: The oxidizing power of halogens depends upon the following factors:

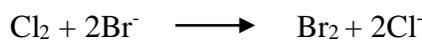
1. Energy of dissociation
2. Electron affinity of atoms
3. Hydration energies of ions
4. Heats of vaporization (for Br₂ and I₂)

5. How can fluorine oxidize other halogens?

Ans: can oxidize all the halide ions to molecular halogens. (A reaction will occur if the value of E° is positive) Iodine being a weak oxidizing agent cannot oxidize chloride or bromide ion.

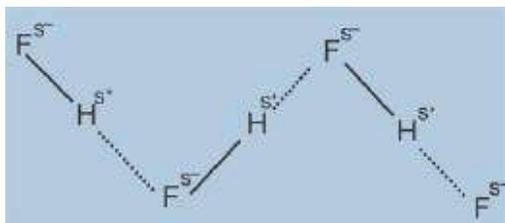


In the similar way, chlorine will oxidize both bromide and iodide ions, while bromine can oxidize only iodide ion.



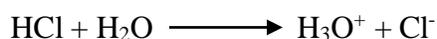
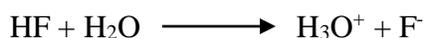
6. Why is HF a weaker acid than other halogen acids?

Ans: HF acts as a weak acid because it has a zig-zag structure and hydrogen is trapped between two fluorine atoms so cannot be released easily, thereby, decreasing the acidic strength of hydrogen fluoride.



7. How halogen acids are ionized in water?

Ans: Halogen acids ionize in water and form halide ions and hydronium ions. For example,



8. What is the trend of hydrogen halides as a reducing agent?

Ans: HF, HCl, HBr and HI act as reducing agents in the following order:



9. What is the order of acidic strength of hydrogen halides?

Ans: Following is the order of acidic strength of hydrogen halides:



10. Mention the oxides of halogens (Any two may come for short question)

Ans:

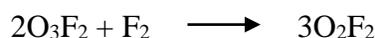
FLUORINE	CHLORINE	BROMINE	IODINE
Oxygen difluoride, OF ₂	Dichlorine monoxide, Cl ₂ O	Bromine monoxide, Br ₂ O	Iodine tetroxide, I ₂ O ₄
Dioxygen difluoride, O ₂ F ₂	Chlorine dioxide, ClO ₂	Bromine dioxide, BrO ₂	Iodine iodate, I ₄ O ₉
Trioxygen difluoride	Chlorine hexaoxide, Cl ₂ O ₆	Bromine trioxide, BrO ₃ , (Br ₃ O ₈)	Iodine pentoxide, I ₂ O ₅

11. Give the products of decomposition of trioxygen difluoride?

Ans: It forms nitrosyl chloride and nitrosyl bromide with chlorine and bromine, respectively in the presence of charcoal.



O₃F₂ reacts with F₂ in the presence of electric discharge to produce O₂F₂



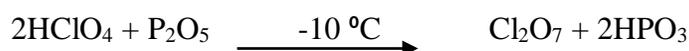
12. How is chlorine dioxide prepared?

Ans: It is prepared by reducing NaClO₃, with NaCl or SO₂ or CH₃OH in strongly acidic solution.



13. How is chlorine heptaoxide obtained?

Ans: Cl₂O₇ is an anhydride of perchloric acid (HClO₄). It can be obtained at -10 °C by dehydration of HClO₄ with P₂O₅.



14. How is bromine monoxide obtained?

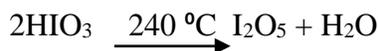
Ans: It can be prepared by the reaction of bromine vapours with mercuric oxide.



Br₂O can also be prepared by treating the suspension of mercuric oxide in CCl₄ with bromine. It is stable in dark in CCl₄ at -20°C.

15. How is iodine pentaoxide prepared?

Ans: It can be prepared by heating iodic acid at 240°C.



16. How iodine pentoxide forms iodic acid?

Ans: Iodine pentoxide forms iodic acid with water.



17. How iodine pentoxide oxidizes carbon monoxide?

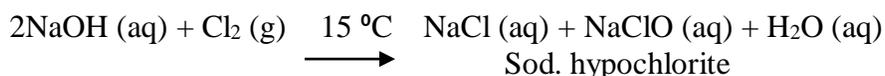
Ans: It reacts with H₂S, HCl and CO as an oxidizing agent. It is used for the quantitative analysis of CO.



18. What are disproportionation reactions of sodium hydroxide? OR How sodium hydroxide reacts with chlorine in cold state and hot state?

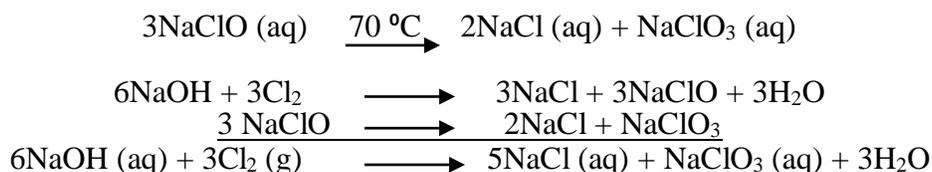
Ans: A reaction in which a species (molecule, atom or ion) is simultaneously oxidized and reduced, is called a “disproportionation reaction”

In cold (15°C) state chlorine will react with NaOH (aq) to form hypochlorite and a halide.



The reaction is a disproportionation reaction, because the zero oxidation state of chlorine atom in Cl₂, is converted to -1 in chloride and +1 in hypochlorite.

Sodium hypochlorite which is produced in cold state in the above reaction, decomposes forming sodium chloride and sodium chlorate at 70°C



Chlorine atoms are both reduced and oxidized.

19. What are oxyacids? Tell about the factors affecting their acidic strength.

Ans: Oxygen containing acids of halogens are called oxyacids. Examples are HClO_4 , HClO_3 , HClO etc.

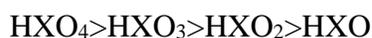
20. Which factors are linked with acidic strength of oxyacids of halogens and increase in oxidation number?

Ans: The increase in the oxidation state of the halogen from +1 to +7 is accompanied by:

- (a) an increase in the thermal stability of the acid
- (b) the decrease in oxidizing power of the acid
- (c) the increase in acidic strength of the acid

21. How the number of oxygen atoms in oxyacids of halogens is linked with acidic strength?

Ans: The more the number of oxygen atoms in the series of oxyacids of a halogen, the greater is the thermal stability. The acid strength increases with the increase in the number of oxygen atoms. As the oxidation state of the halogen increases, the bonding electrons are shifted away from the H atom and the tendency of the molecule to lose a proton increases. This accounts for the change of strength of oxyacids. The oxyacids of halogens show their strength in the order given below:



22. How the strength of oxyacids of halogens linked with electronegativity of the halogen attached?

Ans: An oxyacid molecule contains hydrogen linked to the halogen through an oxygen atom. The oxyacids of chlorine are stronger than the corresponding oxyacids of bromine which are, in turn, stronger than the corresponding oxyacids of iodine. It is due to decrease in the electronegativity and increase in the size of the halogen.

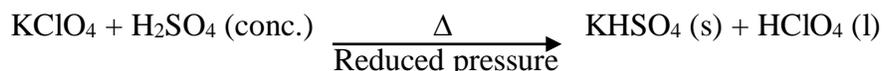
23. Arrange the following oxyacids in the increasing order of acid strength HClO_4 , HClO_3 , HClO_2 , HOCl .

Ans: The oxyacids of halogens show their strength in the order given below:



24. How perchloric acid is obtained?

Ans: Perchloric acid (HClO_4) is commonly obtained in aqueous solution. Pure anhydrous compound can be prepared by distilling a mixture of potassium perchlorate (KClO_4) and conc. H_2SO_4 under reduced pressure.



25. On what basis perchloric acid is considered a valuable analytical reagent?

Ans: Due to its oxidizing effect, acidic strength and solubility of its salts, perchloric acid is considered a valuable analytical reagent.

26. Name the two methods through which bleaching powder can be prepared. Mention the reaction involved in both the methods.

Ans: Bleaching powder can be manufactured by the action of chlorine on dry slaked lime using any one of the following methods:

- (a) Hasenclever's method (old method)
- (b) Beckmann's method (modern method)

The reaction in both the cases will be:



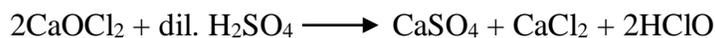
27. How bleaching powder acts as an oxidizing agent?

Ans: It is an oxidizing agent. This property is due to the generation of hypochlorite ion (OCl^-) in water.



28. Give the reaction of bleaching powder with dilute acid.

Ans: With dilute acid it gives hypochlorous acid.



29. Mention the reaction of bleaching powder with excess dilute acid.

Ans: If excess of an acid (weak or strong) is added to bleaching powder, chlorine is given out.



30. What is meant by available chlorine OR How can the efficiency of bleaching powder be checked? OR How can the quality of bleaching powder be tested?

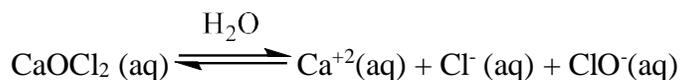
Ans: If excess of an acid (weak or strong) is added to bleaching powder, chlorine is given out.



The amount of chlorine thus set free is called “available chlorine”. The activity of bleaching powder is measured in terms of available chlorine. The average percentage of available chlorine in bleaching powder is 35-40 percent. The bleaching action of bleaching powder is due to its oxidative character.

31. Why bleaching powder shows bleaching action?

Ans: The bleaching action of bleaching powder is due to its oxidative character. The oxidizing property is due to the generation of hypochlorite ion (OCl^-) in water.



32. How HCl is oxidized with bleaching powder?

Ans: It oxidizes HCl, HBr and HI giving the corresponding halogens.



33. How bleaching powder oxidizes ammonia?

Ans: It oxidizes ammonia to nitrogen



34. How bleaching powder reacts with carbon dioxide?

Ans: Calcium hypochlorite reacts with carbon dioxide to form calcium carbonate and release chlorine.



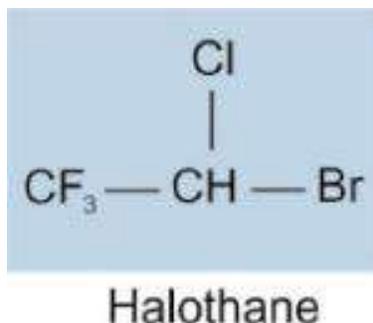
35. Mention uses of bleaching powder (Any two or four uses are asked in short question)

Ans: Bleaching powder is used:

1. for the laboratory preparation of chlorine and oxygen. It is also used in the manufacture of chloroform.
2. as a disinfectant and in the sterilization of water.
3. for making unshrinkable wool.
4. for bleaching cotton, linen and paper pulp. (Delicate fabrics like wool, silk etc. cannot be bleached with it as these could be damaged by chlorine).

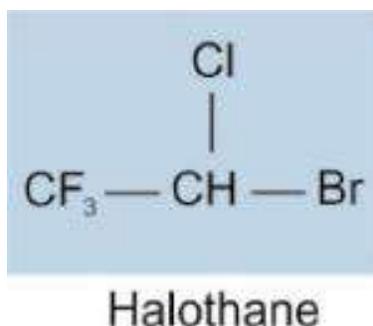
36. What are the commercial uses of fluorine? Or What are Freons and Teflon? Give uses.

Ans: Fluorine is used for the preparation of freons. Freon is the commercial name of low molecular mass fluorochlorocarbons, CCl_2F_2 , CClF_3 . These are being used as refrigerants and aerosol propellants. Fluorine is used to prepare Teflon $(-\text{CF}_2 - \text{CF}_2-)_n$. It is a polymerized tetrafluoro ethylene compound. It is a valuable plastic which resists the action of oxidants, acids and alkalis. Corrosion proof parts of machinery are made of it. It is used for coating the electrical wiring. Teflon is also used as a non-stick coating for cooking pans. Halothane is used as an anaesthetic. Fluorides in toothpastes build a protective coating on teeth.



37. What is halothane?

Ans: Halothane is used as an anesthetic.



38. What is structural formula of Teflon? Mention its two uses.

Ans: The structural formula of Teflon is $(-\text{CF}_2-\text{CF}_2-)_n$. Corrosion proof parts of machinery are made of it. It is used for coating the electrical wiring.

39. Mention commercial uses of chlorine.

Ans: Chlorine is used in the manufacture of bleaching powder. It is used as a disinfectant in swimming pools and water treatment plants. A number of antiseptics, insecticides, weed killers and herbicides are manufactured from chlorine. It is also used in the manufacture of hydrochloric acid, which is the cheapest industrial acid. Chlorine is also used in the manufacture of polyvinyl chloride (PVC) plastics. Chloroform and carbon tetrachloride are prepared from chlorine which are used as solvents.

40. Mention commercial uses of bromine.

Ans: Ethylene dibromide ($C_2H_4Br_2$) is added to leaded gasoline to save the engine from lead oxide and lead sulphate deposits. Bromine is also used as fungicide. Silver bromide is used in photography.

41. Mention commercial uses of iodine.

Ans: The major applications of iodine are in pharmaceutical industry. It is used as disinfectant and germicide. Tincture of iodine and iodex are popular preparations of iodine. Diet with insufficient iodide ions leads to an enlargement of the thyroid (Goiter). To ensure the presence of iodide ion in the diet, sodium or potassium iodide is added to the common salt which is known as iodized salt.

42. What is iodized salt? Write its function.

Ans: To ensure the presence of iodide ion in the diet, sodium or potassium iodide is added to the common salt which is known as iodized salt.

43. What is iodex and tincture of iodine?

Ans: Iodex and tincture of iodine are popular preparations of iodine. It is used as a disinfectant and germicide.

44. Why iodine has metallic luster?

Ans: Iodine has big size due to which its outermost shell electrons can easily excite on absorption of energy and on de-excitation release energy which is seen in the form of metallic luster.

45. Mention names of noble gases. Why are they called inert? OR Why the elements of VIIIA are called noble gases?

Ans: Helium (He), Neon (Ne), Argon (Ar), Krypton (Kr), Xenon (Xe), Radon (Rn). They are inert because their outermost shell is complete and they do not have tendency to react with other elements. So, they are called noble gases.

46. Why solubility of noble gases increases down the group?

Ans: The solubility of the noble gases in water increases with increasing atomic number. This is because the bigger atoms are more readily polarized by water molecules.

47. Mention the compounds of xenon (Mainly should be learnt for objective)

Ans:

Oxidation state	Compound	Physical form	Melting point of xenon (° C)
+2	XeF ₂	Colourless crystals	140
+4	XeF ₄	Colourless crystals	114
+4	XeOF ₂	Colourless crystals	90
+6	XeF ₆	Colourless crystals	48
+6	XeOF ₄	Colourless liquid	-28
+6	XeO ₃	Colourless crystals	25(Explodes)
+8	XeO ₄	Colourless gas	-39.9 (Explodes, on warming)

48. Mention the applications of noble gases (Any two or four applications can come for short.

Separate applications of He, Ne, Ar, Kr, Xe, Rn come for short)

Ans:

Helium

1. Helium is used in weather balloons, in welding and in traffic signal light.
2. A mixture of 80% helium and 20% oxygen is used for breathing by the sea divers.
3. Helium is used as a cooling medium for nuclear reactors.

Neon

4. Neon is largely used in making neon advertising signs, in high voltage indicators and TV tubes.
5. Neon and helium arc is used in making glass lasers.

Argon

6. Argon is used in electric light bulbs, in fluorescent tubes, in radio tubes, and in Geiger counters (used to detect radioactivity).
7. Argon is also used for arc welding and cutting.

Krypton

8. Krypton is used to fill fluorescent tubes and in flash lamps for high speed photography.

Xenon

9. Xenon is used in bactericidal lamps.

Radon

10. Radon being radioactive is used in radiotherapy for cancer and for earth-quake prediction.

49. Name the gas which is used for earthquake prediction.

Ans: Radon is the gas which is used for earthquake prediction.

50. Name the gas which is used for bactericidal lamps.

Ans: Xenon is used in bactericidal lamps.

51. Which halogen is used in water treatment to kill bacteria?

Ans: Chlorine is a disinfectant and used to kill bacteria. It is used as disinfectant in drinking water and also in swimming pools.

52. Which halogen is used as antiseptic?

Ans: Chlorine is used as an antiseptic.

53. Arrange the following ions in order of increasing size.

F⁻, Cl⁻, Br⁻, I⁻

Ans: Ionic radii increase down the group so the order is:



54. Which halogen sublimes to violet vapours?

Ans: Among halogens iodine is the one which sublimes to violet vapours.

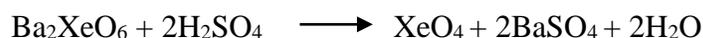
55. How is xenon trioxide obtained?

Ans: Xenon trioxide can be obtained when XeF_6 is hydrolyzed slowly.



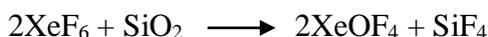
56. How is xenon tetraoxide obtained?

Ans: It is obtained by the addition of barium or sodium perxenate to conc. H_2SO_4

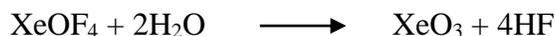


57. How are xenon oxyfluorides prepared?

Ans: Xenon oxytetrafluoride, $XeOF_4$ is also formed by a rapid reaction of XeF_6 with silica (quartz).



$XeOF_4$ is a colourless volatile liquid. It can be kept in nickel vessel. It reacts with water to give XeO_3 .



Xenon oxydifluoride, $XeOF_2$ is obtained when xenon reacts with oxygen difluoride in an electric discharge.



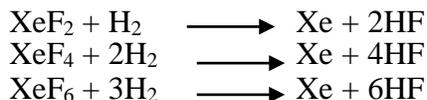
58. How xenon fluorides act as fluorinating agent?

Ans: Xenon tetra-fluoride is a good fluorinating agent and can be used to prepare metal fluorides as follows:



59. How fluorides of xenon can be reduced?

Ans: Fluorides of xenon can be reduced with hydrogen at 400 °C giving xenon and hydrofluoric acid.



60. How xenon fluoride reacts with ammonia?

Ans: Reaction occurs with explosion when XeF_4 is brought in contact with liquid ammonia



61. How xenon fluoride reacts with water?

Ans: Hydrolysis of XeF_6 with small amount of water gives XeOF_4

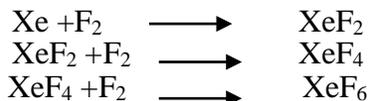


62. How xenon fluorides are prepared?

Ans: XeF_2 can be prepared by direct interaction of the elements.

XeF_4 can be prepared by heating a mixture of Xe and F_2 in 1:5 ratio in a nickel container under 6 atmospheric pressure for a few hours.

XeF_6 requires more severe conditions. Xe and F_2 are taken in 3:20 ratio in a stainless steel vessel and heated to 300°C at 50 atmospheric pressure.



Chapter#6

Transition Elements

1. Define transition elements.

Ans: Transition elements may be defined as those elements which have partially filled d or f-subshells in atomic state or in any of their commonly occurring oxidation states.

2. Why transition elements are called so?

Ans: The d-block and the f-block elements are called transition elements because they are located between the s and p-block elements and their properties are in transition between the metallic elements of the s-block and nonmetallic elements of the p-block.

3. What are typical and non-typical transition elements? Why they are called so?

Ans: Group IIB elements (Zn, Cd and Hg) do not have a partially filled d-subshell either as elements or in any of their ionic state. Neither do they show typical properties of transition elements to any appreciable extent (except complex formation). Similarly, IIIB (Sc, Y and La) is another group of elements which do not show many of the properties associated with typical transition elements.

They are transition elements by definition, as there is one electron in the d-subshell of each atom. In compounds they mostly occur as the tripositive ions, having no d-electron (the atom having lost its only one d-electron), hence they do not exhibit properties of transition elements and behave like main group elements.

4. What are coinage metals?

Ans: Group IB elements (Cu, Ag, Au) are called coinage metals.

5. What is meant by outer transition metals and inner transition metals?

Ans: f-block elements, i.e., Lanthanides and Actinides are also called inner transition metals, whereas, d-block elements are called outer transition metals.

6. Mention the points in which transition elements show resemblance with each other.

Ans: Following are the points of resemblance of transition elements with each other:

1. They are all metals in true sense, some of which play important role in industry, e.g. Ti, Fe, Cr, Ni, Cu, Mo, W, Zr, Nb, Ta, Th, etc.
2. They are all hard and strong metals with high melting and boiling points.
They are also good conductors of heat and electricity.
3. They form alloys with one another and also with other elements.
4. With few exceptions, they show variable valency or oxidation state.
5. Their ions and compounds are colored in solid state as well as in solution form at least in one if not all the oxidation states.

7. How transition metals form alloys? OR What are substitutional alloys? Give examples.

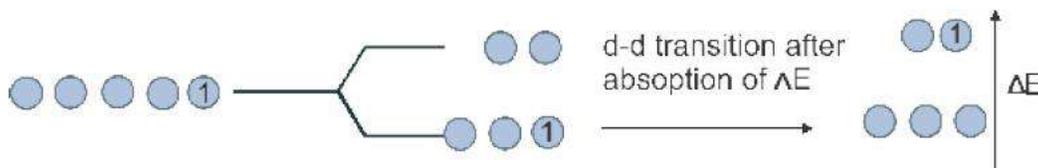
Ans: Owing to the similarity in their sizes, some transition metal atoms are able to replace one another in the metallic lattice and form substitutional alloys among themselves. Alloy steels are an important example of this type of material in which iron atoms are substituted by chromium, manganese and nickel atoms, etc. to give the steel more useful properties. Other examples are brass, bronze, coinage alloys, etc.

8. What are interstitial compounds?

Ans: When small non-metal atoms like H, B, C, N enter the interstices of transition metals and impart useful features to them, they are called Interstitial compounds. These are non-stoichiometric compounds. Sometime they are also termed as interstitial alloys.

9. How is color imparted in transition metal compounds?

Ans: In transition elements, the d orbitals are responsible for the colour development in their compounds. When these orbitals are involved in bonding, they split up into two energy levels, one set has a higher energy than the other. The electrons residing in low energy d-orbitals absorb a part of the visible light and jump to high energy d orbitals. The process is called d-d transition.



In $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$, yellow light is absorbed, while most of the blue and red lights are transmitted, therefore the solution of $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ ions looks violet in color.

10. Why transition elements show variable oxidation state?

Ans: They show variable valencies because of the involvement of the unpaired d electrons in addition to s electrons in bond formation. All 3d series elements show an oxidation state of +2 in addition to higher oxidation states.

+2 oxidation state is shown when only the 2s electrons are involved in bonding. In the highest oxidation states of the first five elements all the s and d electrons are used for bonding. After Mn, the number of oxidation states decreases as the d-subshells fill up and fewer unpaired electrons are available for bond formation.

11. Define Paramagnetism, diamagnetism and Ferromagnetism.

Ans:

Paramagnetism

Substances which are weakly attracted by a strong magnetic field are called paramagnetic substances.

Example



Diamagnetism

Those substances which are weakly repelled by a strong magnetic field are called diamagnetic substances.

Example



Ferromagnetism

A ferromagnetic substance contains permanent atomic magnetic dipoles that are spontaneously oriented. Ferromagnetism is a kind of magnetism that is associated with iron, cobalt, nickel, and some alloys or compounds containing one or more of these elements.

12. What is the cause of paramagnetic and diamagnetic behaviour?

Ans: Paramagnetic behavior is caused by the presence of unpaired electrons in an atom, molecule or ion because there is a magnetic moment associated with the spinning electron. It increases with increase in the number of unpaired electrons.

When the electrons are paired in an orbital, then magnetic moments are cancelled out and the substances become diamagnetic.

13. What is the trend of covalent radii and ionic radii in the transition elements?

Ans: The covalent radii decrease rapidly at the start of the series, then become almost constant and finally begin to increase at the end of the series. The increase in covalent radii is possibly due to the fact that the filled 3d orbitals have contracted into the electron core and so shield the outer 4s electrons more effectively from the nucleus. Changes in the ionic radii along the series are much less regular, so that periodic trends in the properties of these ions are difficult to rationalize.

14. What is the trend of melting and boiling point of transition elements?

Ans: Transition metals have very high melting and boiling points due to strong binding forces

present between their atoms. Melting points increase up to the middle of the series and then decrease to a minimum level at the end of the series.

15. What is the trend of binding energy in transition elements?

Ans: In moving from left to right in any transition series, the number of unpaired electrons increases up to groups VB and VIB, after that pairing takes place and number of unpaired electrons goes on decreasing until it becomes zero at group IIB.

Therefore, binding is stronger up to group VIB and weakens progressively up to group IIB. In the first transition series the general increase in binding energy ends at vanadium. This is due to changes in metallic structure, e.g. Mn. In the third transition series, the increase in binding energy ends at tungsten when all the 5d electrons contribute to binding.

16. What are complex compounds? Give example.

Ans: Compounds containing the complex molecules or complex ions and capable of independent existence are called coordination compounds or complexes.

A complex compound may contain

1. A simple cation and a complex anion
2. A complex cation and a simple anion



Here $[\text{Fe}(\text{CN})_6]^{4-}$ is called a complex ion.

17. Define central metal ion, ligand, coordination number and coordination sphere.

Ans: Central Metal Ion

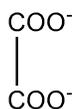
A metal atom or ion (usually a transition element) surrounded by a number of ligands is called a central metal atom or ion, e.g. $\text{K}_4[\text{Fe}(\text{CN})_6]$, $[\text{Ag}(\text{NH}_3)_2]\text{Cl}$ In these examples, Fe^{2+} and Ag^{1+} are the central metal ions, respectively.

Ligand

The atoms or ions or neutral molecules, which surround the central metal ion and donate electron pairs to it, are called ligands. They may be anions or neutral molecules, e.g. $K_4[Fe(CN)_6]$, $[Ag(NH_3)_2]Cl$.

CN^- and NH_3 are the anionic and neutral ligands. Ligands having two donor atoms are called bidentate ligands, e.g.

Oxalate ion



is a bidentate ligand and its coordination with the metal ion occurs through its both negatively charged oxygen atoms.

18. Define coordination number and coordination sphere.

Ans: Coordination Number

The number of lone pair of electrons provided by the ligands to the central metal atom or ion is called the coordination number of the central metal atom or ion, e.g. $K_4[Fe(CN)_6]$, $[Cu(NH_3)_4]SO_4$

In the above examples, coordination number of iron is 6 and that of copper is 4.

Coordination Sphere

The central metal atom or ion along with ligands is called the coordination sphere. It is usually placed in square brackets. It may be anionic, cationic or neutral, e.g.

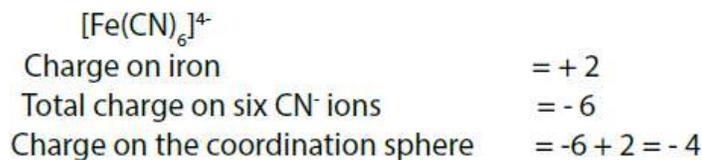


In the above examples, $[Fe(CN)_6]^{4-}$, $[Cu(NH_3)_4]^{2+}$ and $[Ni(CO)_4]^0$ are anionic, cationic and neutral coordination spheres, respectively.

19. How is charge on the coordination sphere calculated?

Ans: It is the algebraic sum of the charges present on the central metal ion and the total charge on

the ligands, e.g;

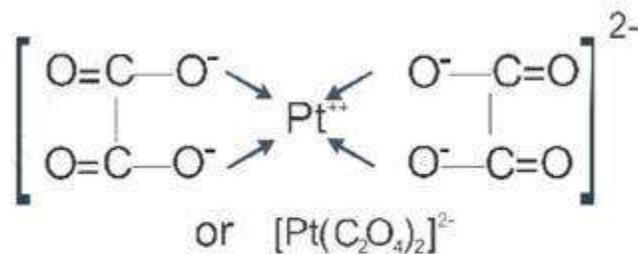


20. Give coordination number and oxidation number of iron (Fe) in $\text{K}_4[\text{Fe}(\text{CN})_6]$.

Ans: The coordination number of iron (Fe) in $\text{K}_4[\text{Fe}(\text{CN})_6]$ is 6 and the oxidation number is 2.

21. What are chelates? Give an example.

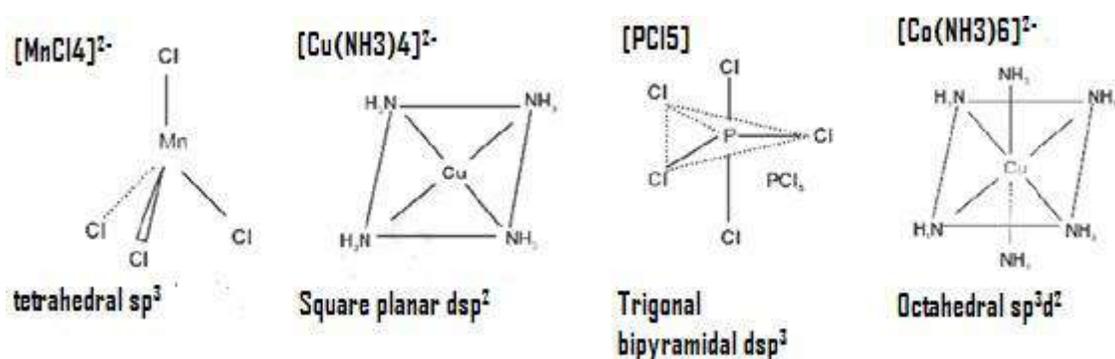
Ans: When all the donor atoms of a polydentate ligand get coordinated with the same metal ion, a complex compound is formed which contains one or more rings in its structure and hence is called a Chelate. Metal chelates are more stable metal complexes. When two oxalato ligands $\text{C}_2\text{O}_4^{2-}$ (bidentate ligand) get coordinated with Pt^{2+} ion, dioxalato platinate (II) ion is obtained. Each oxalate ligand forms a five membered ring with the cation.



Dioxalato- platinate (II)ion

22. What is the geometry of $[\text{MnCl}_4]^{2-}$, $[\text{Cu}(\text{NH}_3)_4]^{2+}$, $[\text{PCl}_5]$, $[\text{Co}(\text{NH}_3)_6]^{2+}$?

Ans:



23. Name the important ores of iron OR Give formulae of magnetite, haematite, limonite.

Ans: The important ores of iron are magnetite (Fe₃O₄), haematite (Fe₂O₃) and limonite Fe₂O₃.3H₂O

24. Name the different commercial forms of iron.

Ans: Iron is available commercially in the following three forms. They differ in carbon contents as follows:

1. Pig iron or cast iron 2.5 to 4.5% carbon
2. Wrought iron 0.12 to 0.25% carbon
3. Steel 0.25 to 2.5% carbon

25. What is meant by ferromanganese?

Ans: Ferromanganese is a combination of Fe, Mn and C.

26. What is the composition of wrought iron?

Ans: It is the purest form of commercial iron and contains the lowest percentage of carbon and upto 0.3% of impurities like S, P, Si and Mn, etc.

$$S = 0.2 \text{ to } 0.15\%, \text{ Mn} = \text{upto } 0.25 \%, \text{ P} = 0.04 \text{ to } 0.2\%$$

27. Define steel. What are the types of steel? Give uses OR Give percentage of carbon in various types of steel.

Ans: Steel is an alloy of iron containing 0.25 to 2.5% of carbon and traces of S, P, Si and Mn.

Classification of Steel

1. Mild Steel (0.1 - 0.2 % C)

It is fairly soft, malleable and ductile, can be forged (shaped by hammering and pressing while hot). It is used in making tubes, nuts, bolts, bars and boiler plates.

2. Medium Carbon Steel (0.2 - 0.7 % C)

It is harder than mild steel. It is also malleable and ductile. It is used in making rails, axles, castings.

3. High Carbon Steel (0.7 -1.5 % C)

It is hard and can be forged, when containing less than 1.0% carbon. Steel containing more than 1.0% carbon cannot be forged. It is used to make hammers, taps, dies, cutting tools, machine tools, hard steel parts of machinery and all sort of engines.

28. Define corrosion.

Ans: Any process of chemical decay of metals due to the action of surrounding medium is called corrosion.

29. What is galvanizing or anode coating? OR What is sacrificial corrosion? Mention its process.

Ans: Galvanizing is done by dipping a clean iron sheet in a zinc chloride bath and heating. The iron sheet is then removed, rolled into zinc bath and air cooled. In this case, if a protective layer of zinc is damaged a galvanic cell is established in the presence of moisture. Iron serves as a cathode and zinc as an anode. Electrons flow from zinc to iron, as a result of which Zn decays while Fe remains intact. This is called **sacrificial corrosion**.



This is the way galvanizing helps protecting iron from rust. This process is used in water pipes, etc.

30. What is tin plating or cathode coating?

Ans: The process of tin plating consists of dipping the clean sheet of iron in a bath of molten tin and then passing it through hot pair of rollers. Such plates are used in the manufacture of tin canes, oil containers and other similar articles. Tin itself is very stable and protects the metals effectively as long as its coating on the iron is intact.

If the protective coating is damaged, then iron comes into contact with moisture. A galvanic cell is established in which tin acts as a cathode and iron as an anode. The electrons flow from iron to tin, where they discharge H^+ ions, leaving behind OH^- in the solution. These hydroxide ions react with iron forming $Fe(OH)_3$, which dissolves rapidly in water. From this, it can be concluded that plated iron gets rust more rapidly when the protective coating is damaged than the non-plated iron.

31. Which different methods are employed to prevent corrosion?

Ans: Different methods are used to prevent corrosion. The simplest of them consists of protecting the surface of the metal from coming in direct contact with the surrounding by coating it with oil, paint, varnish or enamel. It can also be prevented by alloying the metals or by coating the metal with a thin layer of another metal.

32. What the electrochemical theory says about corrosion? OR What is the chemistry involved in corrosion.

Ans: According to this theory, moisture and CO_2 are present on the surface of the metal. Water ionizes into H^+ and OH^- ions. CO_2 dissolves in water forming H_2CO_3 which ionizes as follows:



Suppose, copper and aluminium are in touch with each other. Copper and aluminium are, in a sense, immersed in the solution containing H^+ , OH^- and HCO_3^- ions. This forms a galvanic cell in which aluminium releases electrons and changes to Al^{3+} ion (being more reactive than Cu) i.e it acts as positive electrode and Cu acts as a negative electrode.

Aluminium ions attract OH^- ion to form, $\text{Al}(\text{OH})_3$ i.e. it starts dissolving. The H^+ ions present on the Cu receive the electrons and released as H_2 . In this way, aluminium corrodes rapidly when in contact with copper which is lower in electrochemical series. When an active metal Al (higher in the electrochemical series) comes in contact with less active metal Cu (lower in the electrochemical series) a galvanic cell is established. In this process active metal corrodes rapidly, while the other remains intact.

33. Under what conditions does aluminium corrode?

Ans: The conditions necessary for aluminium corrosion are:

- i. Aluminium is in contact with less reactive metal like Cu.
- ii. Aluminium is exposed to atmospheric moisture or salt solutions

34. What are chromates and dichromates?

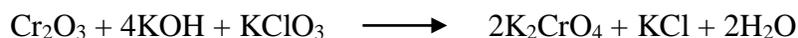
Ans: Chromates and dichromates are the salts of chromic acid, H_2CrO_4 , and dichromic acid, $\text{H}_2\text{Cr}_2\text{O}_7$, respectively. Both acids exist only in aqueous solution and when attempts are made to isolate them from solution they decompose immediately into chromic anhydride (CrO_3) and water. Their salts are, however, quite stable. All the chromates are yellow in color.

35. Mention the methods of preparation of potassium chromate.

Ans: 1. The chromates of alkali metals, which are soluble in water, are obtained by oxidizing trivalent chromium compounds in the presence of an alkali.

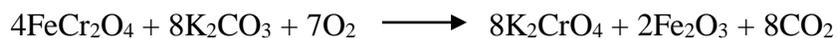


2. Chromates can also be produced by fusing Cr_2O_3 with an alkali in the presence of an oxidant, such as potassium chlorate.



3. Chromates are usually prepared from natural chromite ($\text{FeO} \cdot \text{Cr}_2\text{O}_3$), if the latter is strongly heated with potassium carbonate in the presence of the oxygen. The resulting fused mass will

contain potassium chromate, which can be extracted with water.

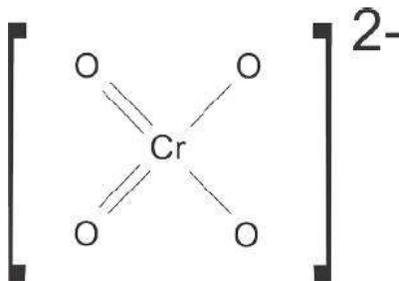


36. Write formulas of chromate and dichromate ions. In which colour they usually exist?

Ans: The formula of chromate ion is CrO_4^{2-} and that of dichromate ion is $\text{Cr}_2\text{O}_7^{2-}$. All the chromates are yellow in color.

37. What is the structure of chromate ion?

Ans: Following is the structure of chromate ion:



38. How potassium dichromate is prepared? OR How potassium chromate is converted to potassium dichromate?

Ans: 1. K_2CrO_4 is converted to $\text{K}_2\text{Cr}_2\text{O}_7$ by using the above mentioned equilibrium. In an acidic medium, the equilibrium will shift in the forward direction i.e. changing chromate ions into dichromate ions.

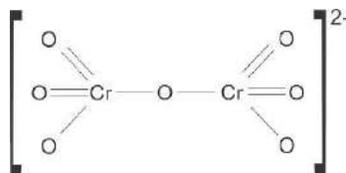


2. Sometimes sodium dichromate is converted into potassium dichromate by reacting it with KCl.



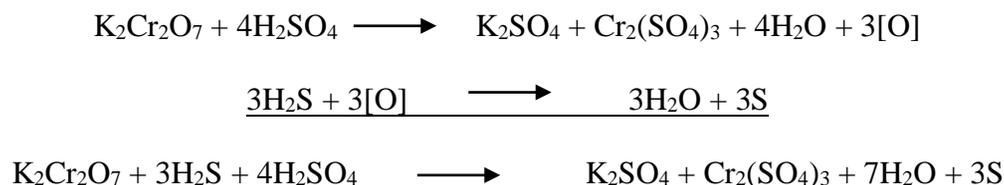
39. What is the structure of dichromate ion?

Ans: Following is the structure of dichromate ion:



40. How potassium dichromate acts as an oxidizing agent? (Mention any two reactions as answer to this question)

Ans: 1. Reaction with H₂S



2. Reaction with ferrous sulphate



3. Reaction with potassium iodide



41. What is chromyl chloride test? Mention the reaction involved.

Ans: When solid potassium dichromate is heated with solid metal chloride in the presence of concentrated sulphuric acid chromyl chloride is produced.



42. What are the uses of potassium dichromate?

Ans: Following are the uses of potassium dichromate:

- K₂Cr₂O₇ finds extensive use in dyeing.
- It is used in leather industries for chrome tanning.
- It is used as an oxidizing agent.

43. How potassium permanganate is prepared?

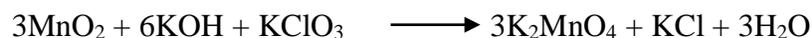
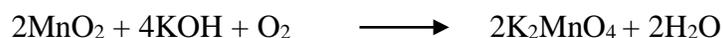
Ans: It is prepared by acidifying the solution of potassium manganate, K_2MnO_4 by H_2SO_4 .



44. How is potassium permanganate prepared on large scale?

Ans: On a large scale it is prepared from the mineral pyrolusite, MnO_2 . The finely powdered mineral is fused with KOH in the presence of air or an oxidizing agent like KNO_3 or $KClO_3$, etc.

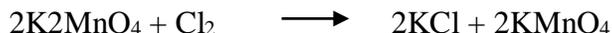
This treatment gives us green coloured potassium manganate, K_2MnO_4 , in fused state.



The fused K_2MnO_4 obtained as above is extracted with water and the solution, after filtration, is converted into potassium permanganate ($KMnO_4$) by stadelers process, passing CO_2 or electrolytic oxidation process.

45. What is Stadelers Process?

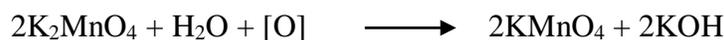
Ans: In this method Cl_2 is passed through the green solution of K_2MnO_4 until it becomes purple due to the formation of $KMnO_4$. Here, Cl_2 oxidizes K_2MnO_4 into $KMnO_4$.



46. What is Electrolytic Oxidation Process? OR How $KMnO_4$ can be prepared by electrolytic method?

Ans: The purple solution of $KMnO_4$, obtained as above is filtered through asbestos, concentrated and allowed to crystallize when $KMnO_4$ deposits as deep purple-red rhombic prisms. In this process, manganate is converted to permanganate by electrolytic oxidation. During electrolysis of an aqueous solution of K_2MnO_4 , water is decomposed to evolve hydrogen gas at the cathode and oxygen gas at the anode. Oxygen liberated at the anode oxidizes manganate ion $(MnO_4)^{2-}$ into

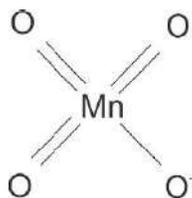
permanganate ion (MnO_4)¹⁻, while hydrogen is liberated at the cathode.



The purple solution of KMnO_4 , obtained as above is filtered through asbestos, concentrated and allowed to crystallize when KMnO_4 deposits as deep purple-red rhombic prisms.

47. What is the structure of permanganate ion?

Ans: Following is the structure of permanganate ion:



48. How potassium permanganate acts as an oxidizing agent? (Mention any two or maximum four as answer to this question)

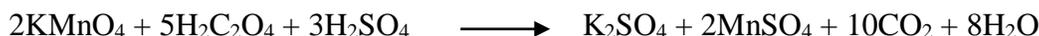
Ans: 1. Reaction with H₂S



2. Reaction with ferrous sulphate



3. Reaction with oxalic acid



4. Reaction with potassium hydroxide



49. Complete and balance the following chemical equation? $\text{KMnO}_4 + \text{FeSO}_4 + \text{H}_2\text{SO}_4 \longrightarrow$



50. What are the uses of potassium permanganate?

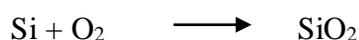
Ans: It is used:

- as an oxidizing agent.
- as a disinfectant and a germicide.
- in the manufacture of many organic compounds

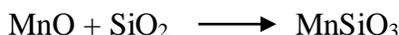
51. Give the chemistry of Bessemer process

Ans: Molten pig or cast iron (25 to 30 tons) from the blast furnace is fed into the converter and hot air blast is injected through the perforated base. This oxidizes carbon, silicon, and manganese.

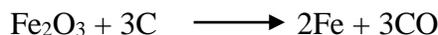
Following reactions take place in Bessemer process:



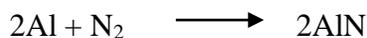
Slag formation



CO produced burns at the mouth of the converter with a blue flame. Iron is partly oxidized to ferric oxide (Fe_2O_3) which also extracts carbon from cast iron to form CO.

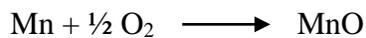
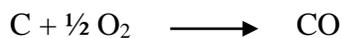


Aluminum removes nitrogen as nitride.

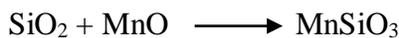
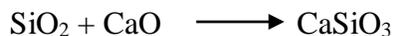


52. Give the chemistry of open hearth process.

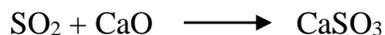
Ans: A mixture of cast iron, scrap steel and quick lime is charged into the furnace. At about 1600 °C Si, Mn, C, S, and P are burnt out and removed. Following reactions take place in open hearth process:



CO escapes in the flue gases. Silica (SiO_2) combines with CaO, MnO and FeO to form silicates (slag) which float on the surface of the molten metal.



These oxides react with calcium oxide to form slag.



53. Mention the linings used in the open hearth process or types of open hearth process.

Ans: Following are the types of linings used in the open hearth process:

1. Furnace with acidic lining like SiO_2 is used when the impurities are Mn, Si, etc.
2. Furnace with basic lining like dolomite (CaO , MgO) is used when the impurities are P and S, etc.

54. Name the processes for the manufacture of steel.

Ans: Following are the processes used for the manufacture of steel:

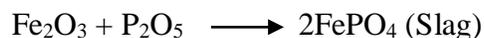
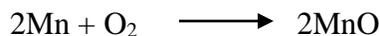
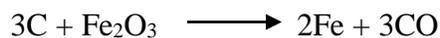
1. Open hearth process (using cast iron, wrought iron or steel scrap)
2. Bessemer's process (using cast iron only)

55. Mention the chemistry of manufacturing wrought iron from cast iron.

Ans: Following reactions take place in the manufacturing of wrought iron from cast iron:

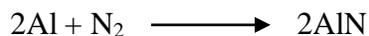


While those of manganese, silicon and phosphorus form slags.

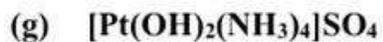
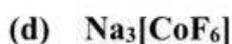
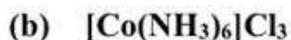


56. How entrapped bubbles of air removed from molten steel?

Ans: In order to remove entrapped bubbles of gases (blow holes) such as O_2 , N_2 , CO_2 , a little aluminium or ferro-silicon is added. Aluminium removes nitrogen as nitride.



57. Give systematic names to following complexes.



Ans:

(a) Penta carbonyl iron (0)

(b) Hexa ammine cobalt (III) chloride

(c) Hexaaqua iron (II) ion

(d) Sodium hexafluoro cobaltate (III)

(e) Potassium tetracyano cuprate (II)

(f) Potassium hexachloro platinate (IV)

(g) Tetra ammine dihydroxo platinum (IV) sulphate

(h) Triaqua trihydroxo chromium (III)

Chapter#7
Fundamental Principles of Organic Chemistry

1. What is vital force theory?

Ans: The early chemists never succeeded in synthesizing organic compounds and their failure led them to believe that organic compounds could be manufactured only by and within living things and these compounds could never be synthesized from inorganic materials. This theory was referred to as vital force theory.

2. Who rejected vital force theory? OR Name the organic compound first of all prepared in the laboratory and how?

Ans: This theory was rejected by Friedrich Wohler when he obtained urea $(\text{NH}_2)_2\text{CO}$, an organic compound in the urine of mammals, from ammonium cyanate, NH_4CNO .

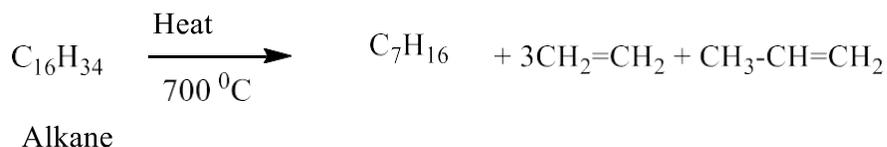


3. Define organic chemistry.

Ans: Organic chemistry is that branch of chemistry which deals with the study of compounds of carbon with hydrogen (hydrocarbons) and their derivatives.

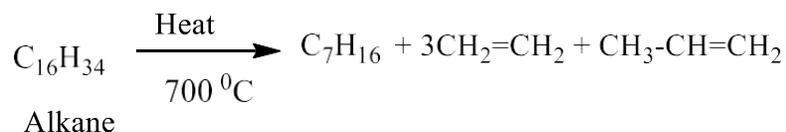
4. What is cracking?

Ans: It is defined as breaking of higher hydrocarbons having high boiling points into a variety of lower hydrocarbons, which are more volatile (low boiling). For example, a higher hydrocarbon $\text{C}_{16}\text{H}_{34}$ splits according to the following reaction.



5. What is thermal cracking?

Ans: Breaking down of large molecules by heating at high temperature and pressure is called Thermal Cracking. It is particularly useful in the production of unsaturated hydrocarbons such as ethene and propene.



6. What is catalytic cracking?

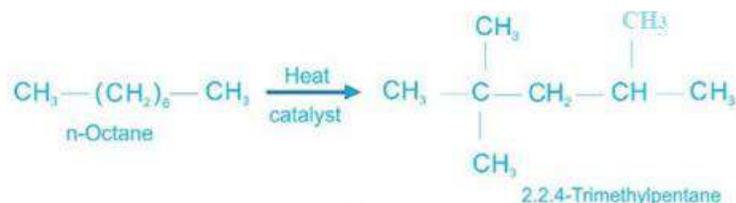
Ans: Higher hydrocarbons can be cracked at lower temperature (500°C) and lower pressure (2 atm), in the presence of a suitable catalyst. A typical catalyst used for this purpose is a mixture of silica (SiO₂) and alumina (Al₂O₃). Catalytic cracking produces gasoline of higher octane number and, therefore, this method is used for obtaining better quality gasoline.

7. What is steam cracking?

Ans: In this process, higher hydrocarbons in the vapour phase are mixed with steam, heated for a short duration to about 900°C and cooled rapidly. The process is suitable for obtaining lower unsaturated hydrocarbons.

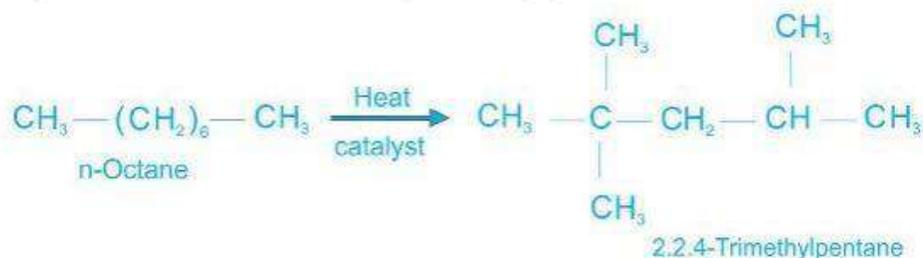
8. Explain reforming.

Ans: The octane number of gasoline is improved by a process called reforming. It involves the conversion of straight chain hydrocarbons into branched chain by heating in the absence of oxygen and in the presence of a catalyst.



9. What is octane number and how it can be improved?

Ans: Percentage by volume of isooctane relative to that of n-heptane in a fuel is called octane number. Octane number is improved by making Isooctane through the process of reforming and adding it to a low octane number fuel.



10. Branched hydrocarbons are better as a fuel as compared to straight chain. Explain.

Ans: Straight chain hydrocarbons e.g., n-Octane have low octane number and burn rapidly in internal combustion engine producing sharp metallic sound called knocking. Branched chain hydrocarbons e.g., Isooctane, on the other hand, are a good quality fuel as they do not cause knocking. This is because branched chain hydrocarbons have a higher octane number and burn smoothly.

11. What is meant by knocking?

Ans: Straight chain hydrocarbons e.g., n-Heptane have low octane number and burn rapidly in internal combustion engine producing sharp metallic sound called knocking.

12. How does cracking and reforming differ from each other?

Ans:

	Cracking	Reforming
1.	Conversion of long chain hydrocarbons having higher boiling points to lower hydrocarbons which are more volatile	Conversion of straight chain hydrocarbons which are low quality fuel to branched chain hydrocarbons which are good quality fuel
2.	It is used to increase the amount of hydrocarbons suitable for making gasoline	It is used to improve the octane number of fuel
3.	It is done using heat, steam or heating hydrocarbons in presence of a catalyst	It is done by heating hydrocarbons in presence of a catalyst.

13. What are open chain or acyclic compounds?

Ans: This type of compounds contain an open chain of carbon atoms. The chains may be branched or non-branched (straight chain). The open chain compounds are also called aliphatic compounds. They are further divided into:

1. Straight chain compounds
2. Branched chain compounds

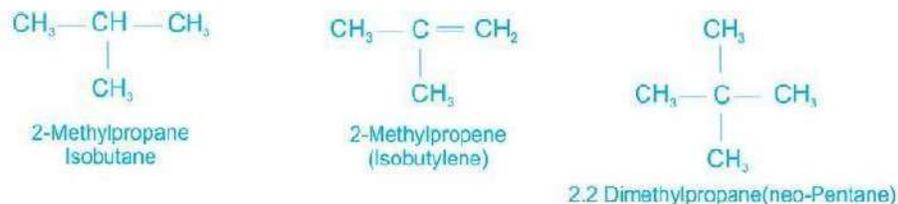
14. What are straight chain (or non-branched) compounds?

Ans: Those organic compounds in which the carbon atoms are connected in series from one to the other.



15. What are branched chain compounds?

Ans: Those organic compounds in which the carbon atoms are attached on the sides of chain.



16. What are closed chain compounds?

Ans: These compounds contain closed chains or rings of atoms and are known as cyclic or ring compounds. These are of two types:

- (a) Homocyclic or carbocyclic compounds
- (b) Heterocyclic compounds

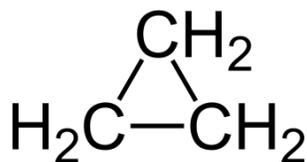
17. What are homocyclic or carbocyclic compounds?

Ans: The compounds in which the ring consists of only carbon atoms Homocyclic or carbocyclic

compounds.

Homocyclic compounds are further classified as:

1. Alicyclic compounds



Cyclopropane

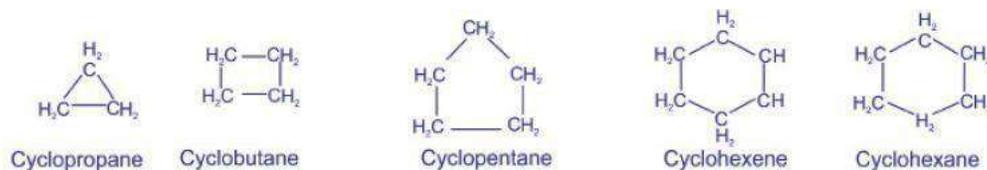
2. Aromatic compounds



Benzene

18. What are alicyclic compounds?

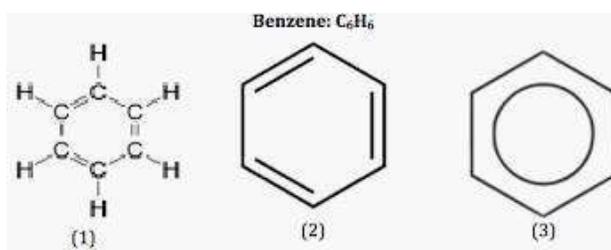
Ans: The homocyclic compounds which contain a ring of three or more carbon atoms and resembling aliphatic compounds are called alicyclic compounds. The saturated alicyclic hydrocarbons have the general formula C_nH_{2n} . Typical examples of alicyclic compounds are given below.



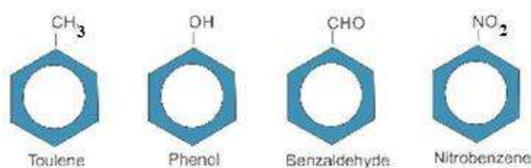
19. What are aromatic compounds?

Ans: These carbocyclic compounds contain at least one benzene ring, six carbon atoms with three alternate double and single bonds. These bonds are usually shown in the form of a circle.

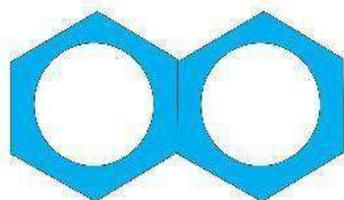
Typical examples of aromatic compounds are given below. For example



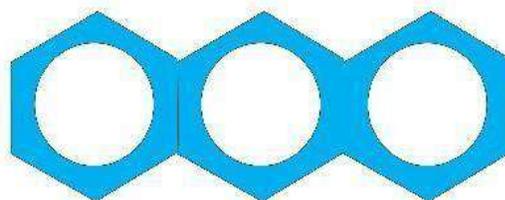
The aromatic compounds may have a side-chain or a functional group attached to the ring. For example:



The aromatic compounds may also contain more than one benzene rings fused together.

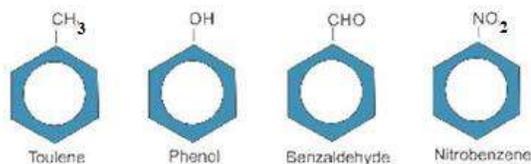


Naphthalene



Anthracene

20. Give structures of toluene, phenol, benzaldehyde, nitrobenzene, naphthalene, anthracene.



Ans:



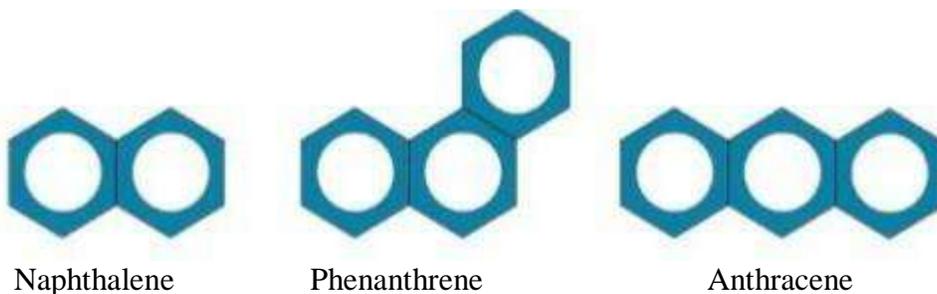
Naphthalene



Anthracene

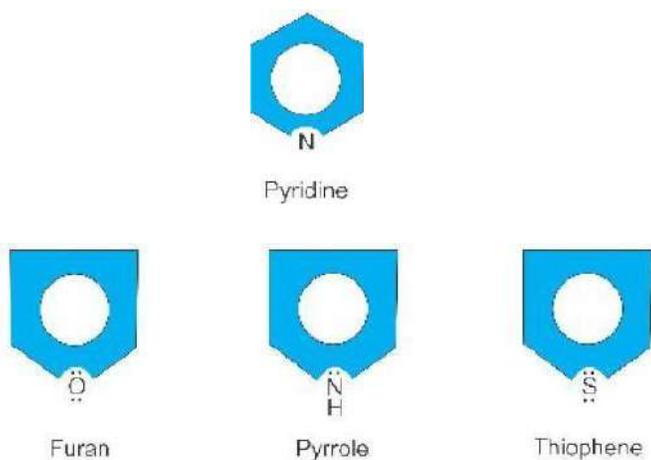
21. What are fused ring aromatic compounds?

Ans: Those in which the benzene rings are fused together at ortho positions so that the adjacent rings have a common carbon to carbon bonds, e.g. naphthalene, phenanthrene and anthracene.



22. What are heterocyclic compounds?

Ans: The compounds in which the ring consists of atoms of more than one kind are called heterocyclic compounds or heterocycles. In heterocyclic compounds generally one or more atoms of elements such as nitrogen (N), oxygen (O) or sulphur (S) are present. The atom other than carbon viz, N, O, or S, present in the ring is called a hetero atom.



23. Give structures of pyridine, furan, pyrrole, thiophene.



Ans: Pyridine



Furan



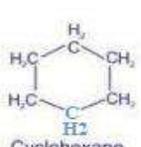
Pyrrole



Thiophene

24. Differentiate between homocyclic and heterocyclic compounds.

Ans: Following are the differences between homocyclic and heterocyclic compounds:

	Homocyclic Compounds	Heterocyclic Compounds
1.	The compounds in which the ring consists of only one type of atoms	The compounds in which the ring consists of atoms of more than one kind
2.	Organic homocyclic compounds have ring made of carbon atoms only.	Generally one or more atoms of elements such as nitrogen (N), oxygen (O) or sulphur (S) are present in the ring.
3.	 Cyclohexane  Phenol	 Pyridine

25. Define homologous series.

Ans: A series of chemically similar organic compounds having same general formula is called a homologous.

Homologous Series	General Formula
Alkanes	C_nH_{2n+2}
Alkenes	C_nH_{2n}
Alkynes	C_nH_{2n-2}

26. Define functional group. Give examples.

Ans: An atom or a group of atoms or a double bond or a triple bond whose presence imparts specific properties to organic compounds is called a functional group, because they are the

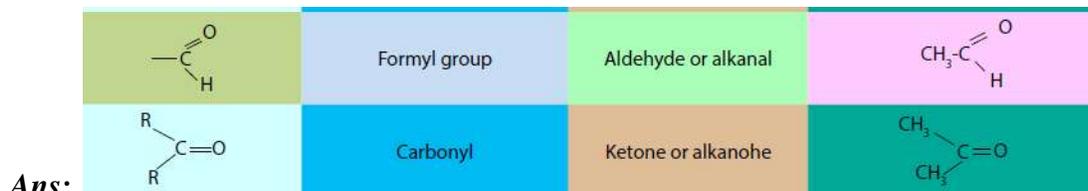
chemically functional parts of molecules.

Example

COOH carboxyl group carboxylic acid CH_3COOH Acetic acid

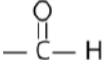
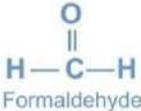
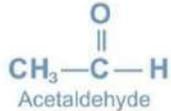
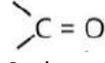
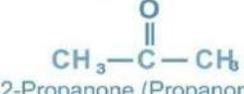
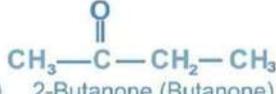
-SH mercapto thioalcohol or thiol $\text{CH}_3\text{CH}_2\text{SH}$ Ethyl thiol

27. Give names of any two functional groups containing oxygen.



28. Write the functional group of aldehyde and ketone. Give one example.

Ans:

	Functional Group	Example
Aldehyde	 Formyl	 Formaldehyde  Acetaldehyde
Ketone	 Carbonyl	 2-Propanone (Propanone)  2-Butanone (Butanone)

29. Define hybridization.

Ans: When atomic orbitals of different energy and shape intermix to form a new set of orbitals of same shape and energy then it is called hybridization.

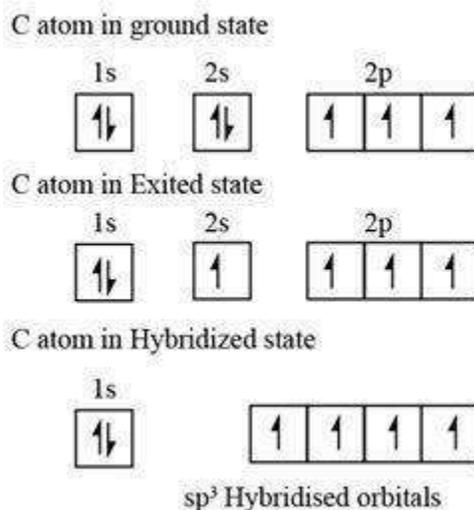
30. Define sp^3 hybridization.

Ans: In sp^3 hybridization, one s and three p atomic orbitals intermix to form four equivalent orbitals called sp^3 hybrid atomic orbitals. Examples CH_4 , NH_3 and H_2O .

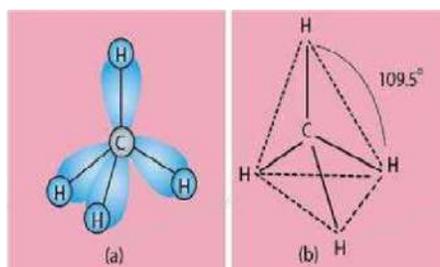
31. Discuss structure of methane according to sp^3 .

Ans: Electronic configuration of ${}_6\text{C}$, its electronic excitation and hybridization is given as

follows:



The hybrid orbitals are oriented in space in such a manner that the angle between them is 109.5° . Methane molecule is formed by the overlap of sp^3 hybrid orbitals of carbon with 1s orbitals of four hydrogen atoms separately to form four sigma bonds. The molecule possesses a tetrahedral geometry. The four C-H bonds which result from sp^3 -s overlaps are directed towards the corners of a regular tetrahedron. There are six bond angles each 109.5° . The structure of CH_4 has four faces, four corners and six edges.

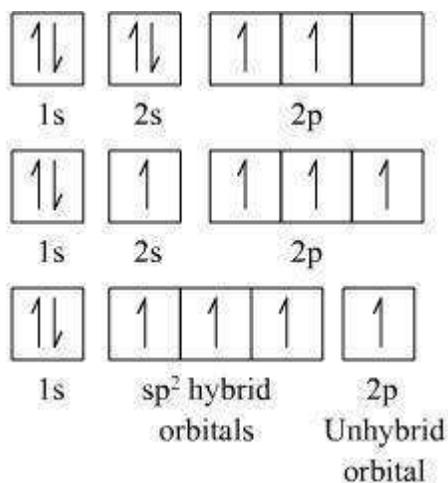


32. Define sp^2 hybridization.

Ans: In sp^2 hybridization, one 's' and two 'p' atomic orbitals of an atom intermix three orbitals called sp^2 hybrid orbitals. Example BF_3 and Ethene.

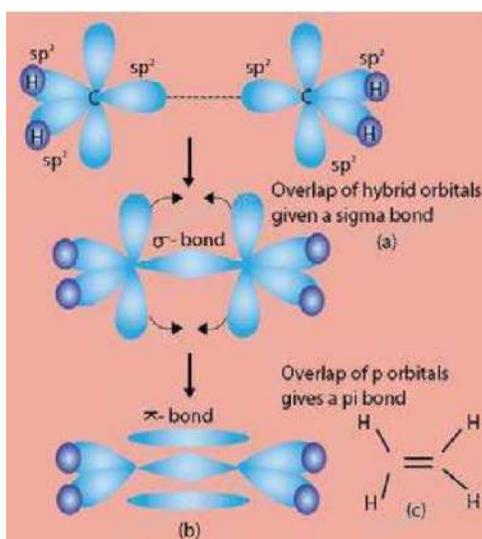
33. Explain structure of ethene (ethylene) according to hybridization.

Ans: Electronic configuration of ${}_6\text{C}$ is:



In the formation of ethene molecule, each carbon atom undergoes sp^2 hybridization to form three hybrid orbitals which are co-planar and are oriented at an angle of 120° . Each atom is left with one half-filled p-orbital perpendicular to the planar sp^2 hybrid orbitals.

Each carbon atom undergoes sp^2 -s overlaps with two hydrogen atoms and sp^2 - sp^2 overlap to form sigma bonds. The partially filled p-orbitals undergo sideways overlap to form a π -bond.



34. Define pi bond.

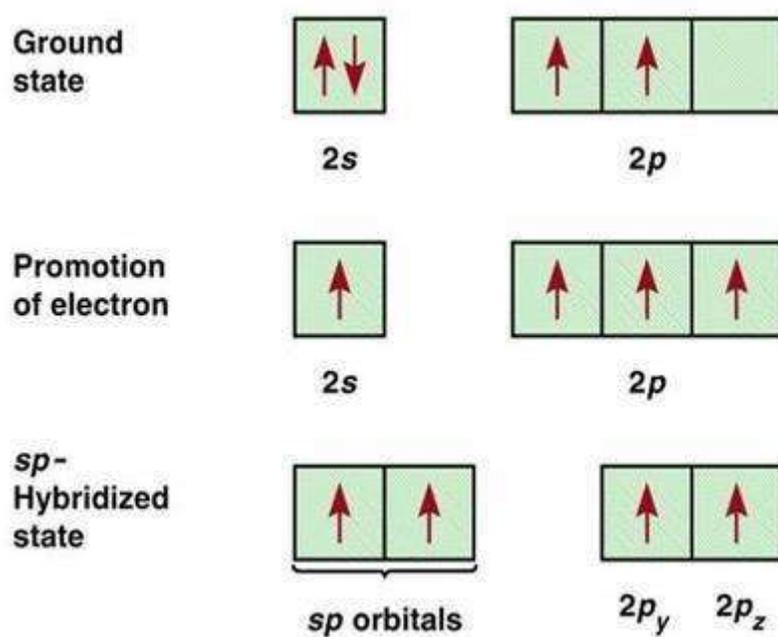
Ans: A pi-bond is formed by the sideways overlap of two half-filled co-planar p-orbitals in such a way that the probability of finding the electron is maximum perpendicular to the line joining the two nuclei.

35. Define sp hybridization.

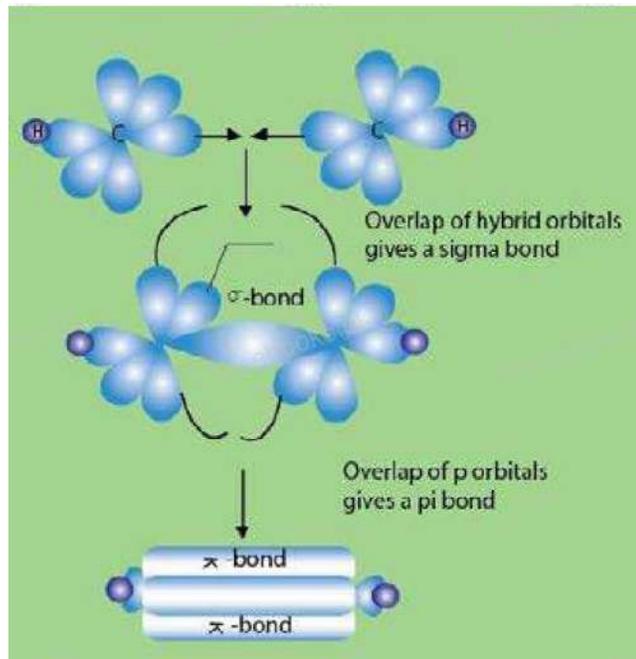
Ans: In sp hybridization, one 's' and one 'p' orbitals intermix to form two sp-hybrid orbital called sp hybrid orbitals. Examples BeCl_2 and ethyne.

36. Explain structure of ethyne according to hybridization.

Ans: Electronic configuration of ${}_6\text{C}$ is



Each carbon atom undergoes sp^3 overlap with one hydrogen atom and sp^3 - sp^3 overlap with other carbon atom. Each carbon atom is left with two unhybridized p orbitals perpendicular to the plane of sp^3 hybrid orbitals. The sideways overlap between the p -orbitals results in the formation of two π -bonds. Ethyne molecule contains one sigma and two π -bonds between the two carbon atoms and each carbon atom is bonded with, one H atom through s bond. Four electronic clouds of two π -bonds intermix and they surround the sigma bond in the shape of a drum.



37. Explain the types of bonds and the shapes of the following molecules using hybridization approach.

Ans: CH₃-CH₃

All sigma bonds, sp³ hybridized, tetrahedral shape

CH₂=CH₂

Seven sigma bonds, one pi-bond, sp² hybridized, triangular shape

CH≡CH

Three sigma bonds, two pi-bonds, sp hybridized, linear shape

HCHO

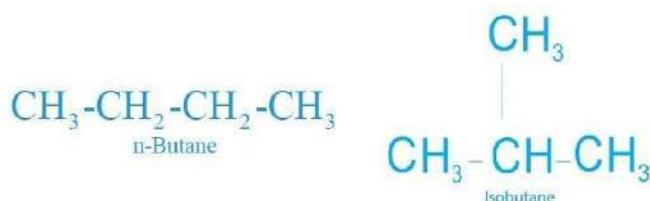
Three sigma bonds, one pi-bond, sp² hybridized, triangular shape

CH₃-Cl

All sigma bonds, sp³ hybridized, tetrahedral shape

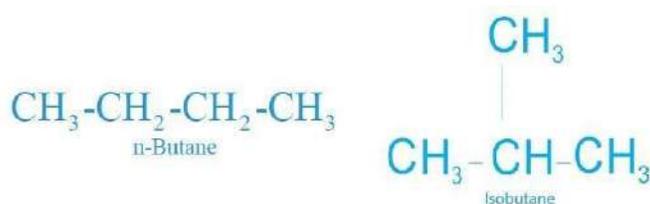
38. Define isomerism.

Ans: Two or more compounds having the same molecular formula but different structural formulas and properties are said to be isomers and the phenomenon is called isomerism.



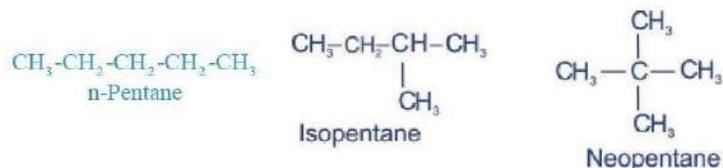
39. Define structural isomerism.

Ans: The structural isomerism is not confined to hydrocarbons only. In fact, all classes of organic compounds and their derivatives show the phenomenon of structural isomerism. The structural isomerism arises due to the difference in the arrangement of atoms within the molecule.



40. Define chain isomerism.

Ans: This type of isomerism arises due to the difference in the nature of the carbon chain. For example, for pentane (C_5H_{12}), the following arrangements are possible.

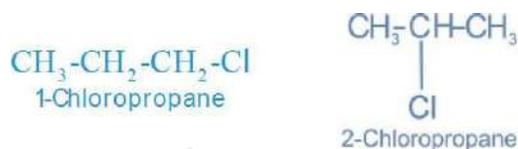


41. Define position isomerism.

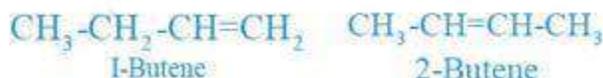
Ans: This type of isomerism arises due to the difference in the position of the same functional

group on the carbon chain. The arrangement of carbon atoms remains the same. For example,

(a) Chloropropane can have two positional isomers given below.



(b) Butene (C_4H_8) can have two positional isomers.



42. Define functional group isomerism.

Ans: The compounds having the same molecular formula but different functional groups are said to exhibit functional group isomerism. For example, there are two compounds having the same molecular formula $\text{C}_2\text{H}_6\text{O}$, but different arrangement of atoms.

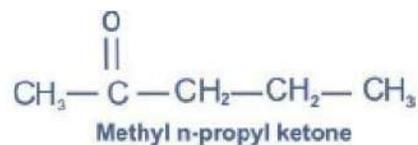
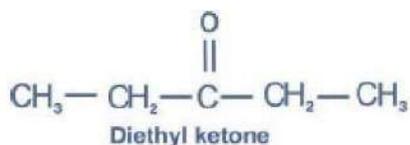


43. Define metamerism.

Ans: This type of isomerism arises due to the unequal distribution of carbon atoms on either side of the functional group. Such compounds belong to the same homologous series. For example, diethyl ether and methyl n-propyl ether are metamers.

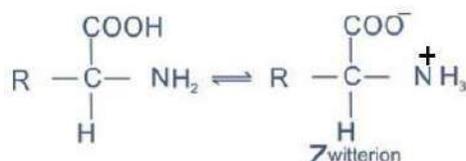


For a ketonic compound having the molecular formula $\text{C}_5\text{H}_{10}\text{O}$, the following two metamers are possible.



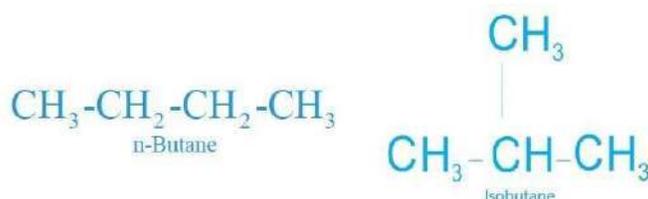
44. Define tautomerism. Give an example.

Ans: This type of isomerism arises due to shifting of proton from one atom to other in the same molecule.



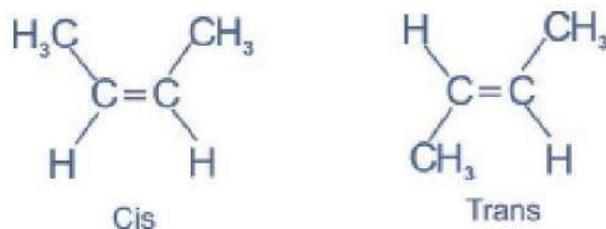
45. Write structural formulas of the two possible isomers of C_4H_{10} .

Ans:



46. What is cis-trans isomerism/geometric isomerism?

Ans: Such compounds which possess the same structural formula, but differ with respect to the positions of the identical groups in space are called cis-trans isomers and the phenomenon is known as the cis-trans or geometric isomerism.



47. Why free rotation is not possible in case of a double bond?

Ans: A single bond is a sigma bond formed by the head to head overlap of half-filled orbitals. The electrons of this bond are on the line joining the nuclei and allow rotation of atoms on nuclear axis in alkanes. A double bond consists of a sigma and a pi bond. A pi bond is formed by the parallel overlap of the half-filled orbitals and its electron cloud lies above and below the nuclear axis. This parallel overlap of the orbitals in a pi bond restricts rotation of the double bonded carbon atoms in alkenes.

48. What are the important conditions of cis-trans isomerism?

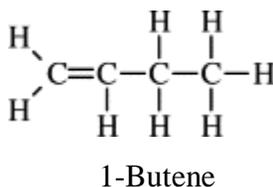
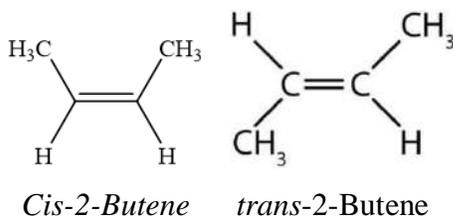
Ans: The conditions for cis-trans isomerism are:

1. Restricted rotation of carbon atoms due to a double bond.
2. Two different groups attached to each carbon atom making the double bond.

49. 2-Butene shows geometric isomerism but 1-Butene does not. Why?

Ans: The conditions for cis-trans isomerism are:

3. Restricted rotation of carbon atoms due to a double bond.
4. Two different groups attached to each carbon atom making the double bond.



2-Butene meets both these conditions therefore shows geometric or cis-trans isomerism. 1-Butene has two hydrogen atoms on first carbon atom therefore it does not fulfill the second condition necessary for geometric isomerism, hence, no cis or trans isomers are seen in its

case.

50. What is carbonization or destructive distillation of coal?

Ans: Carbonization or destructive distillation is when coal is heated in the absence of air (temperature ranging from 500-1000° C); it is converted into coke, coal gas and coal tar. Coal tar contains a large number of organic compounds, which separate out on fractional distillation.

51. What is importance of gasoline and gas oil?

Ans: Gasoline fraction of petroleum has hydrocarbons from C_4H_{10} to $C_{13}H_{28}$ with a boiling point range of 40 to 220 °C. Gasoline is used as a motor fuel. Gas oil fraction ranges from $C_{12}H_{26}$ to $C_{18}H_{38}$ with boiling points above 275 °C. This fraction is used as diesel and heating fuel.

52. What are the uses of Asphalt and Kerosene?

Ans: Asphalt of the petroleum coke is the solid fraction of crude oil and is obtained as residue after fractional distillation. It is used for paving, roofing and a fuel reducing agent. Kerosene fraction ranges from C_8H_{18} to $C_{14}H_{30}$. Its boiling point ranges from 175 – 325 °C and it is used as a heating agent.

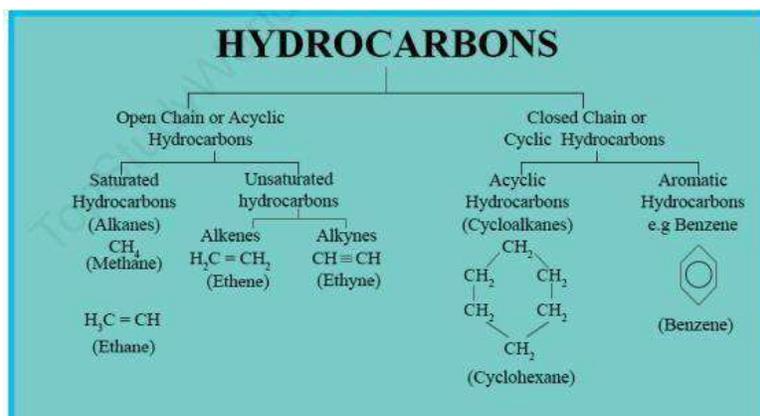
For uses of various fractions see the table below

Fraction	Boiling Point Rang (°C)	Composition	Uses
Natural gas	< 20	$\text{CH}_4 - \text{C}_4\text{H}_{10}$	Fuel, petrochemicals
Petroleum Ether	20 - 60	$\text{C}_5\text{H}_{12}, \text{C}_6\text{H}_{14}$	Solvent
Ligroin, or naphtha	60 - 100	$\text{C}_6\text{H}_{14}, \text{C}_7\text{H}_{16}$	Solvent, raw material
Gasoline	40- 220	$\text{C}_4\text{H}_{10} - \text{C}_{13}\text{H}_{28}$ mostly $\text{C}_6\text{H}_{14} - \text{C}_8\text{H}_{18}$	Motor fuel
Kerosene	175 - 325	$\text{C}_8\text{H}_{18} - \text{C}_{14}\text{H}_{30}$	Heating fuel
Gas oil	> 275	$\text{C}_{12}\text{H}_{26} - \text{C}_{18}\text{H}_{38}$	Diesel and heating fuel
Lubricating oils and greases	Viscous liquids	$> \text{C}_{16}\text{H}_{38}$	Lubrication
Paraffin	M.p. 50 - 60	$\text{C}_{23}\text{H}_{48} - \text{C}_{29}\text{H}_{60}$	Wax products
Asphalt, or petroleum coke	Solids	Residue	Roofing, paving, fuel reducing agent

Chapter#8 Aliphatic Hydrocarbons

1. How are the hydrocarbons classified?

Ans:



2. Mention physical properties of alkanes (Mention any four properties as an answer to short question)

Ans: Following are the physical properties of alkanes:

1. Alkanes containing up to four carbon atoms are colourless, odourless gases while pentane to heptadecane (C₅ to C₁₇) are colourless, odourless liquids. The higher members from C₁₈ onwards are waxy solids which are also colourless and odourless.
2. Alkanes are non-polar or very weakly polar and are insoluble in polar solvents like water, but soluble in non-polar solvents like benzene, ether, carbon tetra chloride, *etc.*
3. Their physical constants like boiling points, melting points, density, *etc.* increase with the increase in number of carbon atoms, whereas solubility decreases with increase in molecular mass. The boiling point increases by 20 to 30 °C for addition of each CH₂ group to the molecule. The boiling points of alkanes having branched chain structures are lower than their isomeric normal chain alkanes, e.g. n-butane has a higher boiling point-0.50 C than isobutane (-11.7°C).
4. The melting points of alkanes also increase with the increase in molecular mass but this increase

is not so regular.

3. Why alkanes are called so? Give reason.

Ans: The alkanes or paraffins (Latin: parum = little, affins = affinity) under ordinary condition are inert towards acids, alkalis, oxidizing and reducing agents.

The unreactivity of alkanes under normal conditions may be explained on the basis of the non-polarity of the bonds forming them. The electronegativity values of carbon (2.5) and hydrogen (2.1) do not differ appreciably and the bonding electrons between C-H and C-C are equally shared making them almost nonpolar. In view of this, the ionic reagents such as acids, alkalies, oxidizing agents, etc find no reaction site in the alkane molecules to which they could be attached.

4. Which type of reactions alkanes undergo?

Ans: Alkanes undergo two types of reactions:

1. Substitution Reactions
2. Thermal and Catalytic Reactions

These reactions take place at high temperature or on absorption of light energy through the formation of highly reactive free radicals.

5. Why sigma bond is inert?

Ans: The unreactivity of alkanes can be explained on the basis of inertness of a sigma bond. In a sigma bond the electrons are very tightly held between the nuclei which make it a very stable bond. A lot of energy is required to break it. Moreover the electrons present in a sigma bond can neither attack on any electrophile nor a nucleophile can attack on them. Both these facts make alkanes less reactive.

6. What are the uses of methane?

Ans: Methane is used:

- (i) As a fuel and as an illuminating gas
- (ii) For the preparation of methyl chloride, dichloromethane, chloroform and carbon tetrachloride.

(iii) For the industrial preparation of methyl alcohol, formaldehyde and hydrogen cyanide.

(iv) For the preparation of carbon black used in paints, printing inks and automobile tyres.

(v) Is used to manufacture urea fertilizer.

7. Why alkenes are called so?

Ans: They are also known as Olefins (derived from Latin word olefiant meaning oil forming) because lower members form oily products on treatment with chlorine or bromine.

8. Mention physical properties of alkenes (Mention any four properties as an answer to short question)

Ans: Following are the physical properties of alkenes:

1. First three members i.e. ethene, propene and butene are gases at room temperature while C_5 to C_{15} are liquids and the higher members are solids
2. They are insoluble in water but soluble in alcohol.
3. They have characteristic smell and burn with luminous flame.
4. Unlike alkanes, they show weakly polar properties because of sp^2 hybridization.

9. Why pi bond is reactive?

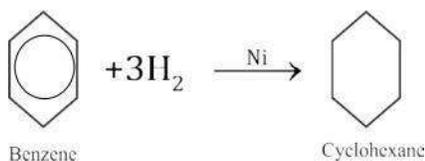
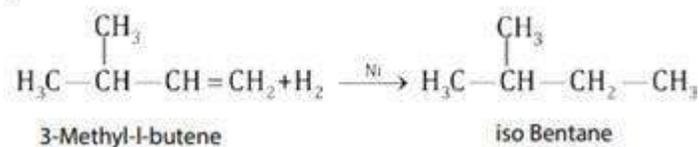
Ans: In the formation of a π -bond, the partially filled p-orbitals overlap in a parallel fashion. The probability of finding electron is thus away from the line joining the two nuclei. Due to this reason π -electrons are less firmly held between the nuclei. A π -bond is, therefore, a weak bond as compared to a sigma bond. During a reaction it breaks comparatively easily rendering alkenes as reactive group of compounds. Moreover, the loosely held π -electrons are more exposed to attack by the electrophilic reagents. Alkenes, therefore, undergo electrophilic reactions very easily.

10. What is Raney-Nickel catalyst?

Ans: It is prepared by treating a Ni — Al alloy with caustic soda.

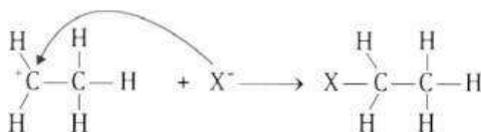
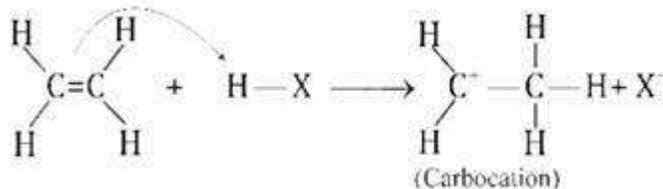


Most alkenes are hydrogenated over Raney nickel at about 100 °C and up to 3 atmospheric pressure.



11. State Markovnikov's rule.

Ans: In the addition of an unsymmetrical reagent to an unsymmetrical alkene, the negative part of the adding reagent goes to that carbon, constituting the double bond, which has least number of hydrogen atoms.



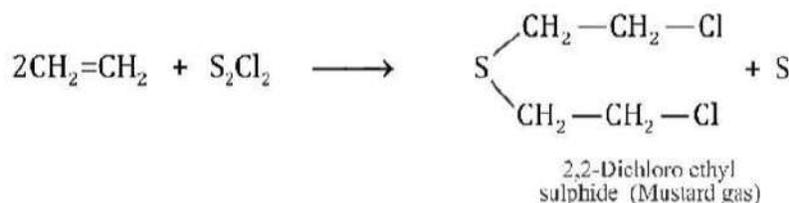
12. Give uses of ethane.

Ans: Ethene is used:

1. for the manufacture of polythene, a plastic material used for making toys, cables, bags, boxes,

etc.

2. for artificial ripening of the fruits.
3. as a general anesthetic.
4. for preparing 'Mustard gas' a chemical used in World War I. The name comes from its mustard like odour. It is not a gas, but a high boiling liquid that is dispersed as a mist of tiny droplets. It is a powerful vesicant i.e., causes blisters.



5. as a starting material for a large number of chemicals of industrial use such as glycols (antifreeze), ethyl halide, ethyl alcohol, etc.

13. Mention physical properties of alkynes (Mention any four as an answer to short question)

Ans: Following are the physical properties of alkynes:

1. They are colourless, odourless, except acetylene which has a garlic like odour,
2. The first three members are gases (ethyne, propyne, butyne) at room temperature, the next eight members ($\text{C}_5 - \text{C}_{12}$) are liquids and higher members are solids.
3. The melting points, boiling points and densities increase gradually with the increase in molecular masses.
4. They are nonpolar and dissolve readily in solvents like ether, benzene and carbon tetrachloride

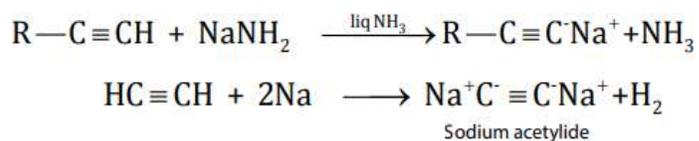
14. Tell about reactivity of alkynes.

Ans: In alkynes, the carbon atoms are held together by a triple bond, a s-bond and two p-bonds. The electron density between the carbon atoms is very high which draws atoms very close to each

other. Electrons in a triple bond are, therefore, less exposed and less reactive towards electrophilic reagents.

15. Why alkynes have acidic nature?

Ans: In ethyne and other terminal alkynes like propyne, the hydrogen atom is bonded to the carbon atom with sp-s overlap. An sp hybrid orbital has 50% s-character in it and renders the carbon atom more electronegative than sp² and sp³ hybridized carbons. As a result, the sp hybridized carbon atom of a terminal alkyne pulls the electrons more strongly making the attached hydrogen atom slightly acidic.



16. Give uses of ethyne.

Ans: Ethyne is used:

1. In oxyacetylene torch which is in turn used for welding and cutting metals.
2. For the preparation of alcohols, acetic acid and acetaldehyde.
3. For the manufacture of polymers like PVC, polyvinyl acetate, polyvinyl ethers, orlon and neoprene rubber.
4. To prepare acetylene tetrachloride a solvent for varnishes, resins, and rubber.
5. For ripening of fruits.

17. Compare reactivity of alkanes, alkenes, alkynes.

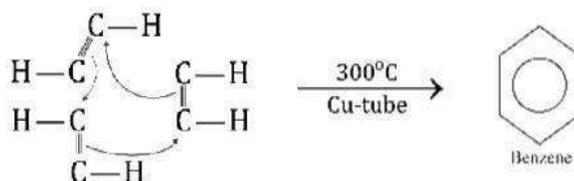
Ans: The general decreasing reactivity order of alkanes, alkenes and alkynes is as follows:



A π -bond in alkenes is not only weak but its electrons are more exposed to an attack by an electrophilic reagent. Both these facts make the alkenes a very reactive class of compounds. Alkynes although contain two π -bonds are less reactive than alkenes towards electrophilic reagents. This is because the bond distance between the two triple bonded carbon atoms is very short and hence the π -electrons are not available to be attacked by electrophilic reagents. Alkynes are, however, more reactive than alkenes towards nucleophilic reagents

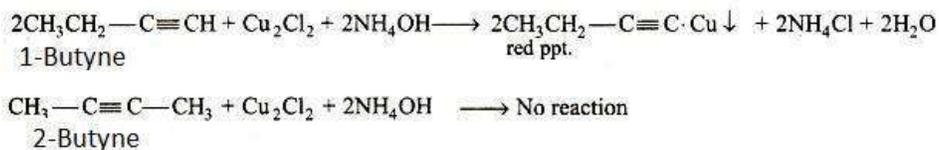
18. How would you establish that benzene is a polymer of acetylene?

Ans: When acetylene is passed through a copper tube at 300°C, it polymerizes to benzene.



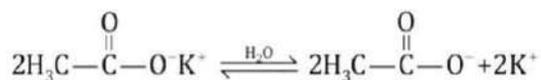
19. How do you distinguish between 1-Butyne and 2-Butyne? OR How Ammonical solution of AgNO₃ can be used to distinguish between 1-Butyne and 2-Butyne?

Ans: 1-Butyne is a terminal alkyne and thus acidic in nature. It therefore reacts with cuprous chloride Cu₂Cl₂ in presence of NH₄OH to produce a red precipitate. In 2-Butyne triple bond is not terminal hence triple bonded carbon atoms do not have a hydrogen atom attached and therefore lack acidic character. It gives no reaction with cuprous chloride Cu₂Cl₂ in presence of NH₄OH.

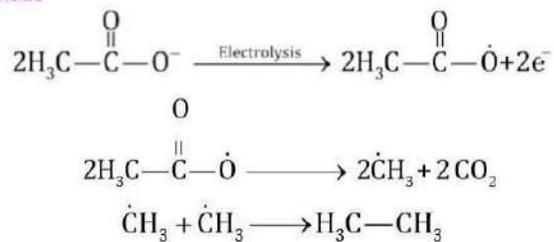


20. Write mechanism for Kolbe's electrolytic method for preparation of an alkane.

Ans:



At Anode



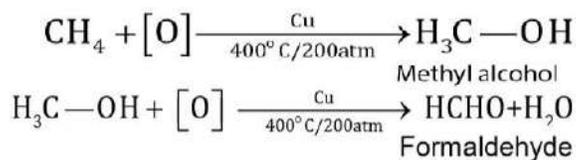
At Cathode



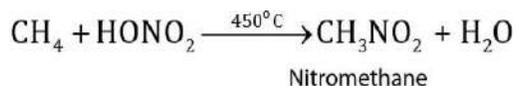
21. Convert methane into i. Formaldehyde ii. Nitromethane

Ans:

Methane into Formaldehyde



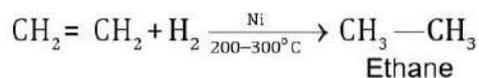
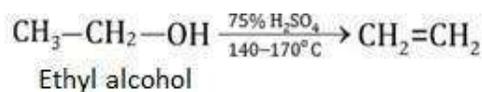
Methane into Nitromethane



22. Prepare Ethane from i. Ethyl alcohol ii. Ethyl chloride

Ans:

Ethane from Ethyl alcohol

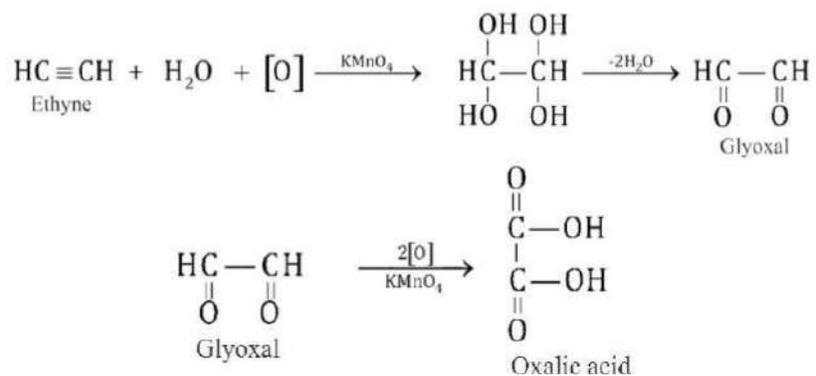


Ethane from Ethyl chloride



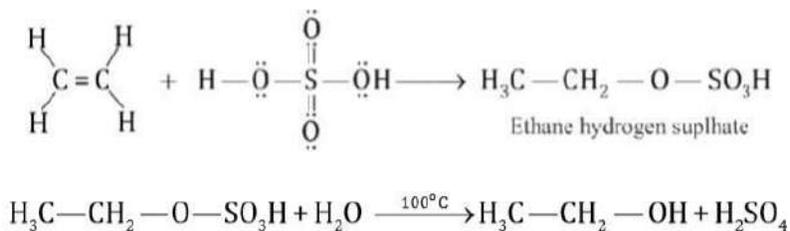
23. Write the chemical equation when alkaline KMnO_4 reacts with ethyne.

Ans:



24. Ethene can be converted to ethyl alcohol. Write equation.

Ans:

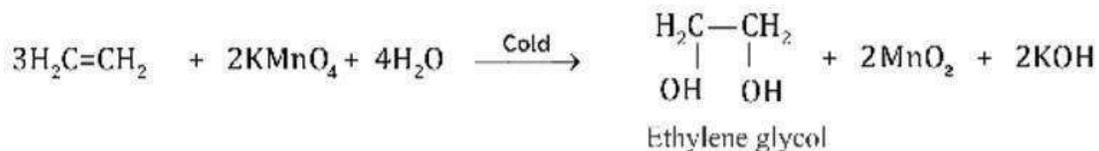


25. What is Baeyer's test? What is it used for?

Ans:

When alkenes are treated with mild oxidizing reagents like dilute (1%) alkaline KMnO_4 solution (Baeyer's Reagent) at low temperature, hydroxylation of double bond occurs resulting in the formation of dihydroxy compounds known as vicinal glycols. The pink colour of KMnO_4 solution is discharged during the reaction. This test is used to check the presence of unsaturation

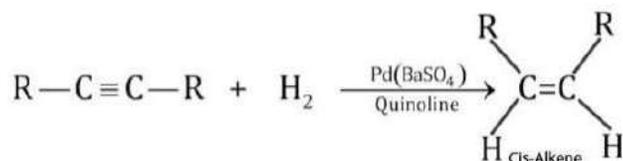
in the molecules. For example,



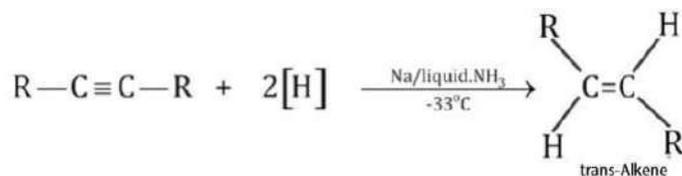
26. How cis and trans alkenes are produced? Give reactions.

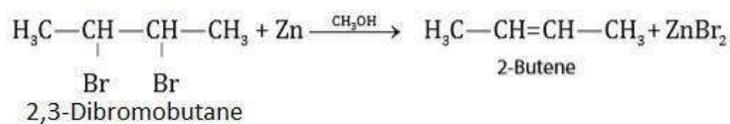
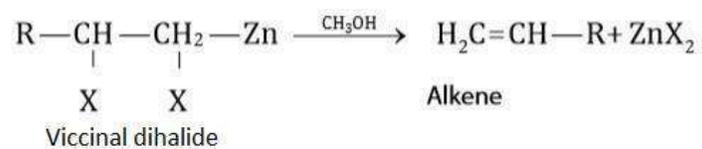
Ans:

Controlled hydrogenation of alkynes with hydrogen gas in an equimolar ratio over heated catalysts, gives alkenes. The catalyst is finely divided palladium supported on BaSO₄ and poisoned by treatment with quinoline (Lindlar's catalyst).



A trans alkene can be obtained by treating an alkyne with Na in liquid NH₃ at -33°C.





30. Write the structural formula for each of the following compounds.

i) 2-Methylpropane.

iii) 3-Ethylpentane.

v) 2,2,3,4-Tetramethylpentane

vii) 2,2-Dimethylbutane.

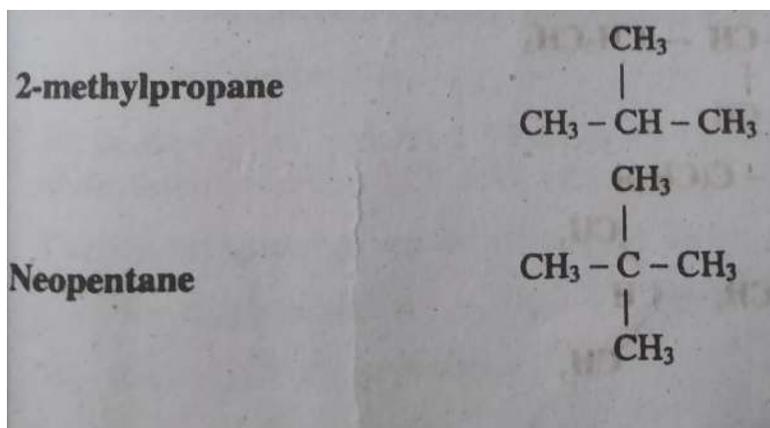
ii) Neopentane.

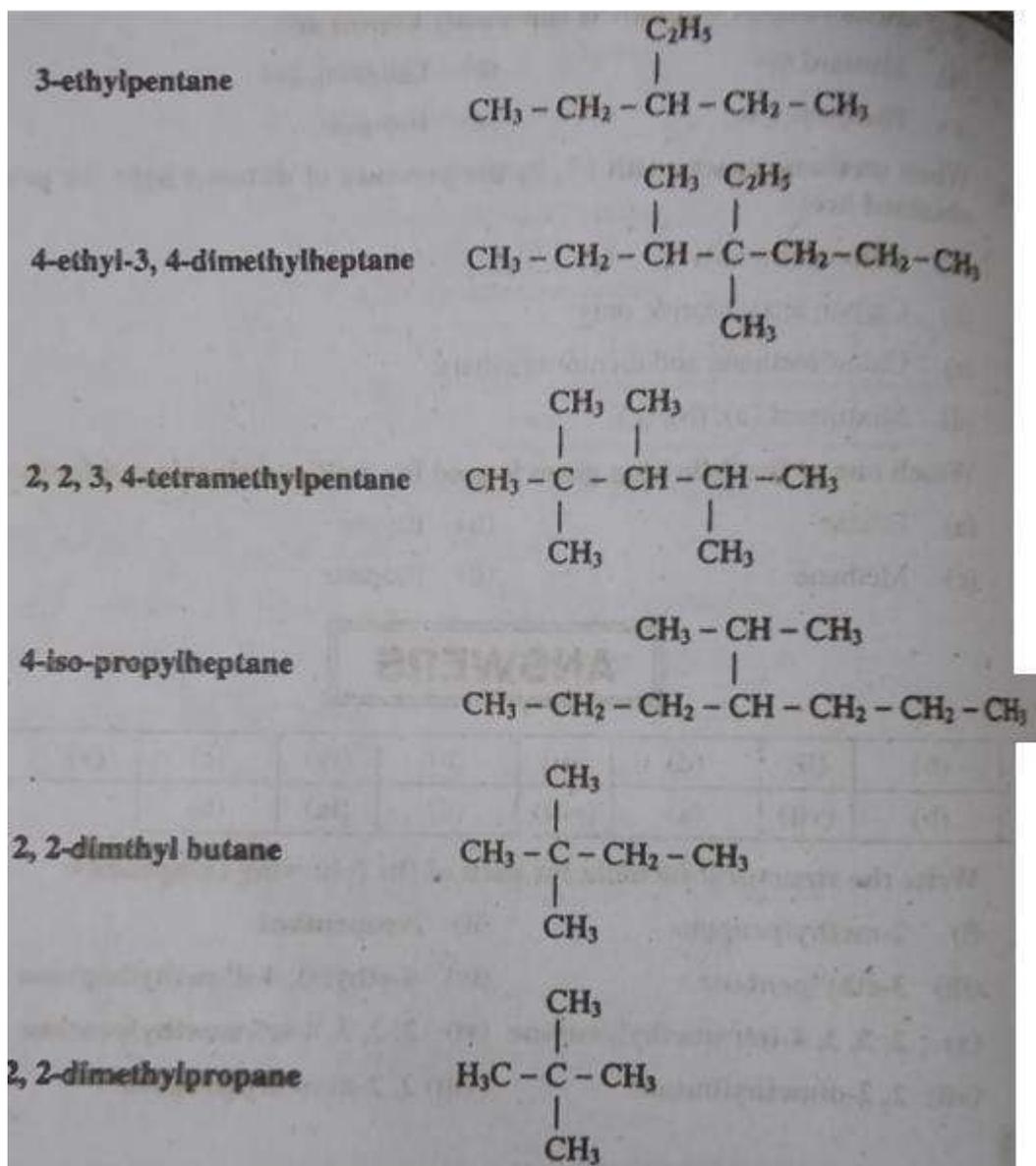
iv) 4-Ethyl-3,4-dimethylheptane.

vi) 4-Iso-Propylheptane.

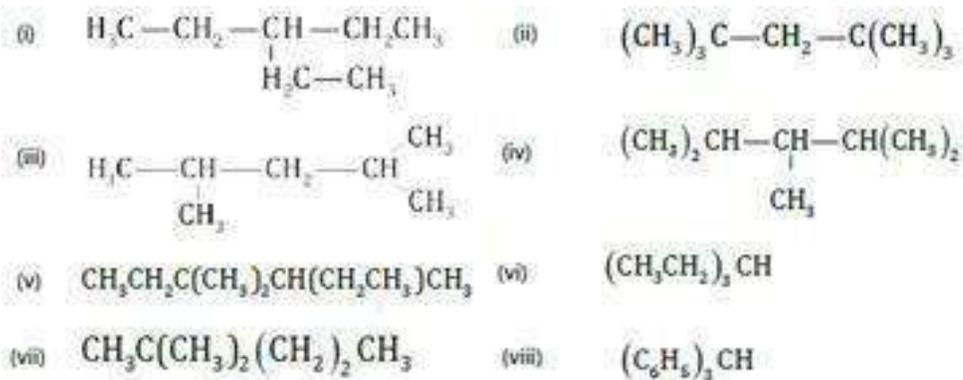
viii) 2,2-Dimethylpropane.

Ans:



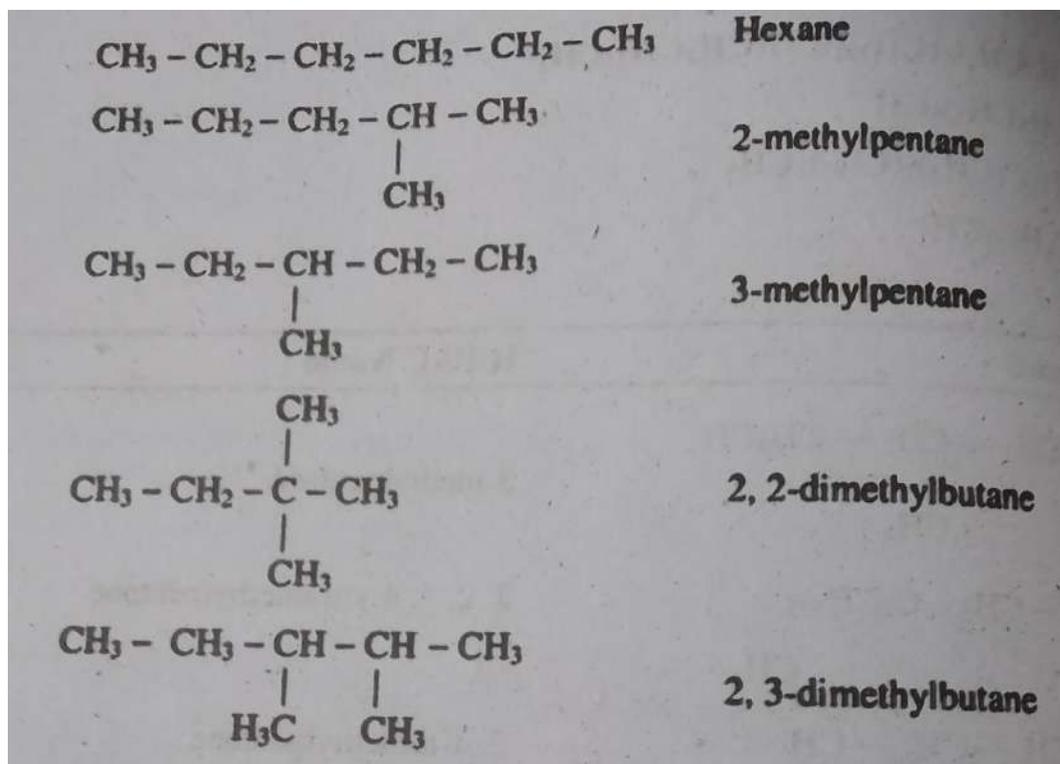


31. Write IUPAC names of the following compounds



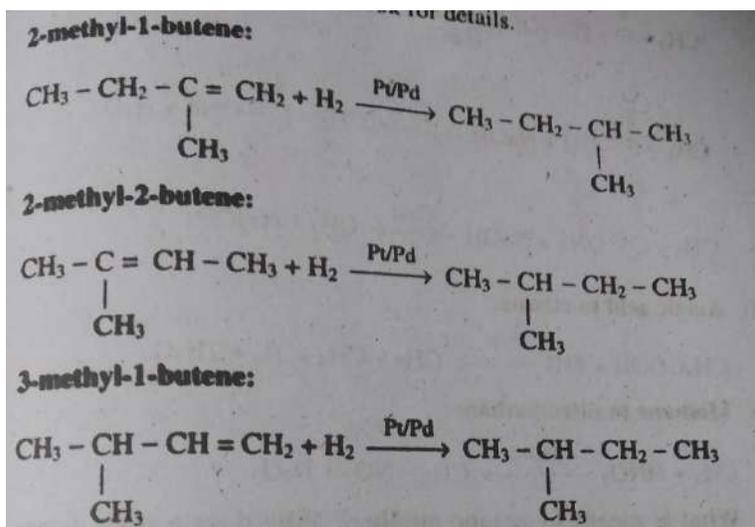
Ans:

- i. 3-methylpentane
- ii. 2,2,4,4-tetramethylpentane
- iii. 2,4-dimethylpentane
- iv. 2,3,4-trimethylpentane
- v. 3,3,4-trimethylhexane
- vi. 3-ethylpentane
- vii. 2,2-dimethylpentane
- viii. triphenylmethane



34. Three different alkanes yield 2-methylbutane when they are hydrogenated in the presence of a metal catalyst. Give their structures and write equations for the reactions involved.

Ans:



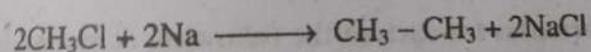
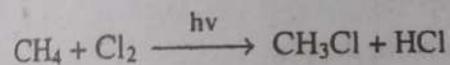
35. How will you bring about the following conversions?

i) Methane to ethane ii) Ethane to methane

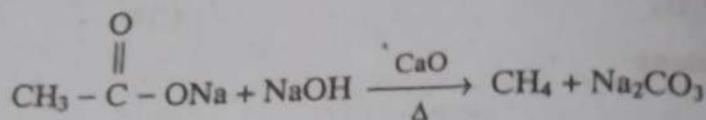
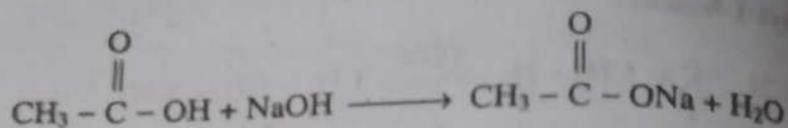
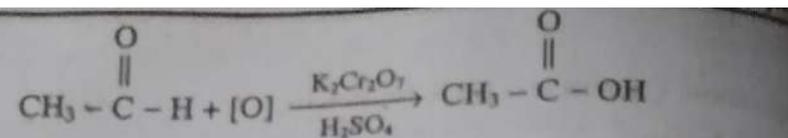
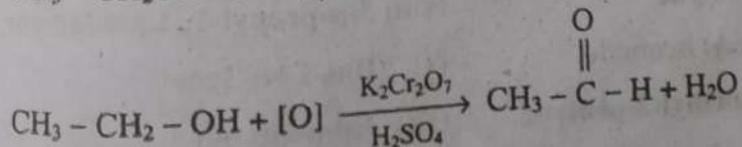
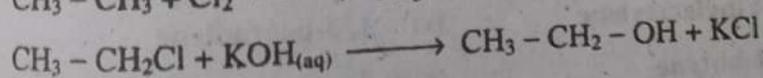
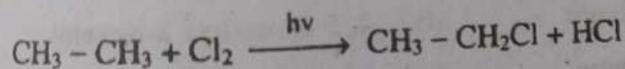
iii) Acetic acid to ethane iv) Methane to nitromethane.

Ans:

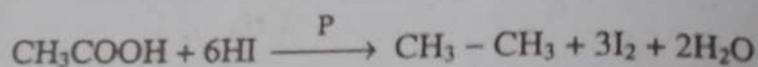
(i) **Methane into ethane:**



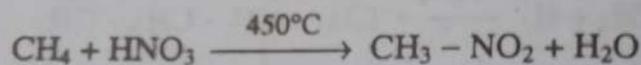
(ii) **Ethane into methane:**



(iii) **Acetic acid to ethane:**



(iv) **Methane to nitromethane:**



36. Write structural formulas for each of the following compounds:

i) *Isobutylene*

iii) *2,5-Heptadiene*

v) *Vinylacetylene*

vii) *1-Butyne*

ix) *Vinyl bromide*

xi) *4-Methyl-2-pentyne*

ii) *2,3,4,4-Tetramethyl-2-pentene*

iv) *4,5-Dimethyl-2-hexene*

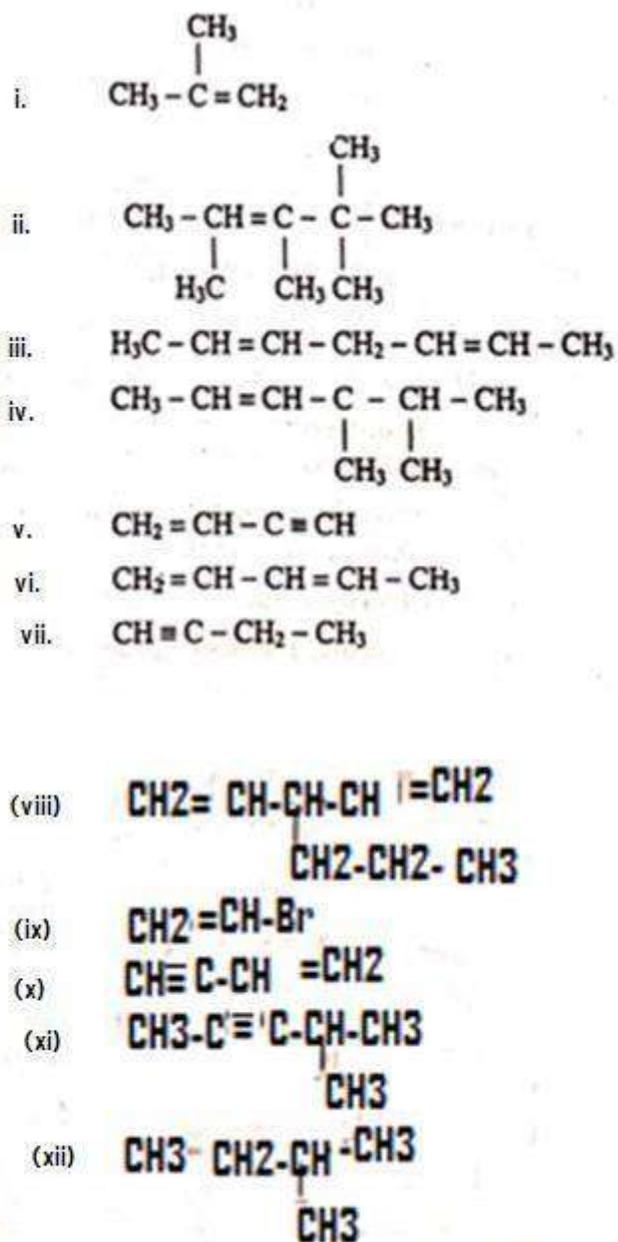
vi) *1,3-Pentadiene*

viii) *3-n-Propyl-1, 4-pentadiene*

x) *But-1-en-3-yne*

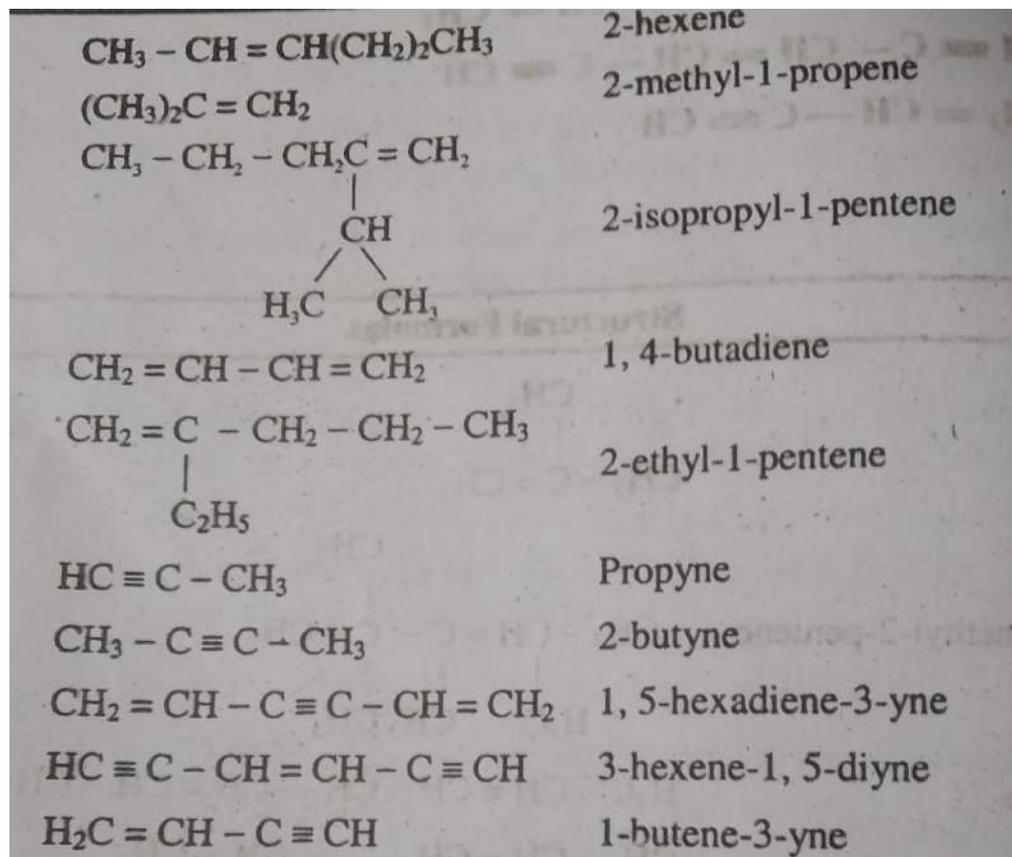
xii) *Isopentane*

Ans:



37. Name the following compounds by IUPAC system.

Ans:

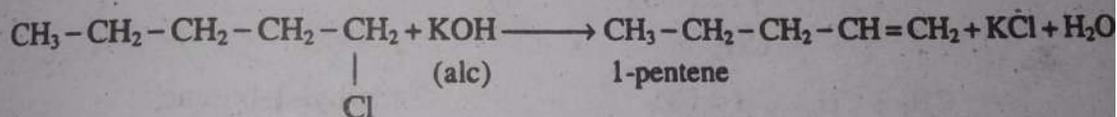


38. Give structure formulas of the alkenes expected to form by the dehydrohalogenation of the following compounds with a strong base:

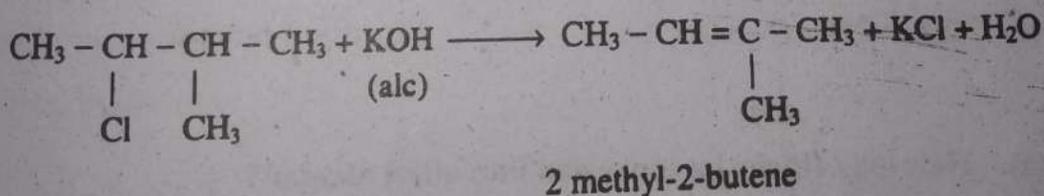
- i) 1-Chloropentane ii) 2-Chloro-3-methyl butane iii) 1-Chloro-2,2-dimethyl propane.

Ans:

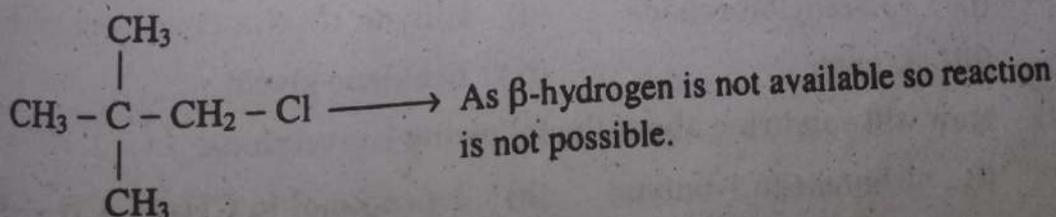
1-Chloropentane:



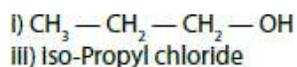
2-chloro-3-methyl butane:



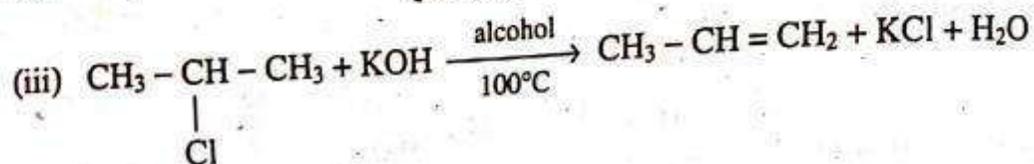
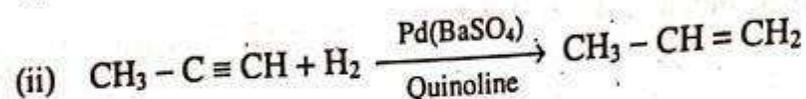
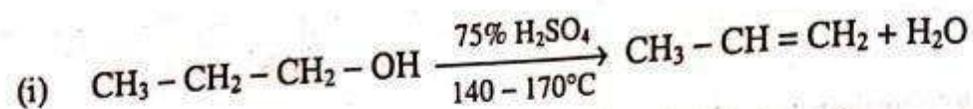
1-chloro-2, 2-dimethyl propane:



39. Write down chemical equations for the preparation of propene from the following equations:



Ans:



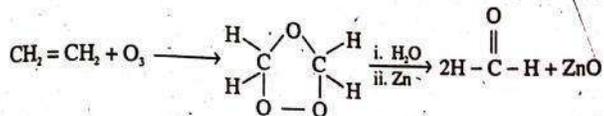
40. How can you establish that ethylene contains a double bond?

Ans:

Baeyer's Test: Purple colour of KMnO_4 discharged



Ozonolysis: Ozone added along double bond indicating point of unsaturation

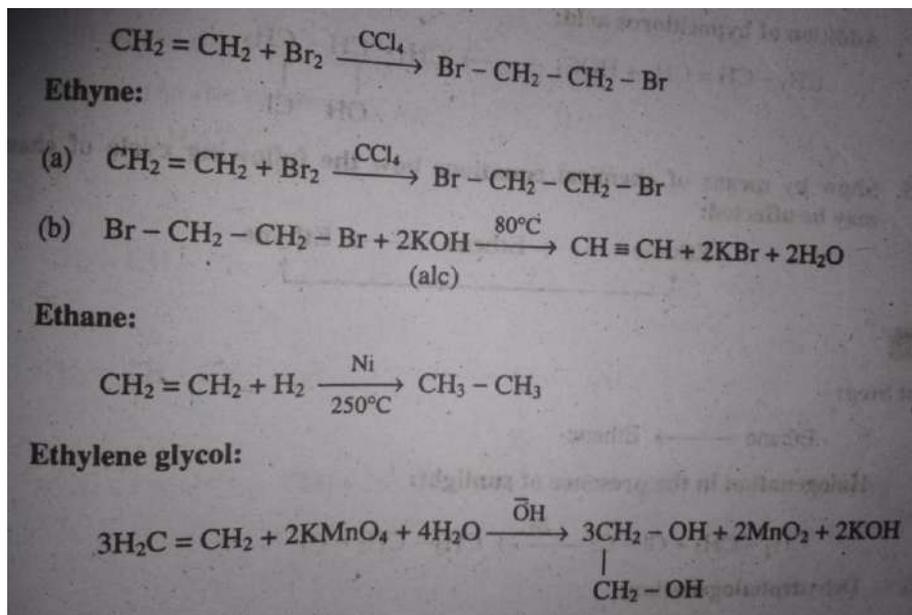


41. Starting from ethene, outline the reactions for the preparation of following compounds.

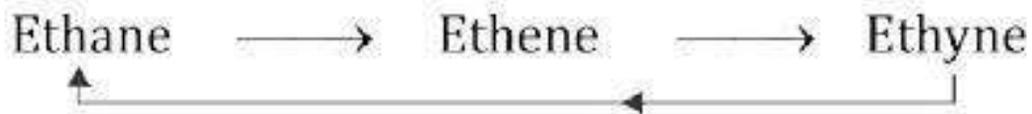
- i) 1,2-Dibromoethane ii) Ethyne iii) Ethane
iv) Ethylene glycol

Ans:

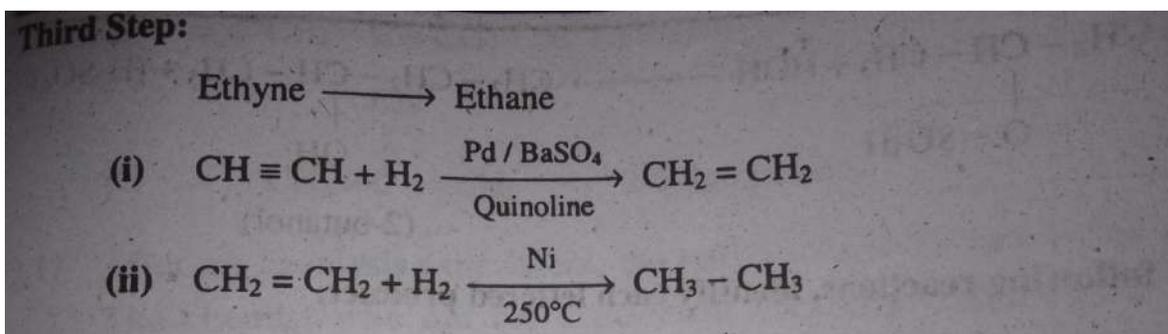
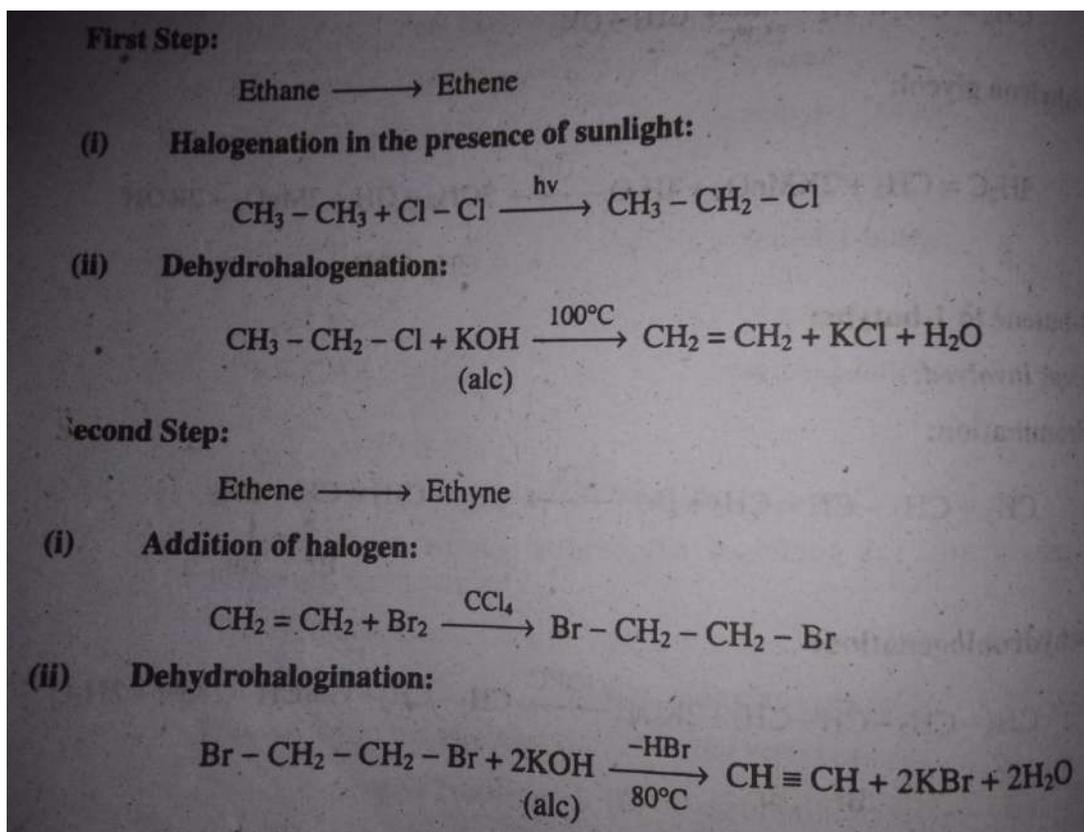
1,2-dibromoethane



42. How the following conversion is carried out?



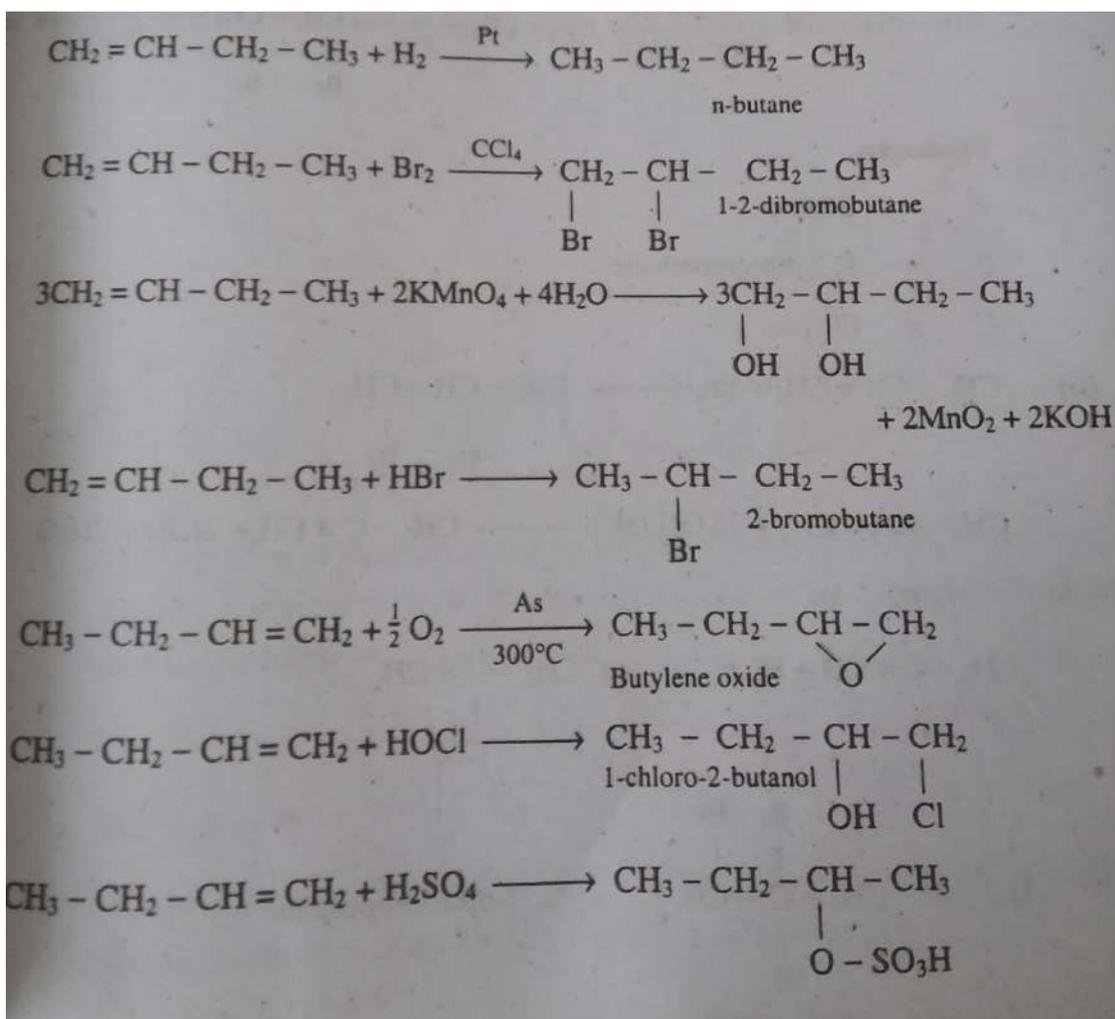
Ans:

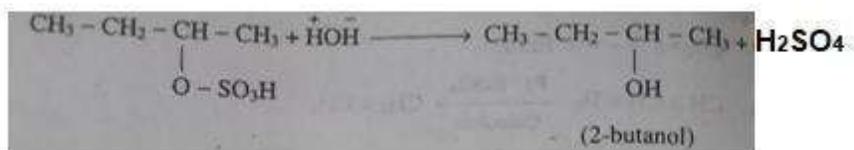


43. Write down structural formulas for the products that are formed when 1-butene will react with the following reagents:

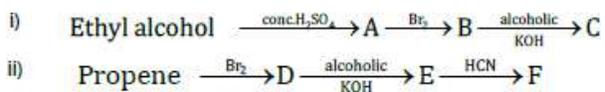
- i) H_2 , Pt ii) Br_2 in CCl_4
 iii) Cold dil. $KMnO_4/OH$ iv) HBr
 v) O_2 in the presence of Ag vi) $HOCl$
 vii) dil. H_2SO_4

Ans:





44. In the following reactions, identify each lettered product.



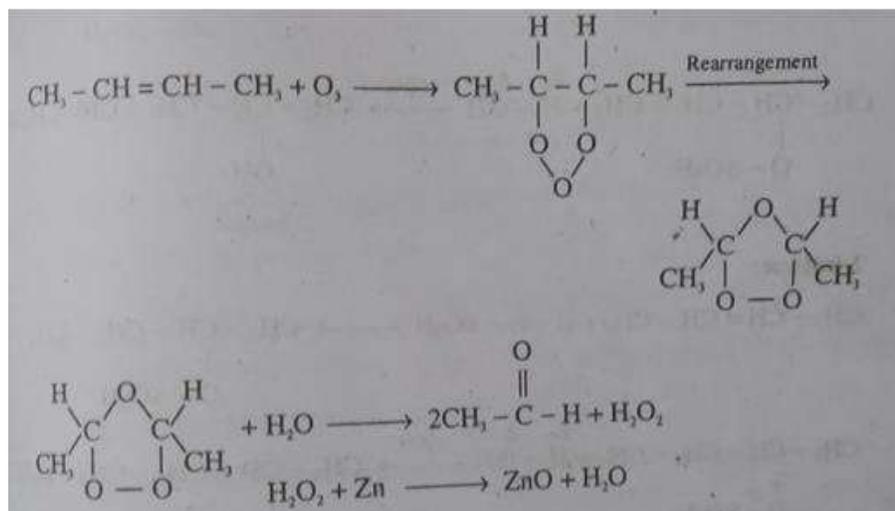
Ans:

(i) A=Ethene B=1,2-dibromoethane C=Ethyne

(ii) D=1,2-dibromopropane E=Propyne F=2-cyano propene

45. After an ozonolysis experiment, the only product obtained was acetaldehyde CH_3CHO . Can you guess the structural formula of this compound?

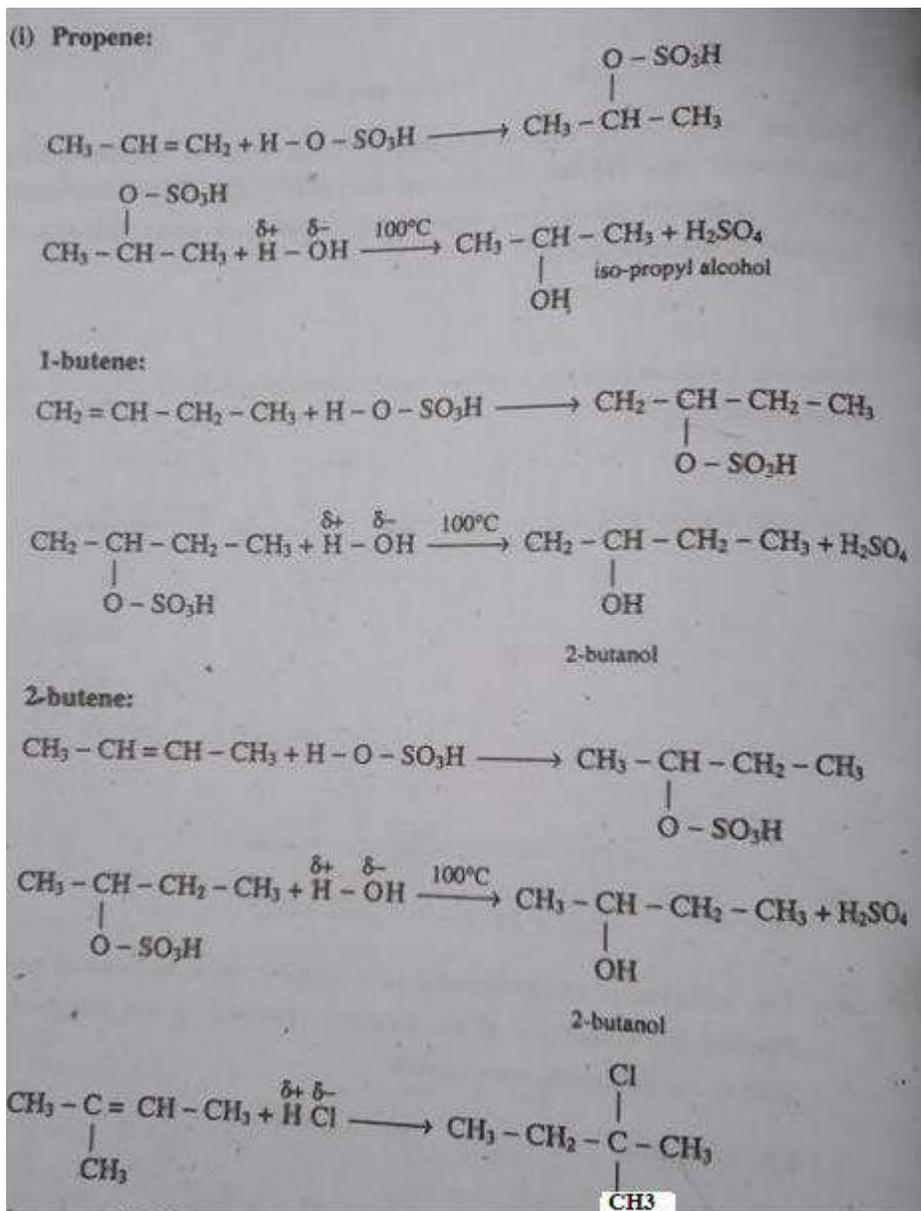
Ans:



46. The addition of sulphuric acid to an alkene obeys Markownikov's rule. Predict the structures of the alcohols obtained by the addition of the acid to the following compounds.

i) Propene ii) 1-Butene iii) 2-Butene

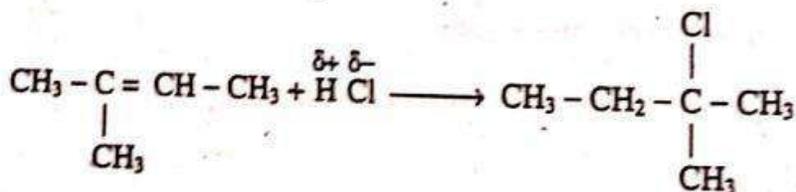
Ans:



As 2-methyl-2-butene is an unsymmetrical compound and HCl is an unsymmetrical reagent so the addition will be according to Markownikov's rule and the product will be 2-chloro-2-methyl butane.

47. Predict the most likely product of the addition of hydrogen chloride to 2-methyl-2-butene. Explain the formation of this product.

Ans: Addition is according to Markownikov's rule and product is 2-chloro-2-methyl butane.



48. Distinguish between ethane, ethene, ethyne.

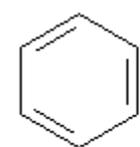
Ans:

Reagent	Ethane	Ethylene	Acetylene
Alkaline KMnO ₄ soln.	No reaction	Decolourized	Decolourized
Bromine water	No reaction	Decolourized	Decolourized
Ammonical AgNO ₃	No reaction	No reaction	White ppt. of silver acetylide
Ammonical Cu ₂ Cl ₂	No reaction	No reaction	Red ppt. of copper acetylide
10% H ₂ SO ₄ + AgSO ₄	No reaction	Ethyl alcohol is formed	Acetaldehyde is formed

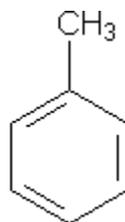
Chapter#9
Aromatic Hydrocarbons

1. *What are aromatic hydrocarbons? Give two examples.*

Ans: The aromatic hydrocarbons are closed-chain hydrocarbons containing a benzene ring or its derivatives. Examples are:



benzene



toluene

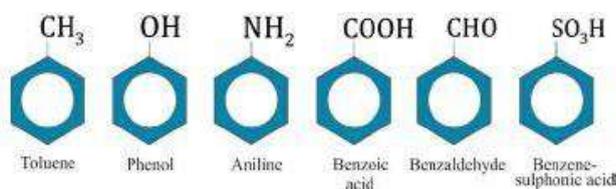
2. *How are the aromatic hydrocarbons classified?*

Ans: On the basis of the number of benzene rings aromatic hydrocarbons can be categorized into following classes:

- a. Monocyclic Aromatic Hydrocarbons and their derivatives
- b. Polycyclic Aromatic Hydrocarbons

3. *What are Monocyclic Aromatic Hydrocarbons? Give examples.*

Ans: Aromatic hydrocarbons containing one benzene ring in their molecules are called Monocyclic Aromatic Hydrocarbons, e.g. benzene and its derivatives.



4. *What are Polycyclic Aromatic Hydrocarbons? Give examples.*

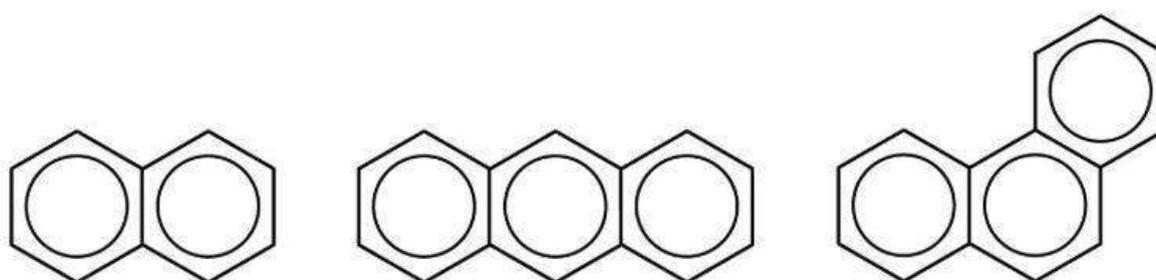
Ans: Aromatic hydrocarbons containing two or more benzene rings in their molecules are called

Polycyclic Aromatic Hydrocarbons. They may be divided into two main classes. (i) Those in which benzene rings are isolated, e.g. biphenyl, diphenylmethane, *etc.*



5. *What are fused ring aromatic compounds? Give examples.*

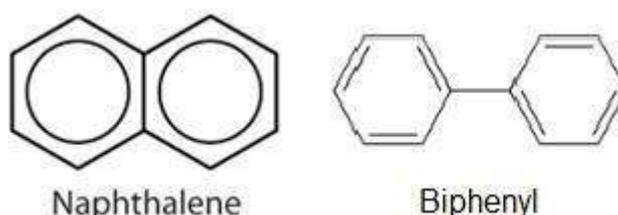
Ans: The compounds in which the benzene rings are fused together so that the adjacent rings have a



common carbon to carbon bond are called fused ring aromatic compounds.

6. *What are polycyclic aromatic hydrocarbons? Give examples.*

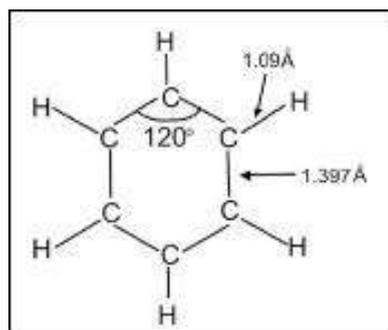
Ans: Aromatic compounds containing two or more benzene rings in their molecules are called polycyclic aromatic hydrocarbons. The benzene rings present in polycyclic aromatic hydrocarbons can be isolated (e.g. Biphenyl) or they may be fused together (e.g. Naphthalene).



7. *Give X-ray studies of benzene.*

Ans: The X-ray studies of benzene have confirmed the hexagonal structure for it. These studies have also revealed that all the carbon and hydrogen atoms are in the same plane. All the angles are of 120°.

All C - C and C - H bond lengths are 1.397 Å and 1.09 Å, respectively.



8. *Compare reactivity of alkanes, alkenes and benzene.*

Ans:

- Alkanes are unreactive class of compounds and their unreactivity is due to their non-polar nature and the inertness of σ -bond. However, they undergo substitution reactions relatively easily and these reactions involve free radicals.
- Alkenes are very reactive class of compounds and their reactivity is due to the inherent weakness of the π -bond and the availability of π electrons for the electrophilic reagents. They undergo electrophilic addition reactions easily. Being relatively unstable, alkenes undergo polymerization reactions and they are also readily oxidized.
- Benzene is unique in its behavior. It is highly unsaturated compound and at the same time, it is very stable molecule. The stability of benzene, is due to the extensive delocalization of π - electrons. It resembles alkenes when it gives addition reactions. The substitution of benzene does not involve free radicals. These are electrophilic substitution reactions and involve electrophiles. Its addition reactions require more drastic conditions than those for alkenes. Benzene does not undergo polymerization and it is resistant to oxidation.

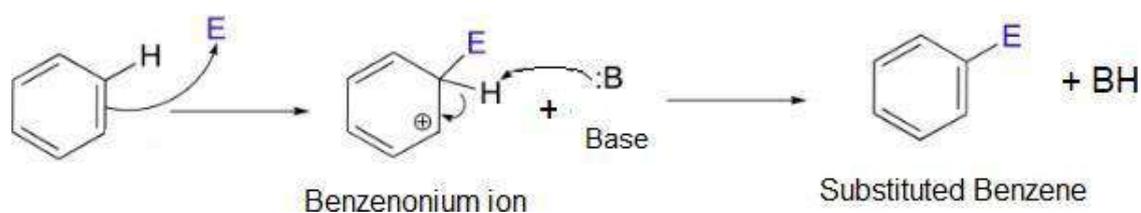
9. *Write general mechanism of electrophilic substitution reactions in benzene OR Give general pattern of reactivity of benzene towards electrophiles.*

Ans: The general pattern of the chemical reactivity of benzene towards electrophiles can be shown as follows.

- Pi electrons of benzene ring are donated to the strong electrophile

(E⁺) and benzenonium ions are formed. Benzenonium ions are unstable.

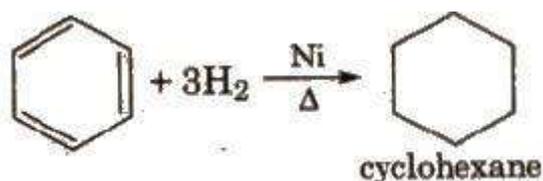
- A proton is released with the help of strong base from benzenonium ion and stability of benzene is retained.



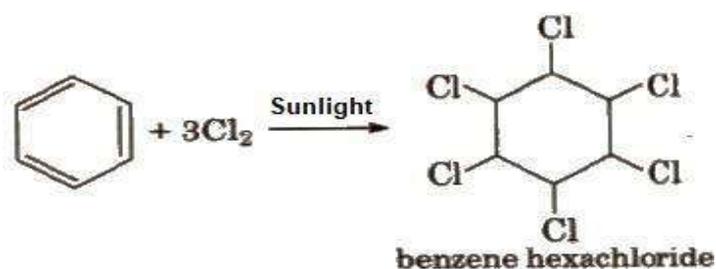
10. Benzene has three pi bonds. Prove it by two points.

Ans:

- Benzene adds three hydrogen molecules in the presence of a catalyst. It indicates that it has three pi bonds in it.



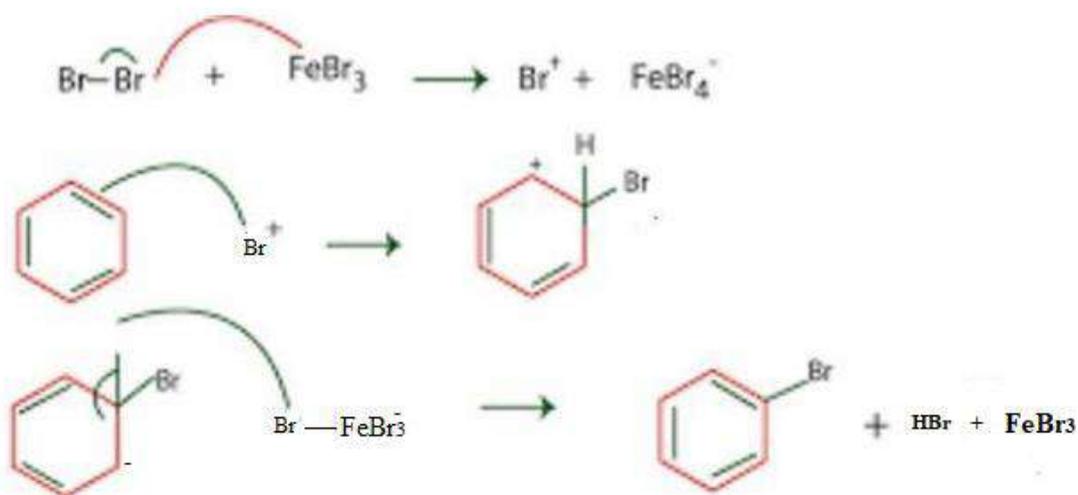
- Benzene adds three molecules of chlorine in the presence of sunlight, showing the presence of three pi bonds.



11. Predict major product of the bromination of benzene. Also give equation.

Ans:

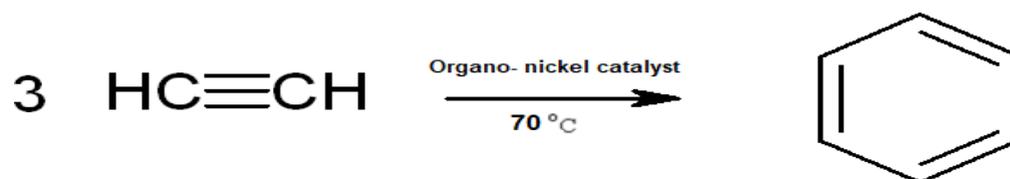
If hydrogen atom of benzene ring is substituted by bromine atom, it is called Bromination.



12. Benzene can be prepared commercially from acetylene. Give reaction with conditions.

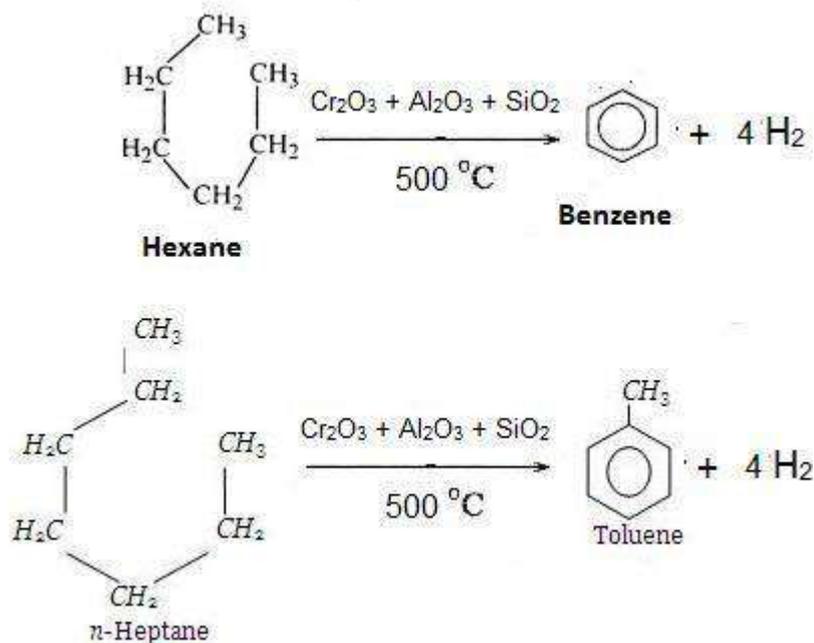
Ans:

Benzene is formed by passing acetylene under pressure over an organo-nickel catalyst at 70°C .



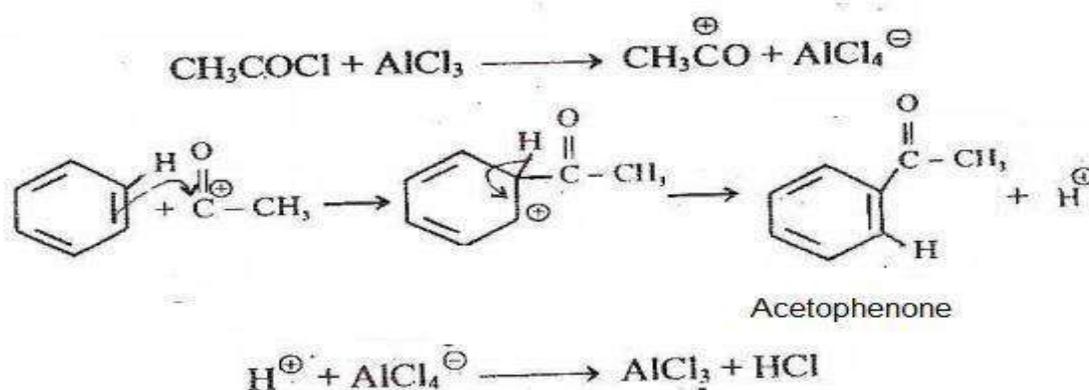
13. How Hexane and Heptane can give Benzene and Toluene respectively?

Ans:



14. How Benzene can be converted to Acetophenone? Give mechanism.

Ans: Benzene can be converted to Acetophenone by Friedel-Craft Acylation. The mechanism of reaction is given below.

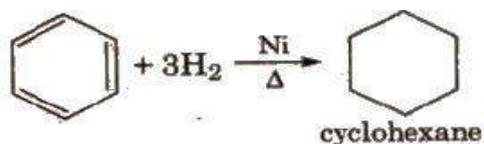


15. Convert benzene into:

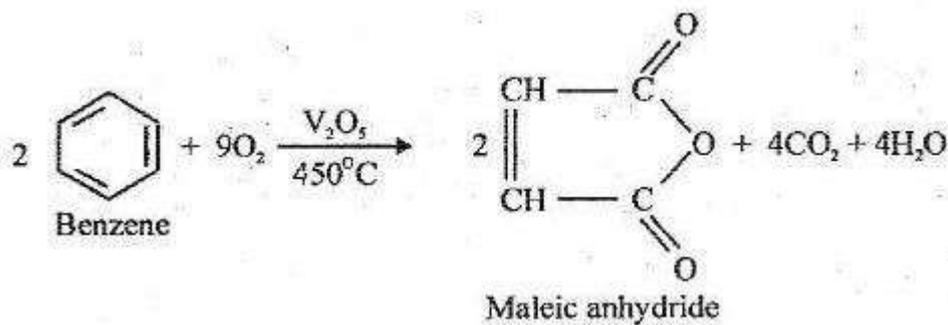
- i. Cyclohexane ii. Maleic anhydride

Ans:

i.



ii.



16. Give two reasons that rule out straight chain structures of benzene.

Ans:

- ii. Considering a straight chain structure for benzene and further assuming that each carbon carries one H-atom, it should be capable of forming three mono substitution products. But benzene only gives one mono substituted product. Which shows it does not have straight chain structure.
- iii. The molecular formula of benzene is C₆H₆. This formula does not correspond to any aliphatic hydrocarbon like Alkane C_nH_{2n+2}, Alkene C_nH_{2n} or Alkyne C_nH_{2n-2}.

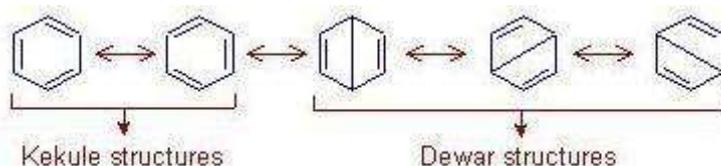
All above points indicate that benzene does not belong to open chain hydrocarbons and has cyclic structure.

17. Define Resonance and write down resonance structures of benzene.

Ans:

The possibility of different pairing schemes of valence electrons of atoms in a molecule is called resonance, and the different structures thus arranged are called resonance structures.

Resonance structures of benzene:



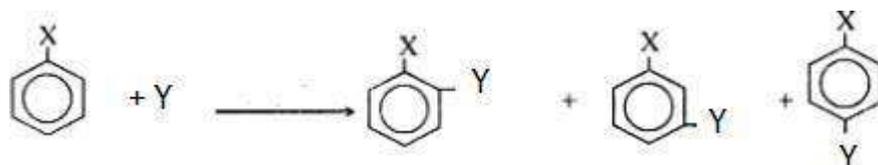
18. Prove that Benzene has cyclic structure.

Ans:

- i. Benzene gives only one mono substituted product.



- ii. Benzene gives only three di substituted products.



These points confirm the regular hexagonal structure for benzene in which all the carbon atoms are occupying identical positions in the molecule. So, we can say that benzene has a cyclic structure, therefore benzene forms only one toluene, one phenol and one nitrobenzene.

19. What is Wurtz-Fittig reaction? Give an example.

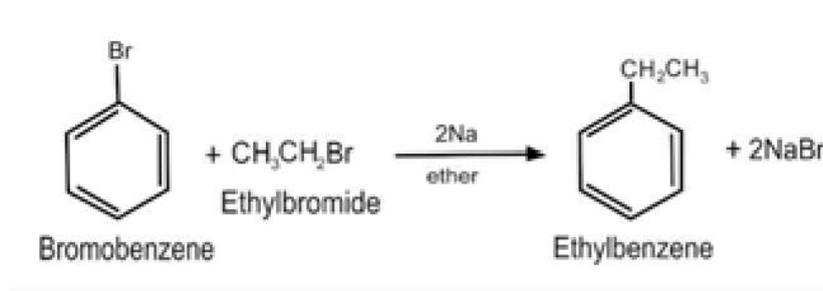
Ans:

The Wurtz reaction for the synthesis of alkanes was extended by Fittig in 1864 to the synthesis of alkyl aromatic hydrocarbons.

When a mixture of alkyl halide and an aryl halide is treated with sodium metal in dry ether, the sodium preferentially attack the alkyl halide to form alkylated aromatic compound. Thus

mixed Wurtz reaction is called Wurtz –Fittig reaction.

Example:



20. Define resonance energy. Give resonance energy of benzene.

Ans:

The difference in energy between hypothetical structure (1,3,5-cyclohexatriene) and actual structure (benzene) is called resonance energy.

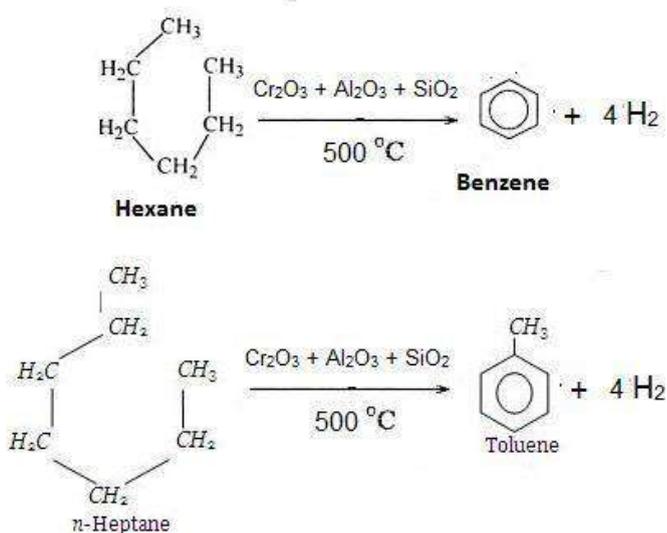
Resonance energy of benzene:

The resonance energy of benzene is 150.5 kJ/mol, which shows that it is more stable than 1,3,5-cyclohexatriene by 150.5kJ/mol.

21. What is aromatization?

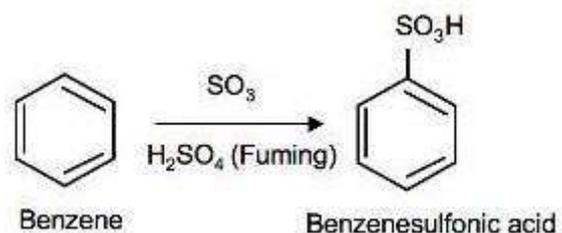
Ans:

Aromatization is the conversion of a nonaromatic hydrocarbon to an aromatic hydrocarbon. Benzene and toluene can be formed by aromatization of n-hexane and n-heptane as follows.



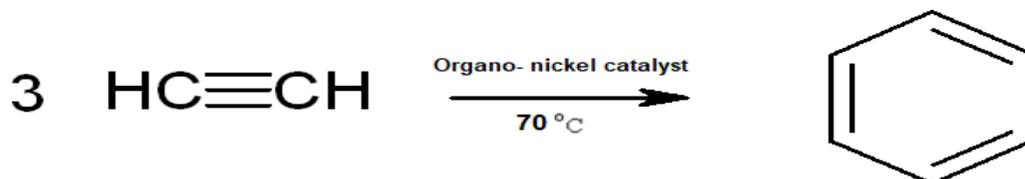
22. Give reaction of benzene with SO_3 .

Ans: Benzene reacts with sulphur trioxide in the presence of concentrated sulphuric acid to produce Benzene sulfonic acid.



23. How will you synthesize benzene from Ethyne?

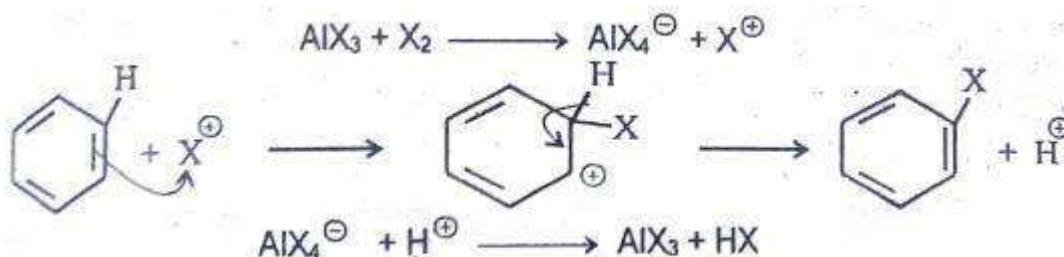
Ans:



Benzene is formed by passing ethyne under pressure over an organo-nickel catalyst at 70°C .

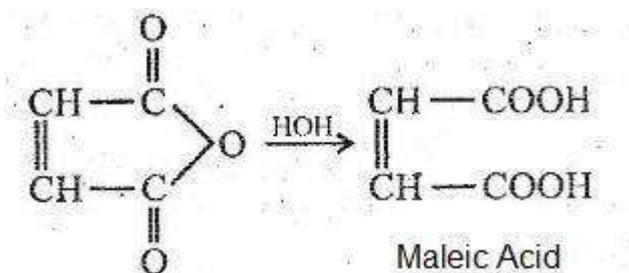
24. Write down mechanism for Halogenation of benzene.

Ans:



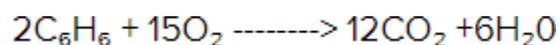
25. Give mechanism for nitration of benzene. OR What is meant by nitration of benzene?

Ans: Introduction of nitro group in the benzene ring is called nitration of benzene. It takes place when benzene is heated with conc. HNO_3 and conc. H_2SO_4 at 50°C .

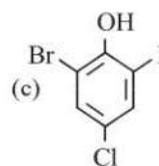
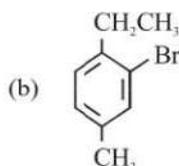
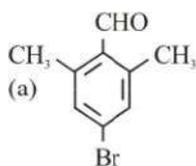


28. *What happens when benzene is burnt in free supply air? Give equation.*

Ans: When benzene is burnt in free supply of air, it is completely oxidized to CO₂ and H₂O.



29. *Write IUPAC names of the following molecules:*



Ans:

(a) 4-bromo-2, 6-dimethyl benzaldehyde

(b) 3-bromo-4-ethyl toluene

(c) 6-bromo-4-chloro-2-iodophenol

30. *Give names and possible isomeric structures of the following:*

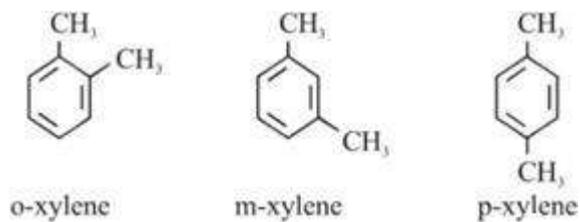
(i) Xylenes

(ii) Trimethylbenzene

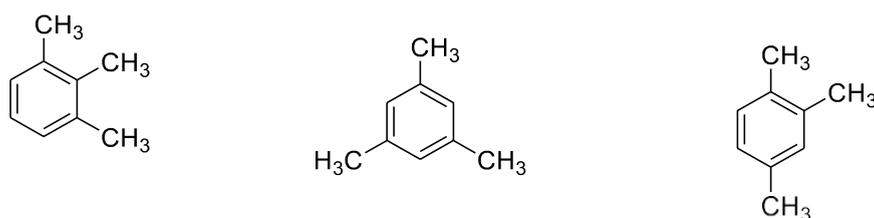
(iii) Bromonitrotoluene

Ans:

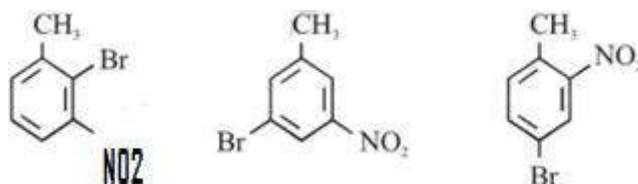
(i) Xylenes



(ii) Trimethylbenzene



(iii) Bromonitrotoluene



31. Draw structural formulas for the following compounds:

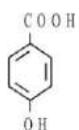
- | | |
|---------------------------------------------------|------------------------------|
| (i) m-chlorobenzoic acid | (ii) p-hydroxybenzoic acid |
| (iii) o-bromonitrobenzene | (iv) o-ethyltoluene |
| (v) p-nitroaniline | (vi) 2, 4, 6 trinitrotoluene |
| (vii) m-nitrophenol | (viii) p-dibenzylbenzene |
| (ix) 2-amino-5-bromo-3 nitrobenzenesulphonic acid | |

Ans:

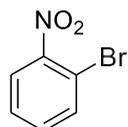
(i)



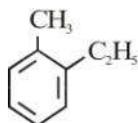
(ii)



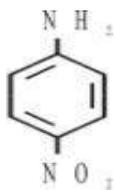
(iii)



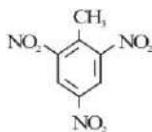
(iv)



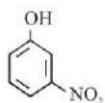
(v)



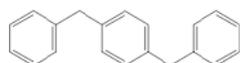
(vi)



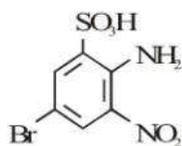
(vii)



(viii)



(ix)



32. *What is meant by the terms:*

- (i) *Aromatic* (ii) *Oxidation* (iii) *Sulphonation* (iv) *Nitration*
 (v) *Halogenation*

Ans:

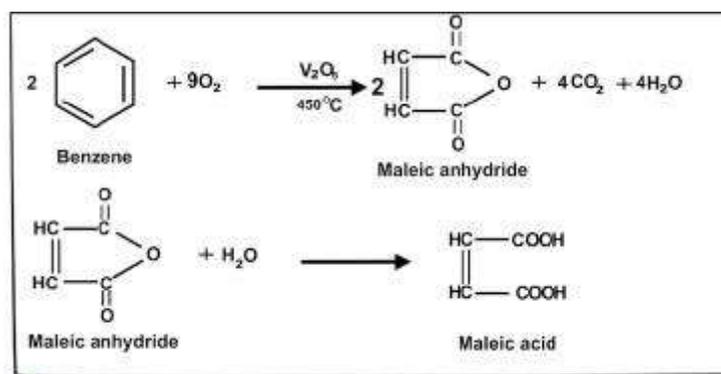
(i) Aromatic

The term aromatic was derived from the Greek word 'aroma' meaning "fragrant" and was used in Organic Chemistry for a special class of compounds which contain benzene ring in their structure. Example



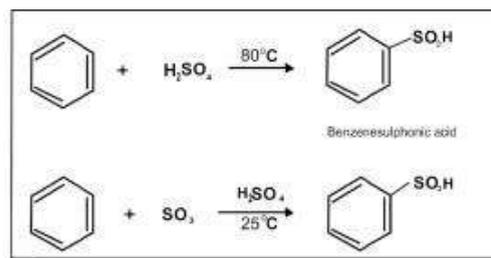
(ii) Oxidation

Oxidation is a process by which a carbon atom gains bonds to more electronegative elements, most commonly oxygen. Benzene is not oxidized by KMnO_4 or $\text{K}_2\text{Cr}_2\text{O}_7$ at room temperature. The ring is destroyed when benzene is strongly heated with air in the presence of V_2O_5 as a catalyst.



(iii) Sulphonation

The introduction of sulphonic acid group in benzene ring is called Sulphonation. When benzene is heated with fuming H_2SO_4 or conc. H_2SO_4 it yields benzene sulphonic acid.

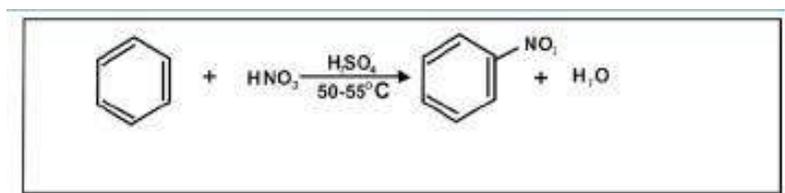


Formation of benzenesulphonic acid

(iv) Nitration

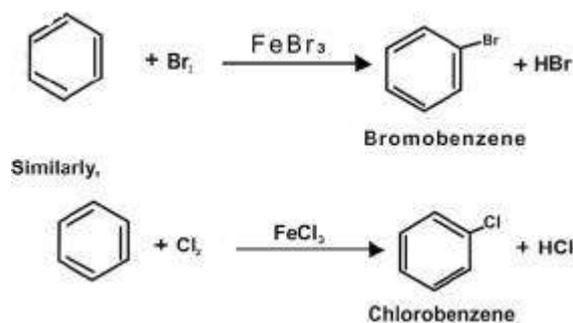
The introduction of NO_2 group in benzene ring is called “Nitration”. The nitration of benzene takes place when it is heated with a 1:1 mixture of con. HNO_3 and conc. H_2SO_4 at $50-55^\circ\text{C}$.

Sulphuric acid reacts with nitric acid to generate nitronium ion, (NO_2^+).



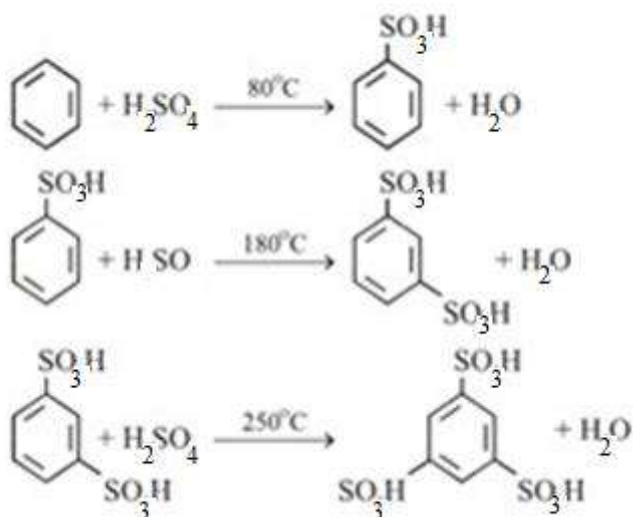
(v) Halogenation

The introduction of halogen group in benzene ring is called “Halogenation” Benzene reacts with halogen in the presence of a catalyst like FeBr_3 , AlCl_3 , etc. Chlorination and bromination are normal reactions but fluorination is too vigorous to control. Iodination gives poor yield.



33. What happens when benzene is heated with conc. H_2SO_4 at $250\text{ }^\circ\text{C}$?

Ans:



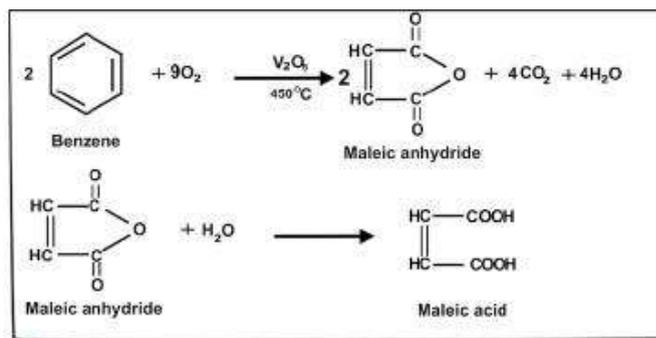
34. What happens when chlorine is passed through benzene in sunlight?

Ans:



35. What happens when a mixture of benzene vapours and air are passed over heated vanadium pentoxide?

Ans:



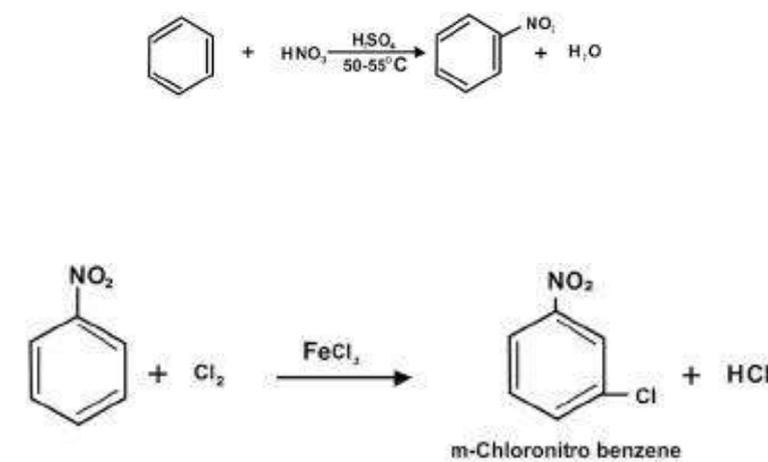
36. *What happens when benzene is burnt in free supply of air?*

Ans:



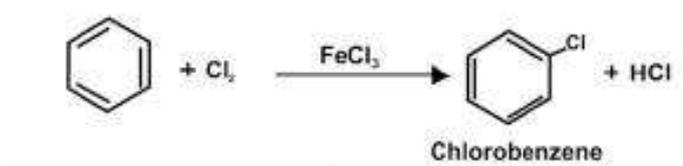
37. *How will you prepare m-chloronitrobenzene from benzene in two steps?*

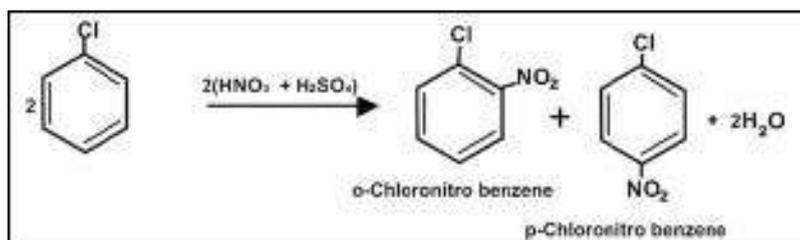
Ans:



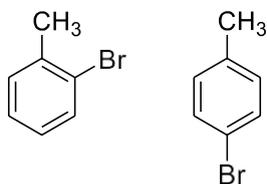
38. *How will you prepare p-chloronitrobenzene from benzene in two steps?*

Ans:





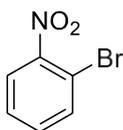
39. Predict the major products of bromination of toluene



Ans:

Write complete equation

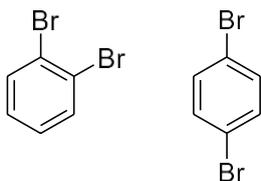
40. Predict the major products of bromination of nitrobenzene



Ans:

Write complete equation

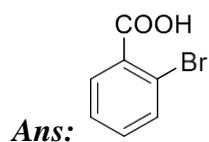
41. Predict the major products of bromination of bromobenzene



Ans:

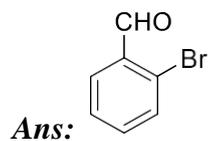
Write complete equation

42. Predict the major products of bromination of benzoic acid



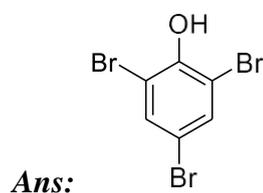
Write complete equation

43. Predict the major products of bromination of benzaldehyde



Write complete equation

44. Predict the major products of bromination of phenol



Write complete equation

Chapter#10
Alkyl Halides

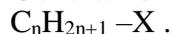
1. What are alkyl halides? Write their general formula and example of monohaloalkanes.

Ans: Alkyl halides:

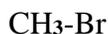
“Those hydrocarbons in which one or more hydrogen atoms of alkanes are replaced by one or more halogen atoms are called alkyl halides or haloalkanes.”

Alkyl halides are represented by R-X.

General formula of monohaloalkanes:



Example:



Methyl bromide

2. What are primary and tertiary alkyl halides? Give one example of each.

Ans: Primary alkyl halides:

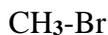
The alkyl halides in which halogen atom is attached to a carbon atom which is further attached with one carbon atom or no carbon atom are called primary alkyl halides.

Tertiary alkyl halides:

The alkyl halides in which halogen atom is attached to a carbon atom which is further attached with three carbon atoms are called tertiary alkyl halides.

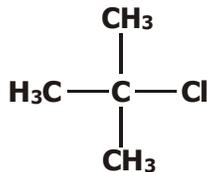
Examples:

Primary alkyl halide:



Methyl bromide

Tertiary alkyl halide:



2-Chloro-2-methylpropane

3. How alkyl halides can be prepared by alcohols? Give two examples.

Or

What are the necessary conditions to convert alcohols into alkyl halides using halogen acids and thionyl chloride?

Ans: (a) Reaction of alcohols with halogen acids:

Alcohols may be converted to the corresponding alkyl halides by the action of halogen acid in the presence of $ZnCl_2$, which acts as a catalyst



Ethyl halide

(b) Reaction of alcohols with thionyl chloride:

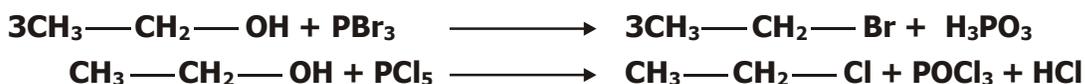
Alcohols react with thionyl chloride in pyridine as a solvent to give alkyl chlorides. This is the best method because HCl, and SO_2 gases escape leaving behind the pure product.



4. Write down reactions of ethanol with (i) PBr_3 (ii) PCl_5

Ans: Reactions of ethanol with phosphorus halides:

Phosphorus tribromide and Phosphorus pentachloride react with Ethanol to produce alkyl halides as follows.



5. Explain the order of reactivity of alkyl halides on the basis of bond polarity.

Ans: According to this factor, greater the electronegativity difference between carbon and halogen greater the bond polarity. Greater the polarity greater the reactivity. So with this rule the alkyl fluorides should be the most polar and the most reactive and alkyl iodides least polar and least reactive.

It means reactivity order must be like this;



6. What is the order of reactivity of HX with Ethene?

Ans: Ethene reacts with HX to form Ethyl halide.

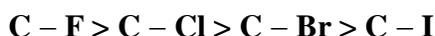


The order of reactivity of HX is given below.



7. How the bond dissociation energy of carbon suggests that alkyl iodides should have maximum reactivity?

Ans: Bond energy directly depends on bond polarity. The bond dissociation energy of C-X bond is in the order:



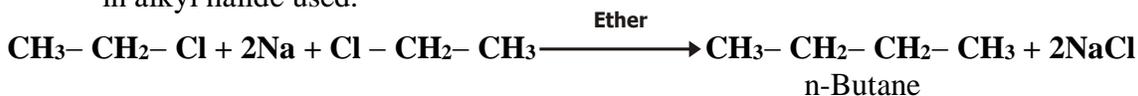
Greater the bond energy, stronger the bond and lesser the reactivity. With this rule the reactivity order must be like this;



Alkyl iodides should be most reactive due to least bond energy.

8. What is Wurtz's synthesis reaction?

Ans: Alkyl halides react with sodium in ether (solvent) to give alkanes. This is called Wurtz's synthesis. The reaction is particularly useful for preparation of symmetrical alkanes with double number of carbon atoms as compared with that in alkyl halide used.



9. What is the difference between molecularity and order of reaction?

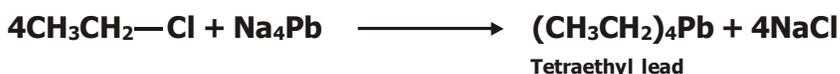
Ans:

Molecularity	Order of Reaction
Molecularity is defined as the number of molecules taking part in the rate determining step of reaction.	Sum of exponents of conc. terms in the rate expression of a chemical equation is called order of reaction.
It is calculated through balanced chemical equation	It is always experimentally determined.

10. How anti-knocking agents are prepared?

Ans: Preparation of anti-knocking agents:

Methyl chloride and Ethyl chloride can react with sodium lead alloy to produce anti-knocking agents, Tetramethyl lead (TML) and Tetraethyl lead (TEL), respectively.



11. In tertiary alkyl halides, S_N1 reaction takes place but not S_N2 reaction. Why?

Ans: In tertiary alkyl halides, attacking nucleophile cannot reach directly at the electrophilic center (carbon) due to steric hindrance. So attachment of attacking nucleophile and removal of leaving group can't occur simultaneously as occurs in S_N2 reactions. As a result, in tertiary alkyl halides nucleophilic substitution occurs in two steps i.e. S_N1 mechanism occurs. In first step halogen (leaving group) is removed to reduce steric hindrance and planar carbocation is formed. In second step attack of new nucleophile takes place.

12. What is the role of carbonium ion for determining S_N1 or S_N2 mechanism?

Ans: Greater the stability of the carbonium ion, greater the possibility for two step mechanism which is S_N1. These alkyl halides which can provide unstable carbonium ion

give S_N2 mechanism, which is a single step reaction. Carbonium ion is stable if it is bonded to maximum number of alkyl groups.

13. What is meant by attacking nucleophile? Give examples.

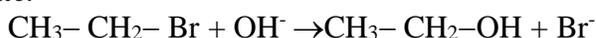
Ans: In S_N reactions, the nucleophile which attacks on the electrophilic carbon of alkyl halide from outside is called attacking nucleophile.

Examples:

-OH⁻, -CN⁻ etc.

14. Reaction of Ethyl bromide with OH⁻ nucleophile is S_N2. Why?

Ans: Reaction of ethyl bromide with OH⁻ is S_N2 because it is a bimolecular reaction. The rate of reaction depends upon the concentration of nucleophile as well as substrate.



$$\text{Rate} = k [\text{CH}_3\text{CH}_2\text{Br}][\text{OH}^-]$$

$$\text{Order} = 2$$

15. What is difference between Electrophile and Nucleophile?

Ans:

Electrophile	Nucleophile
(i) It is an electron deficient species.	It is electron rich species.
(ii) It always acts as Lewis acid.	It always acts as Lewis base.
(iii) It may be neutral or positively charged.	It may be negatively charged or neutral with one or more lone pairs.
(iv) Examples: NO ₂ ⁺ , SO ₃	Examples: Cl ⁻ , NH ₃

16. What are differences between S_N1 and S_N2 reactions?

Ans:

S _N 1	S _N 2
(i) It is a two step mechanism.	It is a single step mechanism.
(ii) First step is slow and second is fast.	It has only one step and that is slow.
(iii) It is unimolecular reaction.	It is a bimolecular reaction.
(iv) It is favored in polar solvents.	It is favored in non-polar solvents.

17. Why tertiary alkyl halides follow S_N1 mechanism and not S_N2 mechanism? OR During S_N1 reaction, what is the significance of first step?

Ans: S_N1 mechanism involves two steps. Due to steric (space) hindrance, the attack of nucleophile on the α-carbon of substrate is not directly possible. In order to create space for the attack, older nucleophile means halogen needs to be removed first.

This is the reason that reaction occurs in two steps. The first step is the reversible ionization of the alkyl halide. This step provides a carbocation as an intermediate. In the second step this carbocation is attacked by the nucleophile to give the substitution product.

In S_N2 reactions, there is no issue of steric hindrance as α -carbon of primary alkyl halide is surrounded by small groups e.g. Hydrogen atoms and attacking nucleophile finds space to attack on carbon.

18. What are leaving group and substrate?

Ans: Leaving Group:

Leaving group (L) is also a nucleophile. In S_N reactions of alkyl halides, the halogens are the leaving groups. It is called leaving group because it departs from alkyl halide.

Examples:



Substrate Molecule:

The alkyl halide molecule on which a nucleophile attacks is called a substrate molecule.

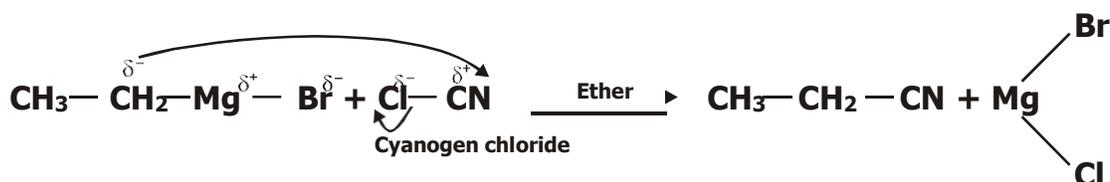
19. What is the difference between Elimination and substitution reactions?

Ans:

Elimination	substitution
Elimination of two atoms or groups from adjacent carbon atoms in the presence of a nucleophile or a base is called elimination reaction.	Substitution reaction involves the breakage of C-X bond and the formation of C-Nu bond.
The product of an elimination reaction is alkene usually.	Substitution reaction yields substitution product
Example: $\text{CH}_3\text{CH}_2\text{X} + \text{OH}^- \longrightarrow \text{H}_2\text{C}=\text{CH}_2 + \text{H}_2\text{O}$	Example: $\text{CH}_3\text{-X} + \text{OH}^- \rightarrow \text{CH}_3\text{-OH} + \text{X}^-$

20. How do we get alkyl nitriles from Grignard's reagent?

Ans: When Cl-CN is reacted with Grignard's reagent. The alkyl group of the Grignard's reagent combines with $-\text{CN}$ group to give Alkyl nitrile. See example below;



21. Explain the structure and reactivity of Grignard's reagent.

Ans: Grignard's reagent is much more reactive than most of the organic compounds. The reactivity is due to the nature of C-Mg bond which is highly polar.

Magnesium is more electropositive than carbon and C-Mg bond though covalent is highly polar, giving alkyl carbon the partial negative charge. The negative charge is an unusual character which makes the alkyl groups highly reactive towards electrophilic centers.

22. What is the nature of C-Mg bond in R-Mg-X?

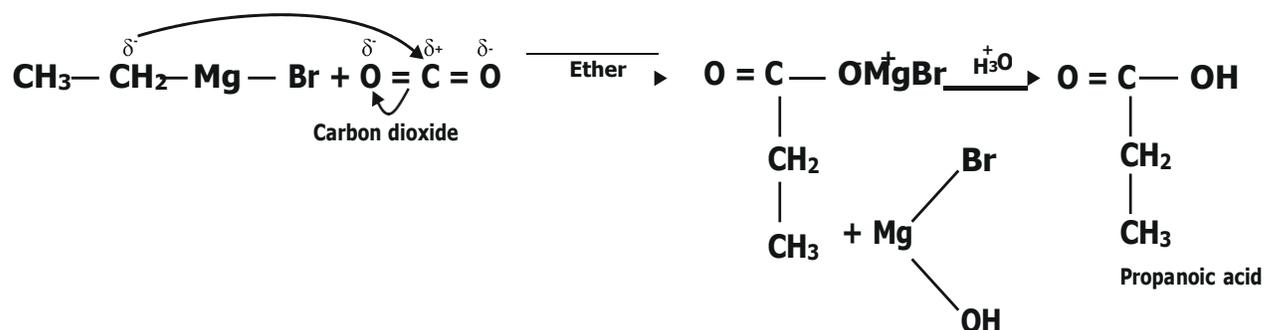
Ans: Grignard's reagents are very reactive organic compounds. Their reactivity is due to C-Mg bond which is highly polar.



Magnesium is less electronegative than carbon so partial positive charge appears on magnesium and partial negative on carbon attached to it. This negative charge on carbon is very unusual which makes alkyl group very reactive towards electrophiles.

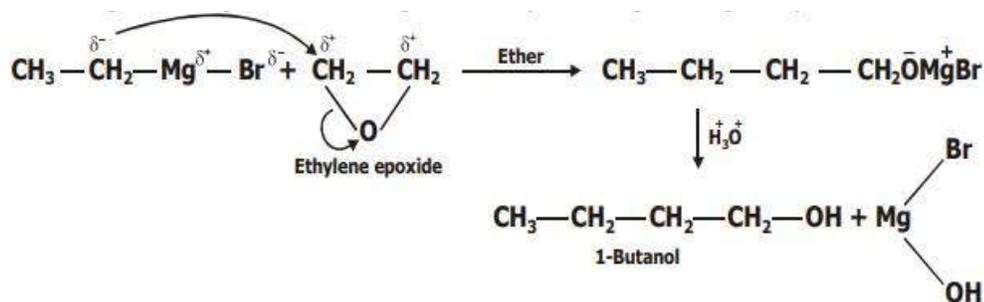
23. How is carboxylic acid prepared from Grignard's reagent?

Ans: When Grignard's reagent is reacted with carbon dioxide gas, we get carboxylic acids as follows;



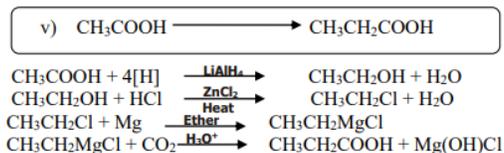
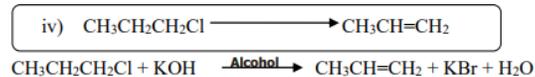
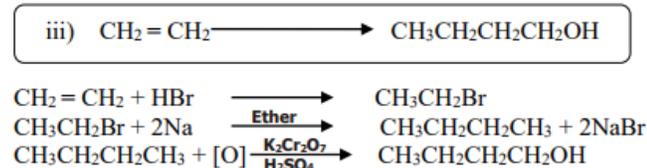
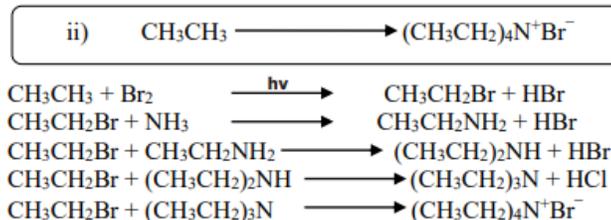
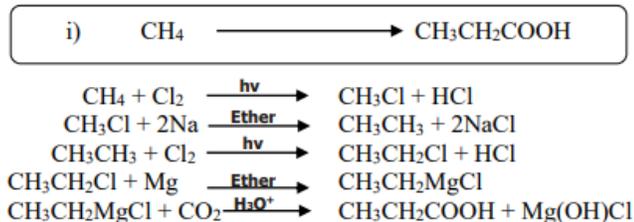
24. How Grignard reagent reacts with epoxides to form alcohol?

Ans: Grignard's reagent reacts with epoxide in dry ether to generate primary alcohols.



25. How will you carry out the following conversions:

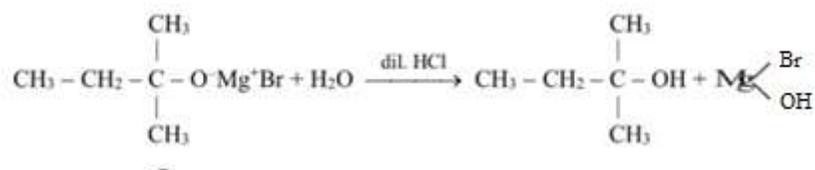
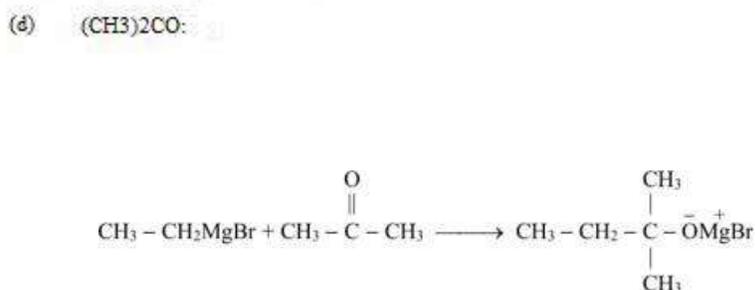
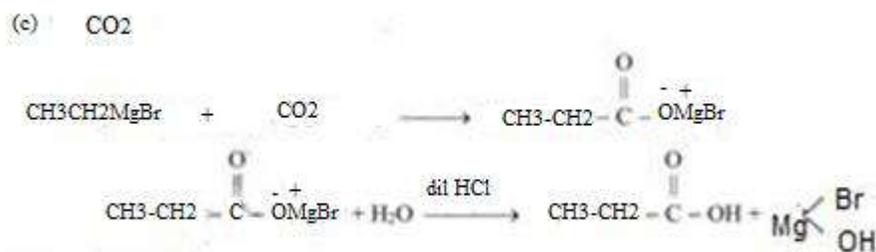
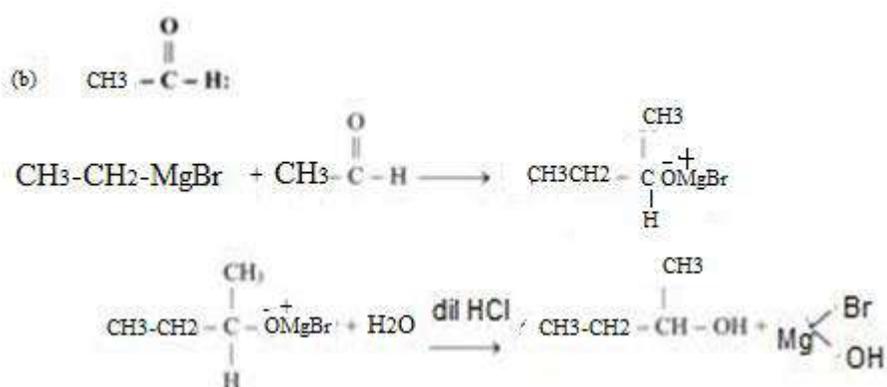
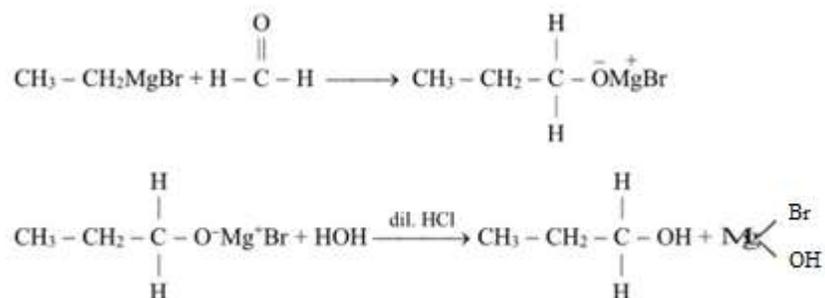
Ans:

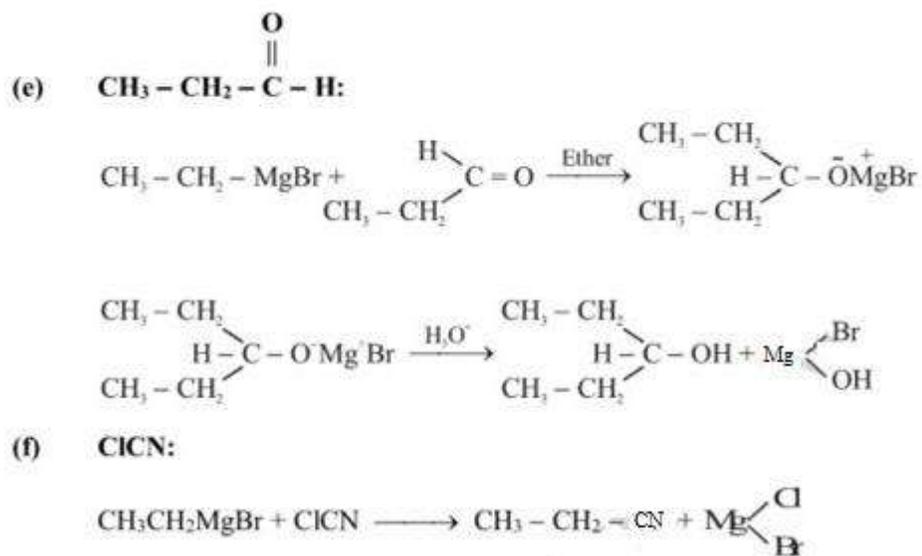


26. What products are formed when the following compounds are treated with ethyl-Mg-bromide followed by hydrolysis in the presence of an acid?

Ans:

(a) HCHO

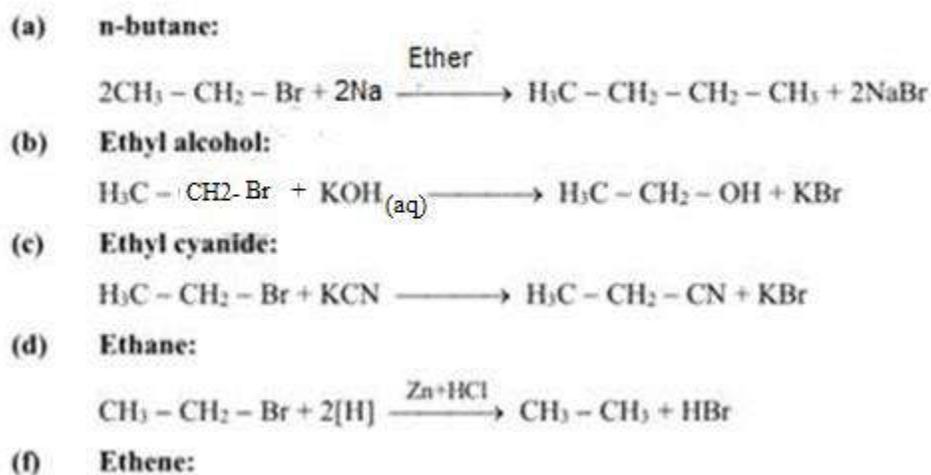


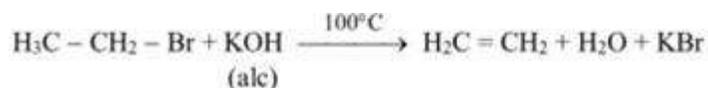


27. Using ethyl bromide as a starting material how would you prepare the following compounds.

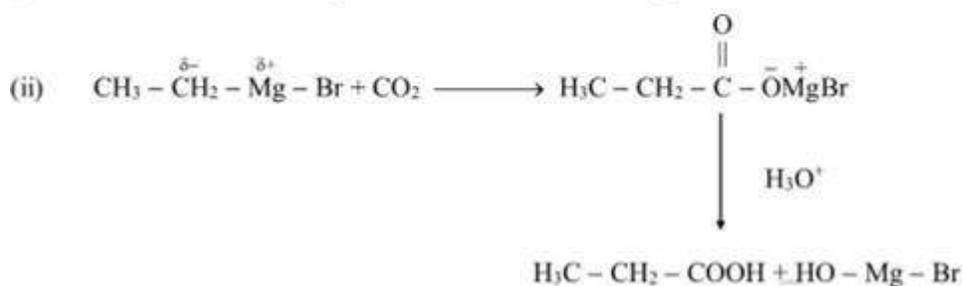
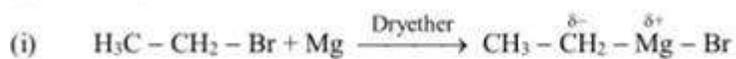
Also mention the inorganic reagents involved.

Ans:



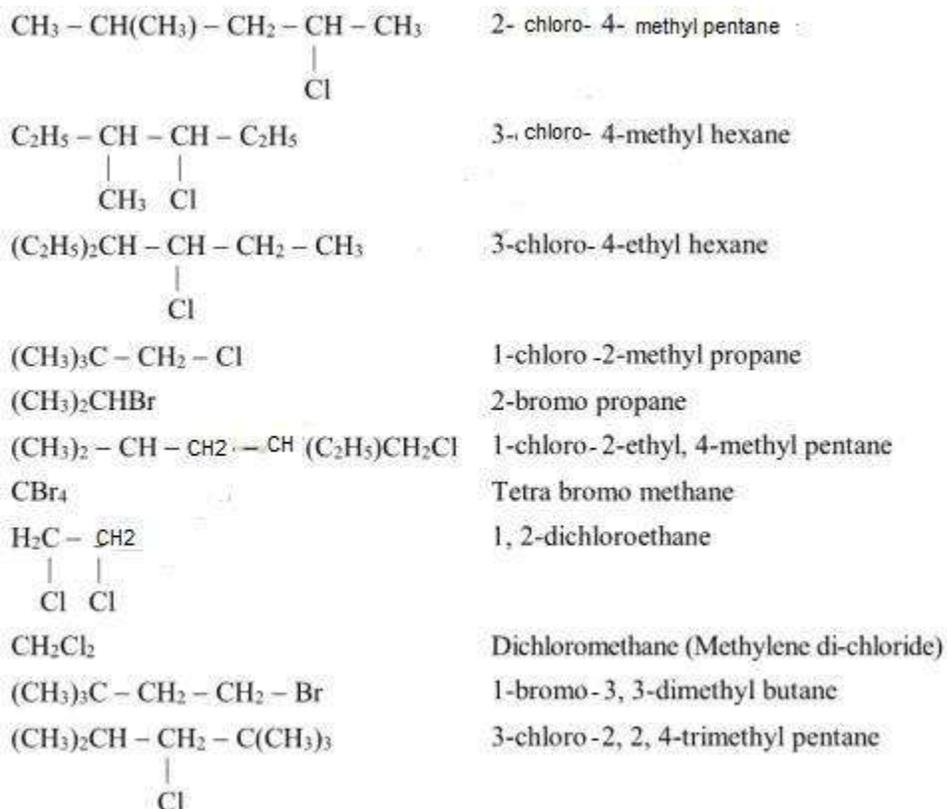


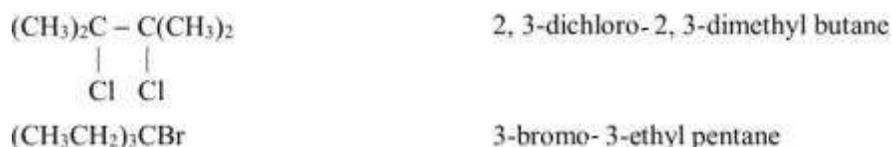
(g) Propanoic acid:



28. Give IUPAC names to the following compounds

Ans:





29. How are the alkyl halides classified?

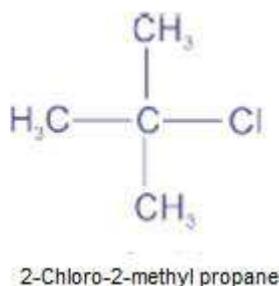
Ans: Mono haloalkanes or alkyl halides are further classified into primary, secondary and tertiary alkyl halides depending upon the type of carbon atom bearing the halogen atom. In a primary alkyl halide halogen atom is attached with a carbon which is further attached to one or no carbon atom e.g.,



Secondary alkyl halides are those in which halogen atom is attached with a carbon atom which is further attached to two other carbon atoms directly, e.g., secondary carbon atom.



In tertiary alkyl halides halogen atom is attached to a carbon which is further attached to three carbon atoms directly.



30. Mention the factors responsible for reactivity of alkyl halides.

Ans: There are two main factors which govern the reactivity of R — X bond.

These are:

- i) C — X Bond energy
- ii) C — X Bond polarity

31. Explain the factor of bond energy.

Ans: The strength of the bonds show that iodo compound (with the weakest bonds) would be the most reactive one while fluoro compound will be the least reactive i.e., the order of reactivity of alkyl halides should be.



32. Explain the factor of bond strength.

Ans: Electronegativities of halogen, carbon and hydrogen atoms present in alkyl halides are shown in the table. The greatest electronegativity difference exists between carbon and fluorine atoms in alkyl fluorides.

If an electrophile is the attacking reagent then this difference suggests that alkyl fluorides would be the most reactive one. On the same lines, alkyl iodides should be the least reactive alkyl halides. In the light of the above discussion it is clear that the two factors mentioned above predict different types of behaviour about the reactivity of alkyl halides

Experiments have shown that the strength of carbon halogen bond is the main factor which decides the reactivity of alkyl halides



In fact the C-F bond is so strong that alkyl fluorides do not react under ordinary conditions.

33. Define nucleophile, electrophile, leaving group and substrate molecule.

Ans:

Nucleophile

Nucleophile means nucleus loving. It has an unshared electron pair available for bonding and in most cases it is basic in character. It may be negatively charged or neutral.

Examples of Nucleophiles

HO ⁻	Hydroxide ion	Cl ⁻	Chloride ion
C ₂ H ₅ O ⁻	Ethoxide ion	Br ⁻	Bromide ion
HS ⁻	Hydrogen sulphide ion	NH ₃	Ammonia
SCN ⁻	Thiocyanate ion	CN ⁻	Cyanide ion
H ₂ O:	Water	I ⁻	Iodide ion
NH ₂ ⁻	Amino group		

Electrophile

It is species which attracts electrons (electron loving). The carbon atom of an alkyl group attached with the halogen atom and bearing a partial positive charge is called an electrophile or electrophilic center. An electrophile may be neutral or positively charged. Example, C⁺, Na⁺, K⁺, BF₃

Leaving Group

L is also a nucleophile. It is called leaving group because it departs with an unshared pair of electrons. If we wish an S_N reaction to proceed in the forward direction the incoming nucleophile must be stronger than the departing one. Cl⁻, Br⁻, I⁻, HSO₄⁻ are good leaving groups. Poor leaving groups are OH⁻, and NH₂⁻. Iodide ion is a good nucleophile as well as a good leaving group.

Substrate Molecule

The alkyl halide molecule on which a nucleophile attacks is called a substrate molecule.

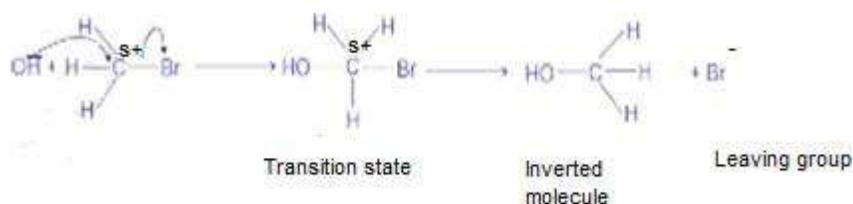
34. Mention types of nucleophilic substitution reactions.

Ans: Alkyl halides may undergo nucleophilic substitution reactions in two different ways:

1. Nucleophilic Substitution Bimolecular (SN₂)
2. Nucleophilic Substitution Unimolecular (SN₁)

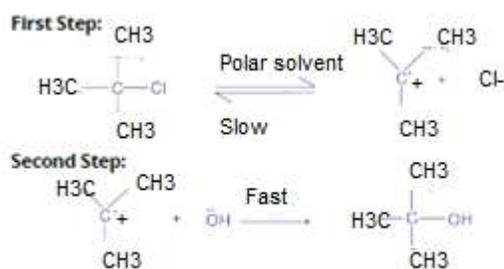
35. Define SN₂ reaction. Give mechanism.

Ans: Nucleophilic substitution reactions on alkyl halides involve two main processes, the breakage of C — X bond and the formation of C — Nu bond. The mechanism of the nucleophilic substitution reactions depends upon the timing of these two processes. If the two processes occur simultaneously the mechanism is called SN₂.



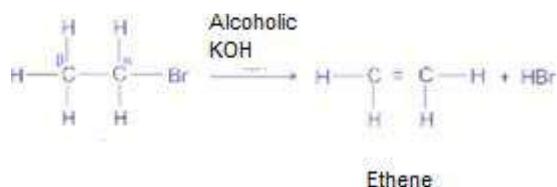
36. Define SN₁ reaction. Give mechanism.

Ans: Nucleophilic substitution reactions on alkyl halides involve two main processes, the breakage of C — X bond and the formation of C — Nu bond. The mechanism of the nucleophilic substitution reactions depends upon the timing of these two processes. If the bond breaks first followed by the formation of a new bond, the mechanism is called SN₁.



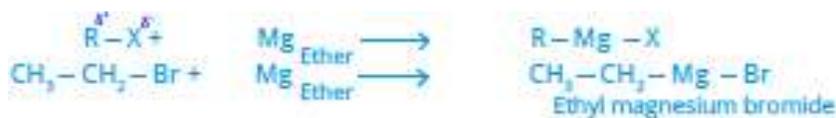
37. Define β-elimination reactions.

Ans: During nucleophilic substitution reactions, the attacking nucleophile attacks the electrophilic carbon atom of the alkyl halide. There is another site present in the alkyl halide molecule where the nucleophile can attack at the same time. Such a site is an electrophilic hydrogen atom attached to the β-carbon of the alkyl halide. When the attack takes place on hydrogen, we get an alkene instead of a substitution product. Such type of reactions is called elimination reactions. These reactions take place simultaneously with substitution reactions and often compete with them.



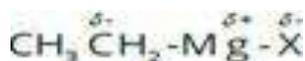
38. How Grignard reagent is prepared?

Ans: Grignard reagents are prepared by the reaction of magnesium metal with alkyl halides in the presence of dry ether (alcohol free, moisture free).



39. Explain structure and reactivity of Grignard reagent.

Ans: Grignard reagents are much more reactive than most of the organic compounds. The reactivity is due to the nature of C - Mg bond which is highly polar.



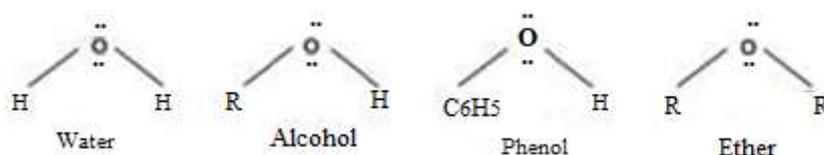
Magnesium is more electropositive than carbon and the C-Mg bond though covalent is highly polar, giving alkyl carbon the partial negative charge. This negative charge is an unusual character which makes the alkyl groups highly reactive towards electrophile centres. Mostly reactions shown by Grignard reagent are exothermic.

Chapter#11

Alcohols, Phenols and Ethers

1. Why are alcohol, phenol and ether considered as derivatives of water?

Ans: Alcohols, phenols and ethers are classes of organic compounds which are much closer to water in structure and hence considered as derivatives of water.



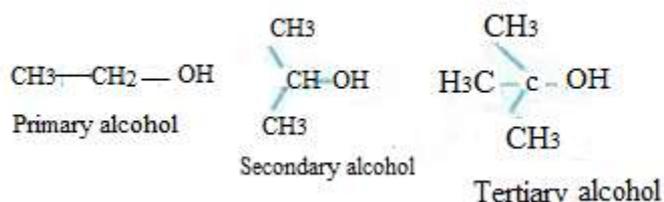
Alcohols and phenols are much more close to one another in structure and properties. Both contain hydroxyl (-OH) group so they may also be termed as hydroxy derivatives of alkanes and benzene respectively. In ether both hydrogens of water are replaced by alkyl or phenyl groups.

2. How are alcohols classified?

Ans: Alcohols are classified into monohydric and polyhydric alcohols. Monohydric alcohols contain one -OH group while polyhydric alcohols may contain two, three or more OH groups and named as dihydric or trihydric alcohols, etc.

3. What are primary, secondary and tertiary alcohols?

Ans: In primary alcohols, -OH functional group is attached with primary carbon atom, in secondary alcohols with secondary carbon atom and in tertiary alcohols it is attached with a tertiary carbon atom.

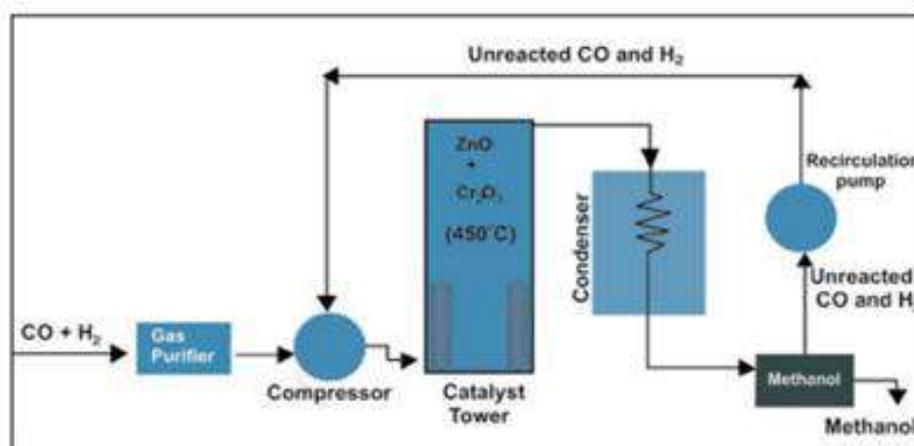
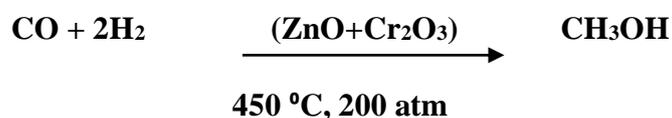


4. What are monohydric alcohols?

Ans: Monohydric alcohols contain one -OH group while polyhydric alcohol as may contain two, three or more OH groups and named as dihydric or trihydric alcohol, etc. Monohydric alcohols are further classified into primary secondary and tertiary alcohols.

5. Write about industrial preparation of methanol OR Give preparation of methanol by reaction between CO and H₂.

Ans: Formerly methanol was prepared by distillation of wood. That is why, it is also called as wood spirit. Now-a-days methanol is prepared from carbon monoxide and hydrogen or water gas as follows:



First of all a mixture of carbon monoxide and hydrogen is purified. It is compressed under a pressure of 200 atmospheres and taken into a reaction chamber by means of coiled pipes.

Here the catalyst is heated up to 450-500 °C. Gases react to form methanol vapours. These vapours are passed through a condenser to get methanol. Unreacted gases are recycled through compressor to reaction chamber.

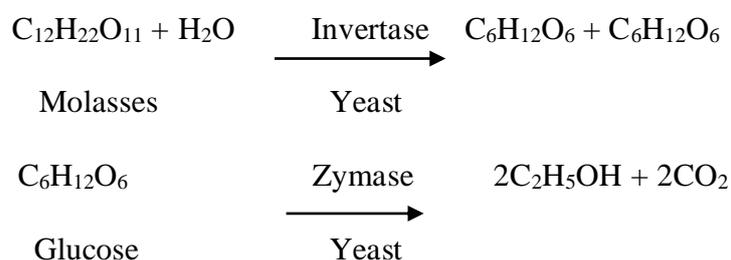
6. Define fermentation. What are the conditions of fermentation? OR Which compound may be obtained by fermentation on industrial scale?

Ans: Ethanol is prepared on industrial scale world over, by the process of fermentation. Fermentation is a biochemical process which occurs in the presence of certain enzymes secreted by microorganisms such as yeast. Optimum temperature for this process of fermentation is 25-35°C. Moreover, proper aeration, dilution of solution and the absence of any preservative are essential conditions for fermentation.

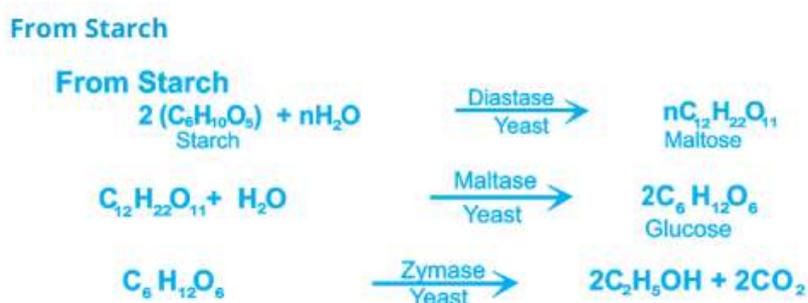
7. Explain industrial preparation of ethanol from molasses.

Ans: From Molasses

The residue obtained after the crystallization of sugar from concentrated sugar cane juice is called molasses. It undergoes fermentation in the presence of enzymes present in yeast to give ethanol.



8. Explain industrial preparation of ethanol from starch.



Ans:

9. Why we cannot get ethanol beyond 12 or 14% through fermentation?

Ans: Alcohol obtained by fermentation is only up to 12% and never exceeds 14% because beyond this limit enzymes become inactive.

10. What is rectified spirit or absolute alcohol?

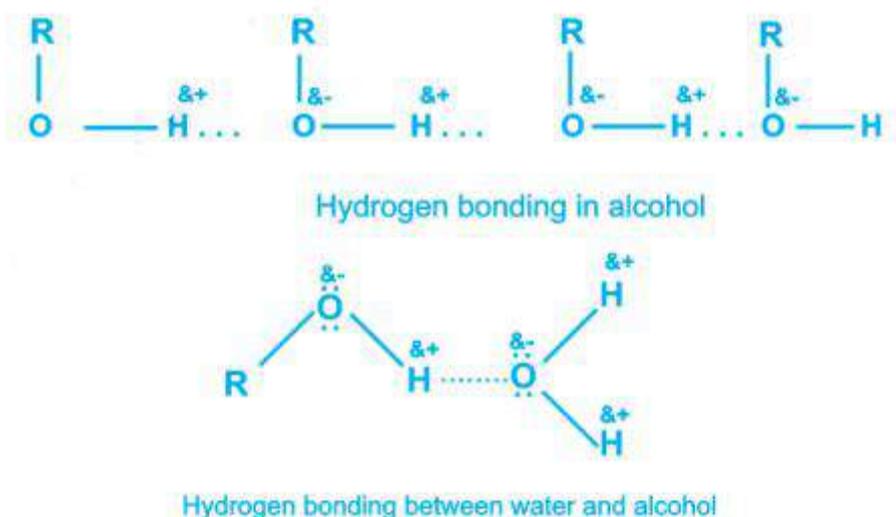
Ans: Alcohol is distilled again and again to obtain 95% alcohol which is called rectified spirit. Absolute alcohol can be obtained by re-distillation of rectified spirit in the presence of CaO which absorbs its moisture.

11. Define denaturing of alcohol OR How methylated spirit is prepared?

Ans: Sometimes ethanol is denatured by addition of 10% methanol to avoid its use for drinking purposes. Such alcohol is called methylated spirit. A small quantity of pyridine or acetone may also be added for this purpose.

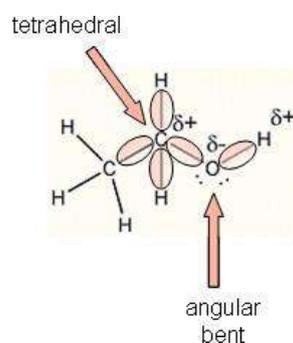
12. Why lower alcohols are soluble in water but higher alcohols insoluble?

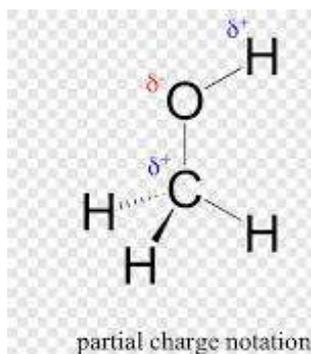
Ans: Lower alcohols are soluble in water due to hydrogen bonding but as the chain length increases the solubility decreases as the alkyl chain is non-polar.



13. Why ethanol is more soluble in water than methanol?

Ans: Ethanol is more soluble in water than methanol due to greater charge separation in ethanol. This can be understood well through structure:





This shows that because of more charges on ethanol it is more soluble in water making stronger hydrogen bonding.

14. How can we distinguish between primary, secondary and tertiary alcohol? OR what is Lucas test?

Ans: Primary, secondary and tertiary alcohols are identified and distinguished by reacting them with conc. HCl in anhydrous $ZnCl_2$.

An oily layer of alkyl halides separates out in these reactions.

1. Tertiary alcohols form an oily layer immediately
2. Secondary alcohols form an oily layer in five to ten minutes.
3. Primary alcohols form an oily layer only on heating

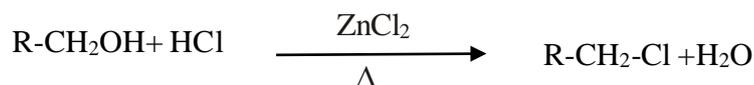
(i) Tertiary alcohols form an oily layer immediately.



(ii) Secondary alcohols form an oily layer in 5 to 10 minutes.



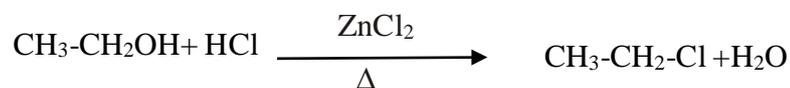
(iii) Primary alcohols form an oily layer only on heating.



15. Distinguish ethanol and tertiary butyl alcohol by Lucas Test.

Ans: Ethanol and tertiary butyl alcohol are distinguished by reacting them with concentrated HCl in anhydrous $ZnCl_2$. An oily layer of alkyl halides separates out in these reactions

1 Ethyl alcohol forms an oily layer immediately



2. Tertiary Butyl alcohol forms an oily layer only on heating



16. Which type of reactions is given by alcohols?

Ans: Alcohols react with other reagents in two ways

(i) Reactions in which C — O bond breaks



(ii) Reactions in which O — H bond breaks



17. Give any four uses of Methyl alcohol OR Give uses of methyl alcohol.

Ans: Following are the uses of methyl alcohol:

1. Methanol is widely used in the production of acetic acid and formaldehyde
2. In order to stop use of ethanol for drinking purposes, methanol is often added to it as a denaturant
3. This compound is also used as an antifreeze (an additive that is used to lower the freezing point of a liquid) in many pipelines
4. It is also used as solvent for fats, oils and paints.

18. Write two uses each of methanol and ethanol.

Ans: Uses of methanol

- i. Methanol is used as an antifreeze
- ii. It is also used as solvent for fats, oils and paints

Uses of ethanol

- i. It is used as a fuel in some countries
- ii. It is used as preservative for biological specimens

19. Write any four uses of ethyl alcohol.

Ans: Uses of ethanol are as follows:

- (i) It is used as solvent
- (ii) It is used as a drink
- (iii) It is used as a fuel
- (iv) It is used as a preservative for biological specimen.

20. When the C-O bond breaks?

Ans: If a nucleophile attacks, it is the C — O bond which breaks.



21. When the O-H bond breaks?

Ans: If an electrophile attacks on alcohol, it is the O — H bond which breaks.



22. How can you distinguish between methanol and ethanol?

Ans: Ethanol gives iodoform with iodine in the presence of NaOH. Formation of yellow crystals indicates that the alcohol is ethanol. Methanol does not give iodoform test.



23. Ethanol gives different products with conc. H_2SO_4 under different conditions.

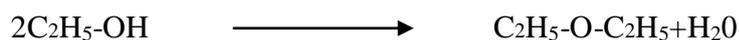
Justify?

Ans: Ethyl Alcohol gives different products with conc. H_2SO_4 on different temperatures;

At 180°C with conc. H_2SO_4 .

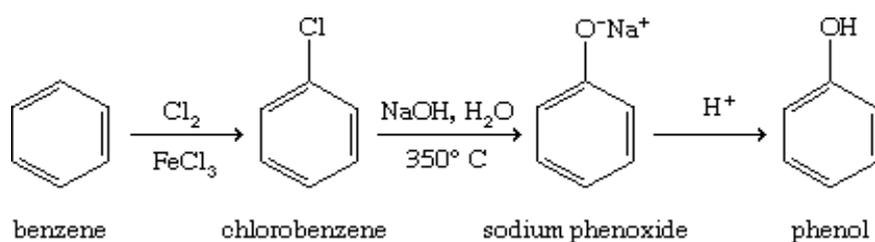


At 140°C with conc. H_2SO_4 .



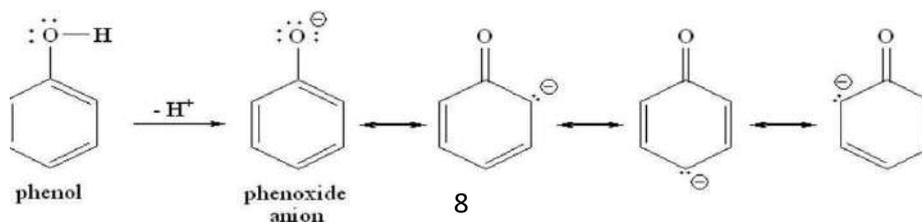
24. Prepare Phenol from Chlorobenzene by Dow's method.

Ans: In this method chlorobenzene is treated with 10% NaOH at 360°C and 150 atmospheres pressure sodium phenoxide is produced which on treating with HCl gives phenol.



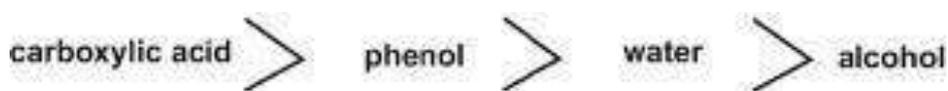
25. Explain acidic behaviour of phenol.

Ans: Phenol is much more acidic than alcohols but less acidic than carboxylic acids. It dissolves readily in alkalis but it is too weak to affect the litmus paper or to evolve CO_2 from carbonates. Its dissociation constant (K_a) is 1.3×10^{-10} .



Phenol is partially soluble in water and its solution has a pH of around 5 or 6. This makes phenol different from aliphatic alcohols. The reason why phenol is acidic lies in the nature of the phenoxide ion. The negative charge on oxygen atom can become involved with the p-electron cloud on the benzene ring. The negative charge is thus delocalized in the ring and the phenoxide ion becomes relatively stable. This type of delocalization is not possible with alcohols.

26. Compare acidic strength of alcohol, phenol, water and carboxylic acid.



Ans: Relative acidic strength of alcohol, phenol, water, and carboxylic acid is as follows:

Hence, carboxylic acids are more acidic than phenol and alcohol because of greater resonance stabilization of their conjugate base.

27. Compare the reaction of conc. H_2SO_4 with

Ans:

(i) Ethyl alcohol

Ethyl Alcohol gives different products with conc H_2SO_4 on different temperatures;

At 180 °C with conc. H_2SO_4 .

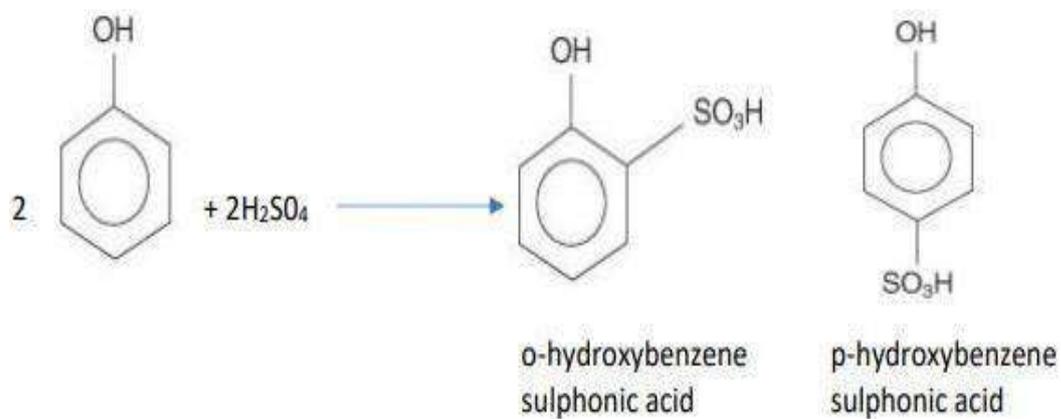


At 140 °C with conc. H_2SO_4 .



(ii) Phenol.

Phenol reacts with conc. sulphuric acid at room temp.as follows;

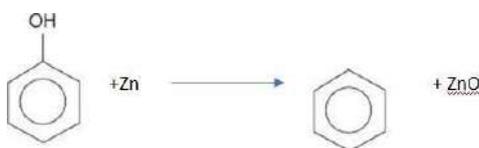


28. Picric acid is a phenol which behaves like an acid. Justify.

Ans: Picric acid 2,4,6-Trinitrophenol has 3 nitro groups present which have electron withdrawing nature. Nitro groups can engage the negative charge on benzene ring in delocalization, setting the proton free for longer time. So picric acid acts as an acid.

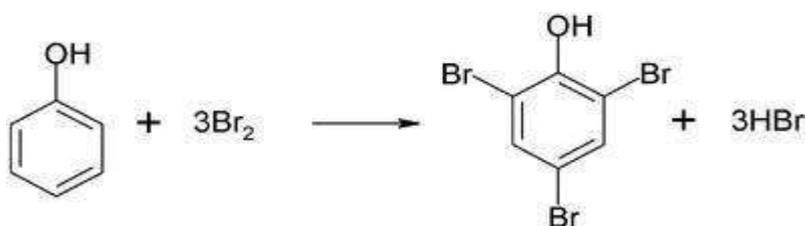
29. How phenol can be converted to benzene?

Ans: Phenol can be converted into Benzene by the reduction with Zinc.



30. How does phenol react with bromine water?

Ans: An aqueous solution of phenol reacts with bromine water to give white ppts of 2,4, 6-Tribromophenol.



31. How does phenol react with alkali?

Ans: Phenol reacts with sodium hydroxide solution to give a colourless solution containing sodium phenoxide.



32. How are ethers classified?

Ans: Ethers are classified into two categories

1. Simple or symmetrical ethers, which contain two same alkyl groups e.g. dimethyl ether CH_3OCH_3 and diethyl ether $\text{CH}_3\text{—CH}_2\text{—O—CH}_2\text{—CH}_3$.
2. Mixed or unsymmetrical ethers, which contain different alkyl or phenyl groups, e.g., ethyl methyl ether $\text{CH}_3\text{—O—CH}_2\text{—CH}_3$

33. What is Williamson's synthesis?

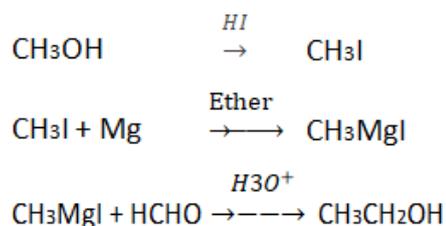
Ans: Alcohols are reacted with metallic sodium to form alkoxides. This alkoxide ion is a strong nucleophile and readily reacts with alkyl halide to produce ether. This method is called Williamson's synthesis.



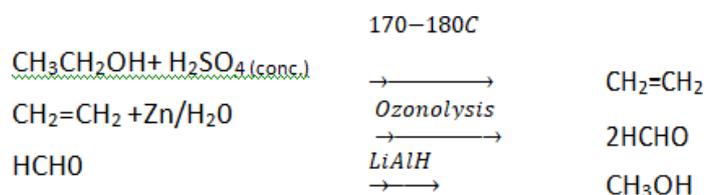
34. How will you convert:

Ans:

iii. Methanol into Ethanol



iv. Ethanol into Methanol



35. Write structural formulas of:

Ans:

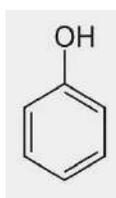
v. Methoxyethane $\text{CH}_3\text{-O-CH}_3$

vi. Ethoxybenzene $\text{C}_6\text{H}_5\text{-O-C}_2\text{H}_5$

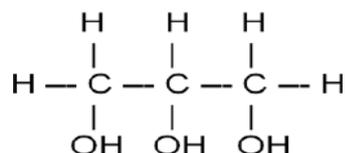
36. Write structural formulas of:

Ans:

i. Carboic acid



ii. Glycerol

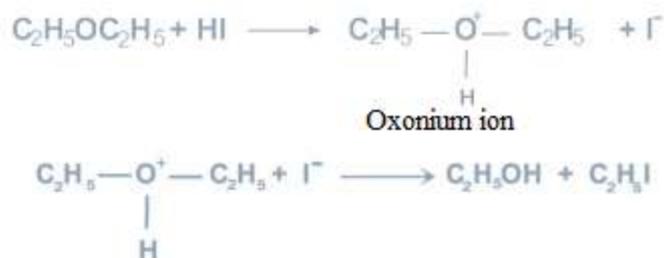


37. Why ethers are referred to as inert compounds?

Ans: Ethers are comparatively inert substances. The reagents like ammonia, alkalies, dilute acids and metallic sodium, have no reaction on ethers in cold state. Moreover, they are not oxidized or reduced easily. That's why ethers are considered as inert.

38. Explain chemical reactivity of ethers.

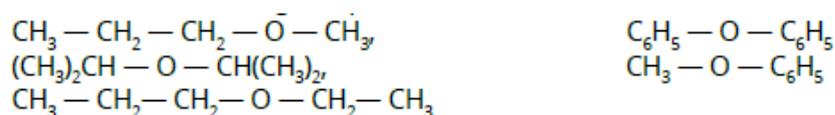
Ans: Ethers are comparatively inert substances. The reagents like ammonia, alkalies, dilute acids and metallic sodium, have no action on ethers in cold state. Moreover, they are not oxidized or reduced easily. However ethers show some reactions, e.g.



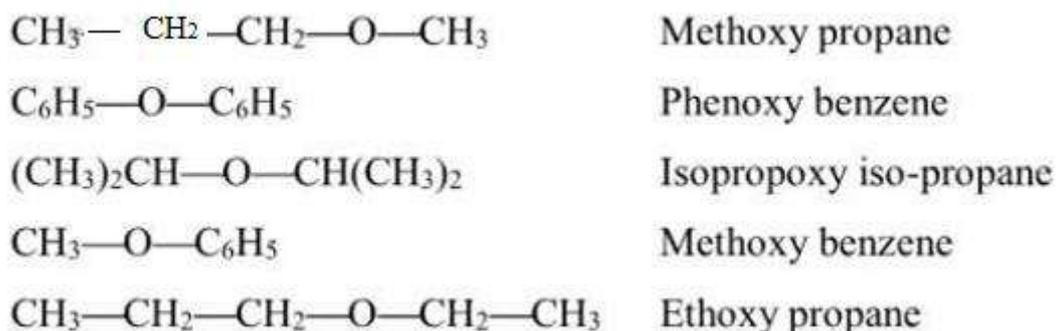
1. With hydrogen iodide ethers give alcohols which can react further to give alkyl iodides.
2. Ethers also react with hot phosphorus pentachloride to give alkyl chloride.



39. Name the following compounds

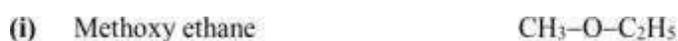


Ans:

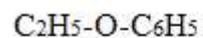


40. Write the structural formulas of the following compounds

Ans:



(ii) Ethoxy benzene



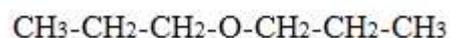
(iii) Sodium ethoxide



(iv) Sodium phenoxide

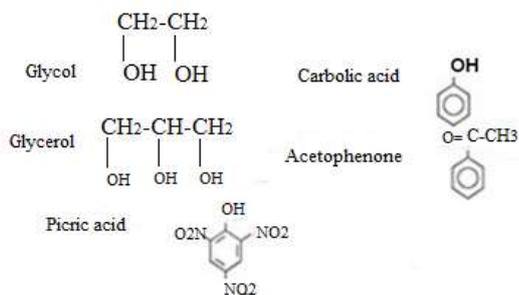


(v) Propoxy propane



41. Write structural formulas of the following compounds

Ans:



42. Write IUPAC names of the following compounds

Ans:

- | | | |
|-------|--------------------------------------------------------------------------------------|---------------------|
| (i) | $(\text{CH}_3)_2\text{CH-OH}$ | 2-propanol |
| (ii) | $(\text{CH}_3)_2\text{CHCH}_2\text{OH}$ | 2-methyl-1-propanol |
| (iii) | $(\text{CH}_3)_3\text{COH}$ | 2-methyl-2-propanol |
| (iv) | $\begin{array}{c} \text{C}_2\text{H}_5\text{-CH-OH} \\ \\ \text{CH}_3 \end{array}$ | 2-butanol |

43. Explain the following terms using ethyl alcohol as an example

i) Oxidation

ii) Dehydration

iii) Esterification

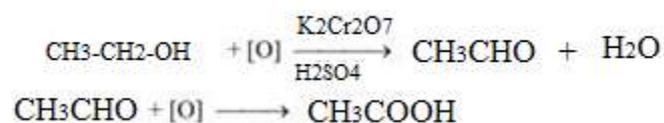
iv) Ether formation

Ans:

Oxidation

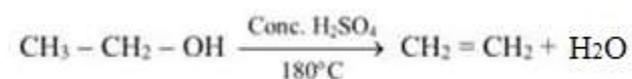
Ethyl alcohol on oxidation changes to acetaldehyde and finally acetic acid.

Mixture of $K_2Cr_2O_7$ and conc. H_2SO_4 is a good oxidizing agent.



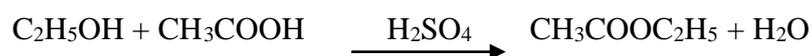
Dehydration

Ethyl alcohol when reacted with conc. H_2SO_4 at $180^\circ C$ releases water. This phenomenon is called dehydration.



Esterification

When excess amount of ethyl alcohol reacts with less amount of conc. H_2SO_4 at $140^\circ C$ ether is formed.



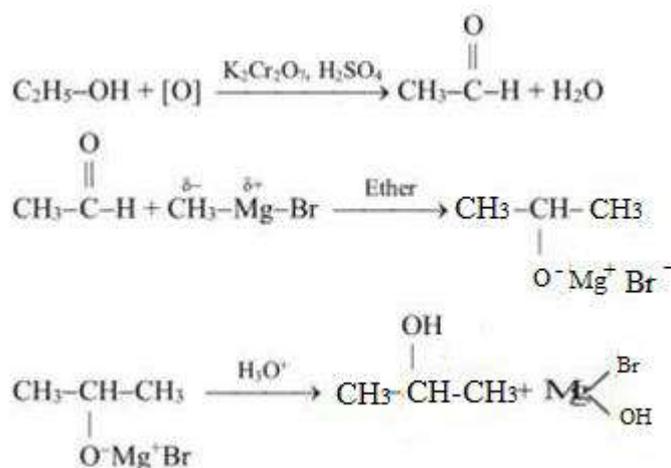
Ether Formation

When excess amount of ethyl alcohol reacts with less amount of conc. H_2SO_4 at $140^\circ C$ then ether is formed as a product.



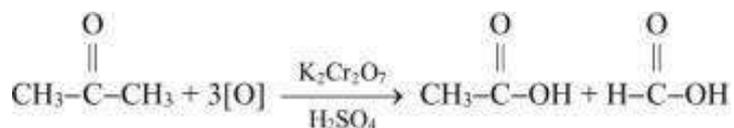
44. How will you convert ethanol into isopropyl alcohol?

Ans:



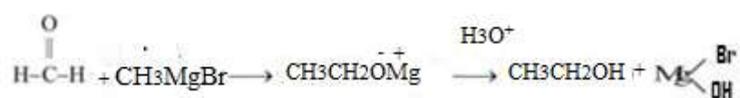
45. How will you convert acetone into ethyl alcohol?

Ans:



46. How will you convert formaldehyde into ethyl alcohol?

Ans:



47. Ethyl alcohol is a liquid while methyl chloride is a gas. Why?

Ans: Ethyl alcohol has strong hydrogen bonding between its molecules whereas methyl chloride does not have rather its molecules experience weaker dipole-dipole forces.

Therefore, ethyl alcohol is a liquid while methyl chloride is a gas.

48. Ethanol has higher boiling point than diethyl ether. Why?

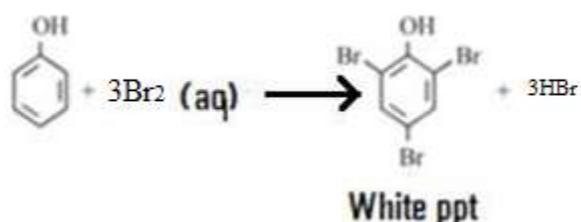
Ans: Due to strong hydrogen bonding in ethanol it has higher boiling point than diethyl ether.

49. Why water has higher boiling point than ethanol?

Ans: In water there is strong three-dimensional hydrogen bonding due to only one hydrogen bond per molecule. Hence, boiling point of water is higher than ethanol.

50. How will you distinguish between an alcohol and a phenol?

Ans: Phenol gives white ppt. with bromine water while alcohols do not react with bromine water.



51. How will you distinguish between an alcohol and an ether?

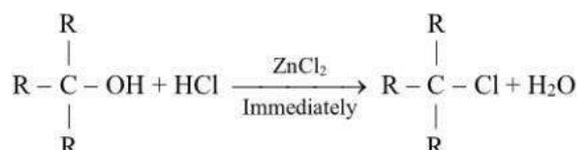
Ans: Alcohols give an oily layer of alkyl halides while reacting with conc. HCl in anhydrous ZnCl_2



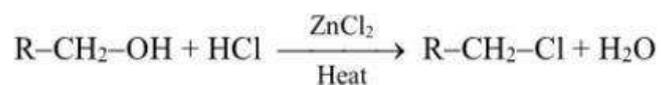
Ethers do not give this reaction

52. How will you distinguish between a tertiary alcohol and a primary alcohol?

Ans: Tertiary alcohols form an oily layer immediately when reacted with conc. HCl in anhydrous ZnCl_2

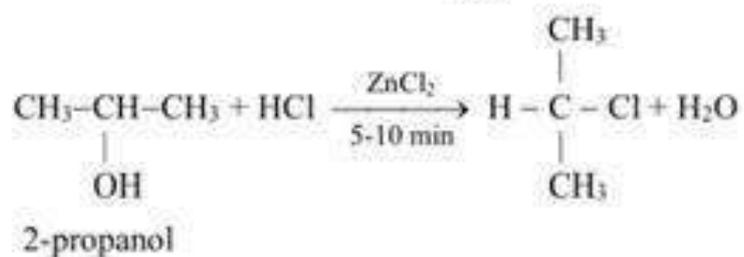
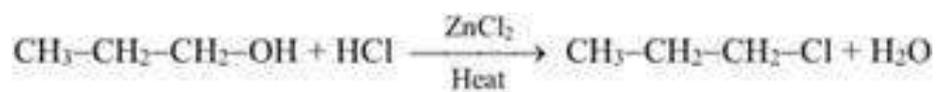


While primary alcohols form an oily layer on heating



53. How will you distinguish between 1-propanol and 2-propanol?

Ans: We can distinguish between 1-propanol and 2-propanol by Lucas test

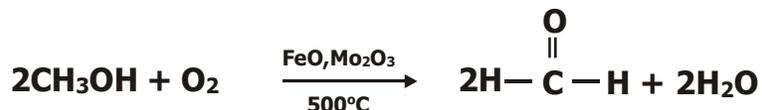


Chapter#12
Aldehydes and Ketones

1. Describe preparation of formalin from methanol on commercial scale.

Ans: Industrial (Commercial) Method:

Formaldehyde (Formalin) is manufactured commercially by passing a mixture of methanol vapours and air over iron oxide-molybdenum oxide or silver catalyst at 500°C.



2. Explain one method of formation of formaldehyde from methyl alcohol.

Ans: Formaldehyde is prepared in the laboratory by passing a mixture of methyl alcohol vapours and air over platinized asbestos or copper or silver catalyst at 300 °C.

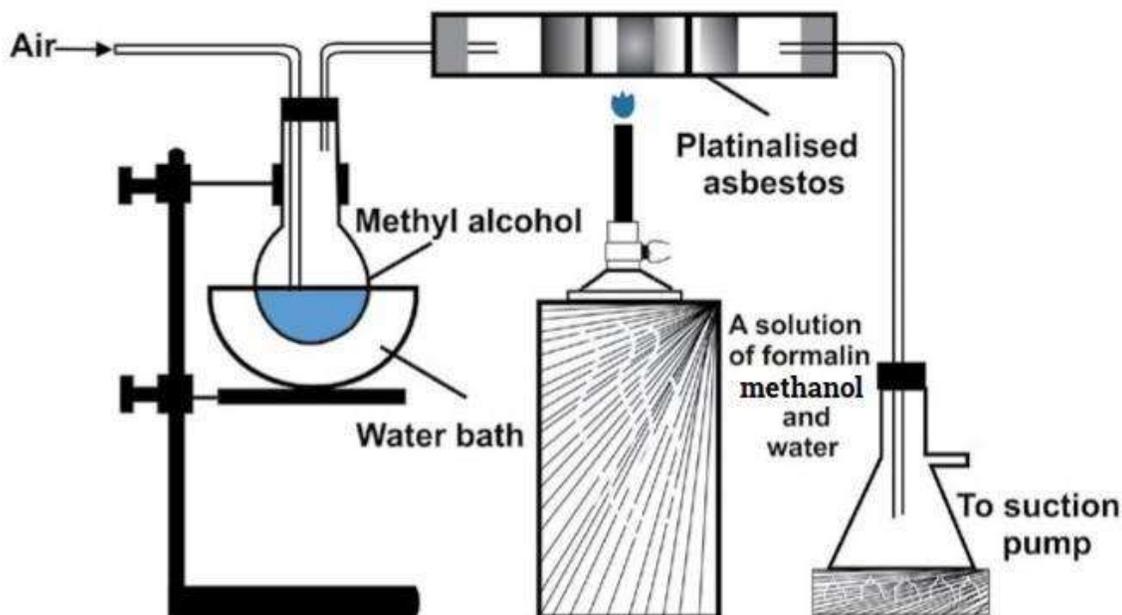
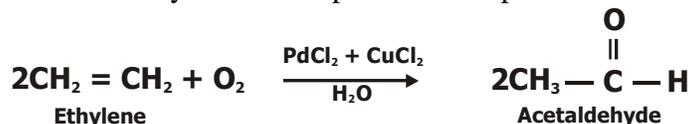


Fig. Preparation of Formaldehyde (formalin)

3. Write a method for the commercial preparation of acetaldehyde?

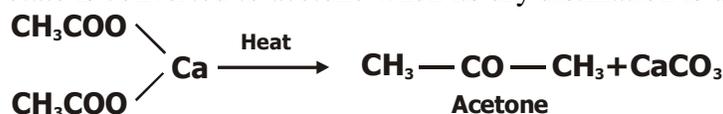
Ans: Industrial Method:

Acetaldehyde is prepared industrially by oxidation of ethylene in air using palladiumchloride catalyst with a cupric chloride promoter.



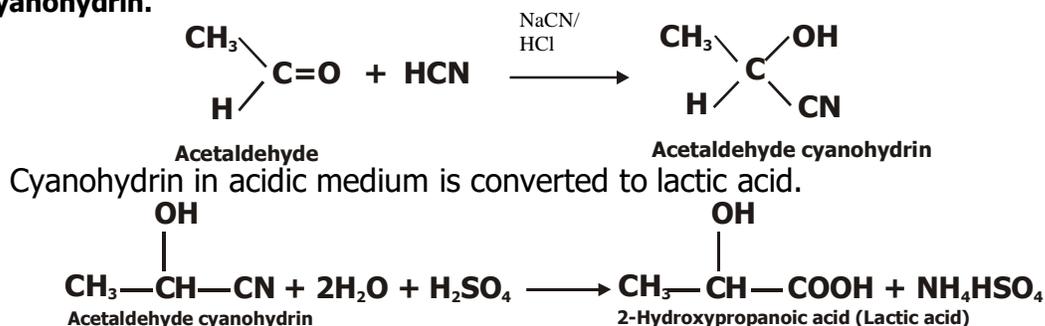
4. Convert calcium acetate to acetone.

Ans: Calcium acetate is converted to acetone when its dry distillation is done.



5. Convert acetaldehyde into lactic acid.

Ans: Acetaldehyde is reacted with hydrogen cyanide to produce acetaldehyde cyanohydrin.



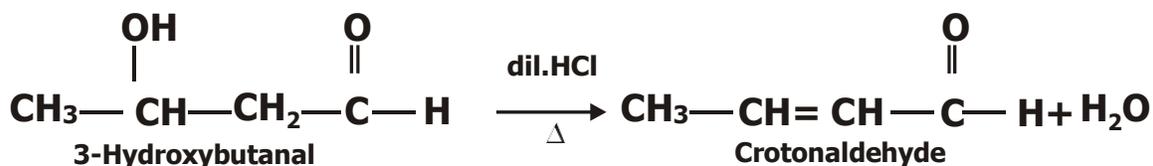
6. For Aldol condensation the presence of α -hydrogen is must in aldehydes and ketones. Give reasons.

Ans: Aldol condensation proceeds through the formation of carbanion in the first step. This ion is produced when the acidic hydrogen at the α -carbon is removed by the base (OH^-). In the absence of α -hydrogen, carbanion cannot be produced, so aldol condensation cannot take place.

7. How is crotonaldehyde obtained from Aldol?

Ans: Conversion of Aldol to Croton aldehyde:

The aldol undergoes dehydration on heating in the presence of dilute acid to form α,β -unsaturated carbonyl compound. A carbon-carbon double bond is formed between the α - and β -carbon atoms.



8. What are disproportionation reactions?

Ans: It is a disproportionation (self oxidation-reduction) reaction. The molecules being oxidized and reduced are the same chemical species.

Example:

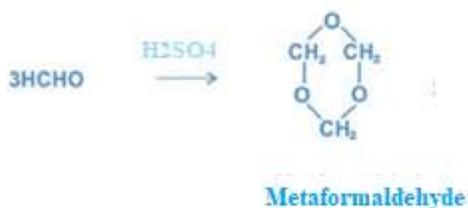


9. Justify that Cannizaro's reaction is a self-redox reaction.

Ans: In Cannizaro's reaction, one of the molecules of aldehyde is oxidized and the other is reduced. The oxidation yields carboxylic acid and reduction alcohol. (Mechanism already discussed in exercise questions section given above. Benedict's solution are some examples of mild oxidizing agents.

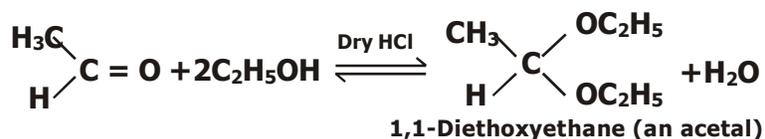
10. Convert formaldehyde to meta-formaldehyde?

Ans: Formaldehyde polymerizes in the presence of dil. H_2SO_4 to give Meta formaldehyde as shown below.



11. What is the importance of converting aldehyde to Acetal?

Ans: Aldehydes combine with alcohols in the presence of hydrogen chloride gas to form acetals shown below.

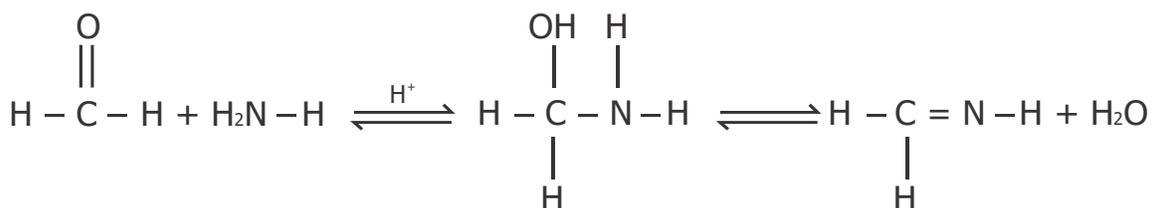


Importance of reaction:

The reaction may be used to protect the aldehyde group against alkaline oxidizing agents. To regenerate Aldehyde, the Acetal is hydrolyzed in the presence of an acid.

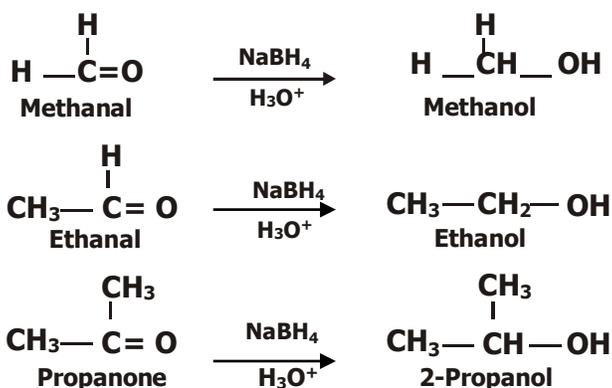
12. Describe reaction of aldehyde with ammonia?

Ans: Aldehyde and Ketones react with ammonia (H-NH_2) to form compounds containing the group $-\text{C} = \text{N}$ and water. The reaction is known as condensation reaction or elimination reaction because water is lost after addition occurs. This reaction is acid catalyzed.



13. How aldehydes and Ketones are reduced to alcohols?

Ans: Aldehydes and ketones are reduced to alcohols with sodium borohydride (NaBH_4) in acidic medium.



14. Write the names of those weak oxidizing agents which can oxidize aldehydes but not ketones.

Ans: Some examples of such oxidizing agents are as follows

- (i) Fehling's solution (an alkaline solution containing a cupric tartrate complex ion)
- (ii) Benedict's solution (an alkaline solution containing a cupric citrate complex ion)
- (iii) Tollen's reagent (ammonical silver nitrate solution)

15. Why the oxidation of Ketones is difficult?

Ans: Ketones do not undergo oxidation easily because they require breaking of strong carbon– carbon bond. They give no reaction with mild oxidizing agents. They are only oxidized by strong oxidizing agents such as $K_2Cr_2O_7/H_2SO_4$, $KMnO_4/H_2SO_4$, and conc. HNO_3

16. What are the factors which make aldehydes more reactive than ketones?

Ans: The following two factors account for this:

- i) The presence of hydrogen atom with the carbonyl group in aldehyde decreases steric hindrance around carbonyl carbon. In ketones there is more steric hindrance.
- ii) In ketones the two alkyl groups (electron donating groups) decrease the electrophilic character of carbonyl carbon atom to a great extent while one alkyl group in aldehyde does not decrease the electrophilic character of carbonyl carbon atom to that extent.

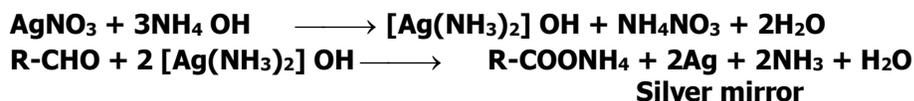
17. How aldehydes are identified by Tollen's test?

OR

Tollen's test is also called silver mirror test. Justify it.

Ans: Tollen's Test [Silver Mirror Test]:

Aldehydes form silver mirror with Tollens' reagent (ammonical silver nitrate solution). Add Tollens' reagent to an aldehyde solution in a test tube and warm. A silver mirror is formed on the inside of the test tube.

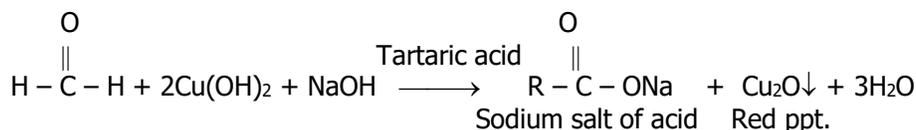


18. Give examples of mild oxidizing agents?

Ans: The reagents or compounds which can only oxidize aldehydes and not the ketones are called mild oxidizing agents such as Tollen's reagent, Fehling's solution etc.

19. Fehling's solution reacts with aldehydes to give red ppt. justify it.

Ans: Fehling's solution is a mixture of $\text{Cu}(\text{OH})_2$, NaOH and tartaric acid. It reduces aldehyde and produces brick red ppt of Cu_2O on heating.



20. How is acetaldehyde distinguished from formaldehyde?

Ans:

Acetaldehyde (Ethanal)	Formaldehyde (Methanal)
Ethanal produces yellow ppt of Iodoform (CHI_3) with NaOH and I_2 . $\text{CH}_3\text{-CHO} + 3\text{I}_2 + 4\text{NaOH} \rightarrow \text{CHI}_3 + \text{HCOONa} + 3\text{NaI} + 3\text{H}_2\text{O}$	Methanal does not produce Iodoform with NaOH and I_2 . $\text{H-CHO} + \text{I}_2 + \text{NaOH} \rightarrow$ No reaction

21. How Iodoform is prepared from ethanol and acetaldehyde?

Ans: Preparation of iodoform from ethanol and acetaldehyde:

Heating ethanol or acetaldehyde with NaOH and solid iodine gives Iodoform as follows: -



22. Give uses of formaldehyde (Any two or four can be asked)

Ans: Uses of formaldehyde:

- (i) It is used in the manufacture of resins like urea-formaldehyde and plastics such as bakelite.
- (ii) It is used in the manufacture of dyes such as indigo, para-rosaniline, etc.
- (iii) Its 40% aqueous solution called formalin is used as an antiseptic, a disinfectant, a germicide, a fungicide and for preserving animal specimens and sterilising surgical instruments.
- (iv) It is used as a decolourising agent in vat dyeing.
- (v) It is used in the silvering of mirrors.
- (vi) It is used in making medicine urotropine used as a urinary antiseptic.
- (vii) It is used in making formamint (formaldehyde + lactose) used as throat lozenges.
- (viii) It is used in the processing of anti-polio vaccine.

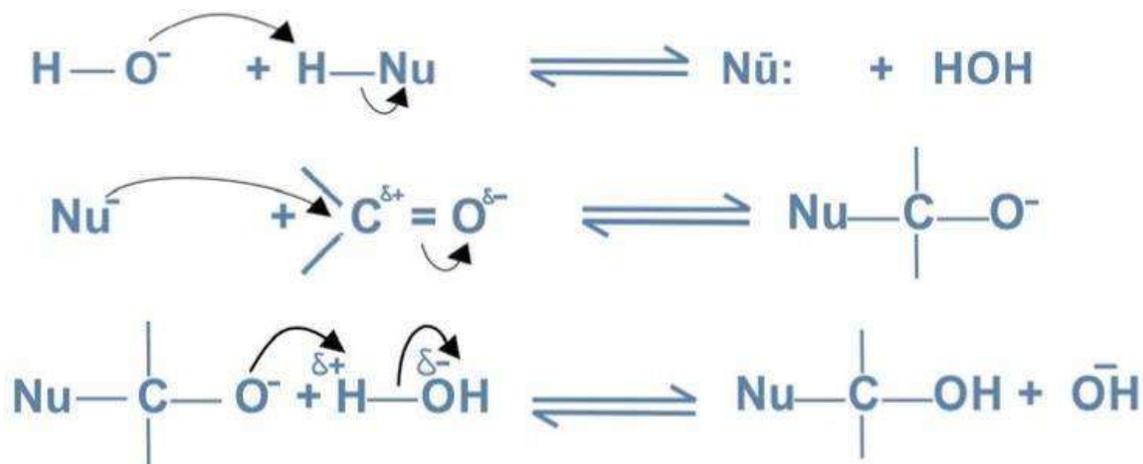
23. Write uses of acetaldehyde (Any two or four can be asked)

Ans: Uses of acetaldehyde:

1. It is used in the production of acetic acid, acetic anhydride, n-butanol, ethanol, 2-ethyl-1-hexanol, vinyl acetate, paraldehyde, ethylacetate, etc.
2. It is used to make acetaldehyde ammonia used as a rubber-accelerator.
3. It is used to make chloral hydrate, ethanol trimer and tetramer. Chloral hydrate and ethanol trimer are both used as hypnotic drugs whereas ethanol tetramer is used as a slug poison.
4. It is used as an antiseptic inhalent in nasal infections.
5. It is used in silvering of mirrors.
6. It is used to make phenolic resins and synthetic drugs.

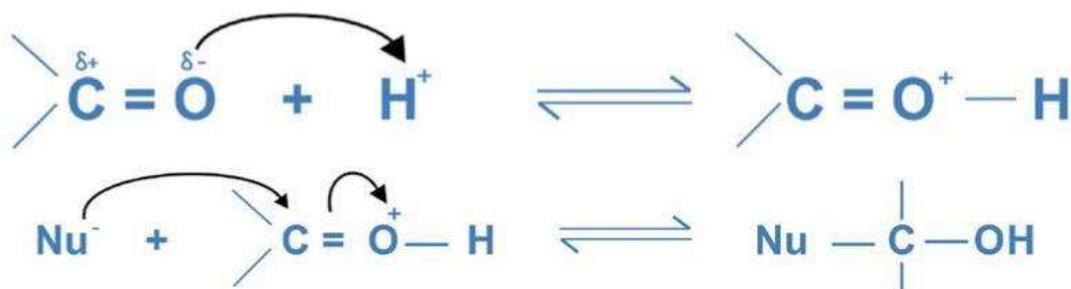
24. Describe briefly the base-catalyzed mechanism of nucleophilic addition to a carbonyl compound.

Ans:



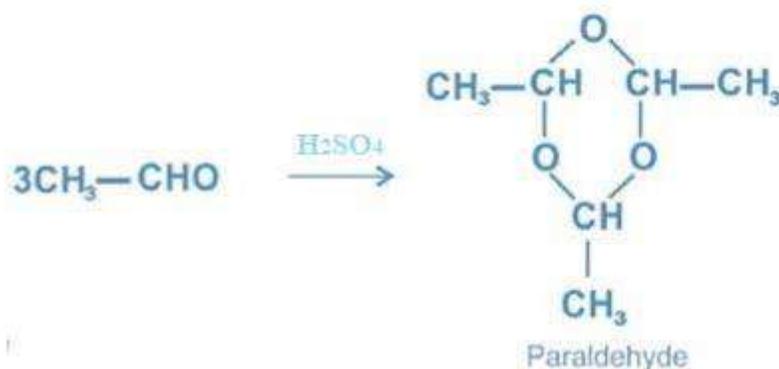
25. Describe briefly the acid-catalyzed mechanism of nucleophilic addition to a carbonyl compound.

Ans:



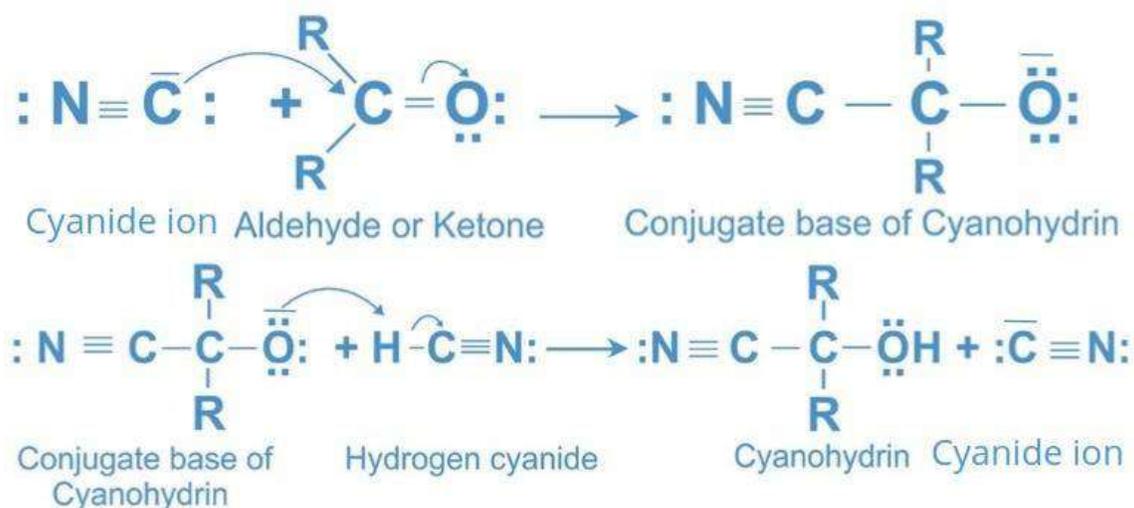
26. Convert acetaldehyde to paraldehyde.

Ans: Acetaldehyde polymerizes in the presence of dil. H_2SO_4 to give paraldehyde as shown below:



27. Give the mechanism of addition of HCN to aldehyde or ketone.

Ans:



28. Describe preparation of acetaldehyde from ethanol in laboratory.

Ans: Acetaldehyde is prepared in the laboratory by the oxidation of ethyl alcohol with acidified sodium dichromate solution. A mixture of ethyl alcohol and sodium dichromate solution is run into boiling dilute sulphuric acid. Immediately a vigorous reaction takes place and the acetaldehyde formed in liquid state is immediately distilled off. This prevents the oxidation of acetaldehyde to acetic acid. Ethyl alcohol remains in solution until it is oxidized. Pure acetaldehyde is obtained by redistillation.

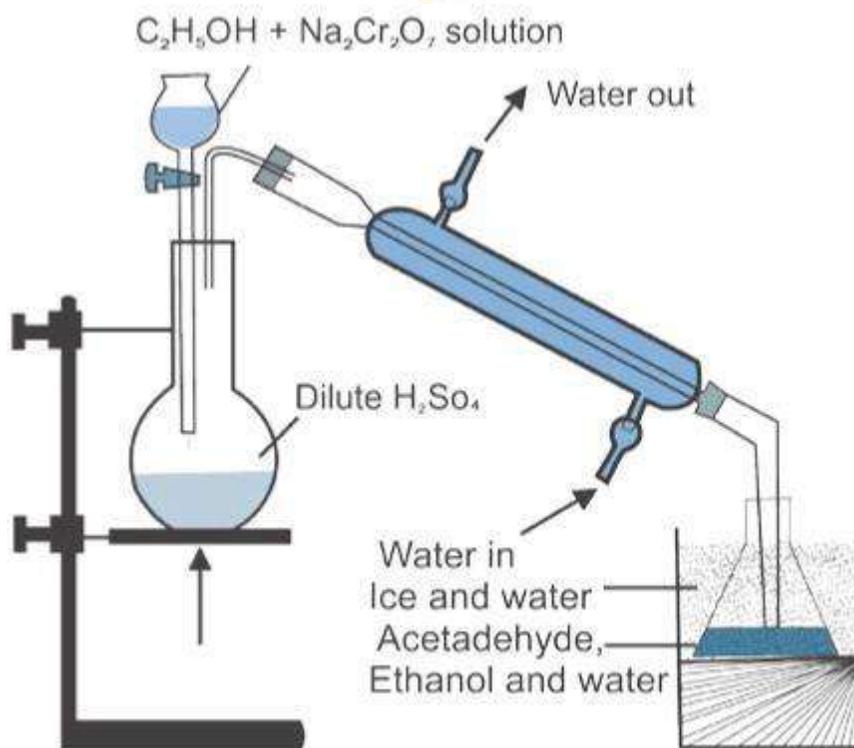
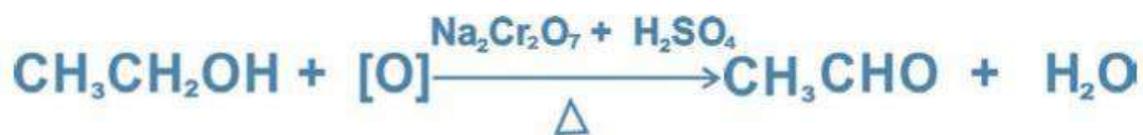


Fig. Preparation of Acetaldehyde

29. How aldehydes and ketones react with NaHSO_3 ?

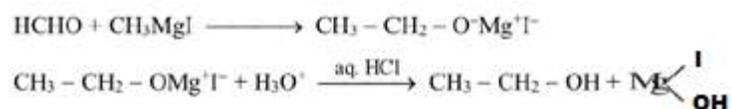
Ans: Aldehydes and small methyl ketones react with a saturated aqueous solution of sodium bisulphite to form a crystalline white precipitate of sodium bisulphite adduct.



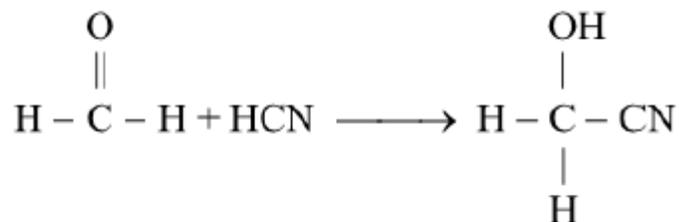
30. How does formaldehyde react with the following reagents?

Ans:

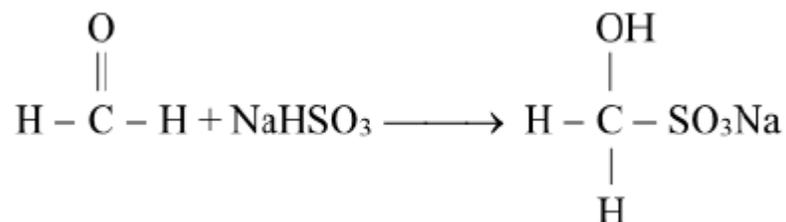
(i) CH_3MgI



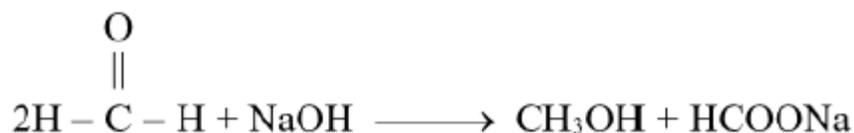
(ii) HCN



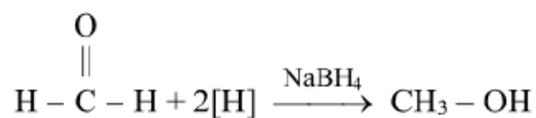
(iii) NaHSO_3



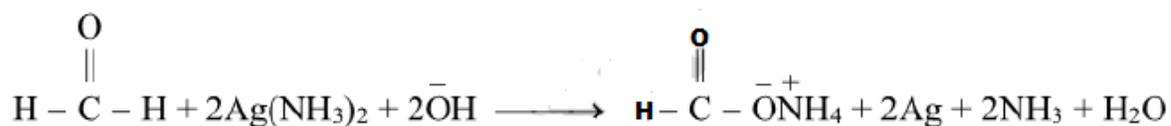
(iv) NaOH



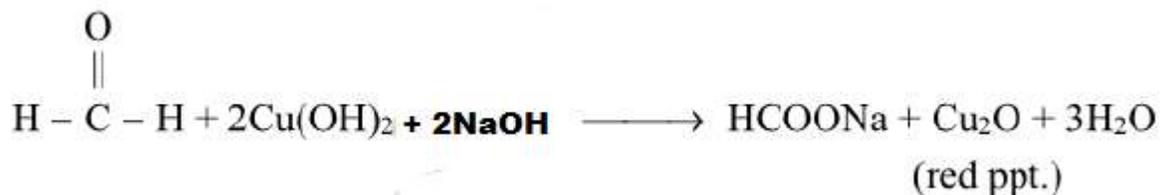
(v) Hydrogen



(vi) Tollen's Reagent



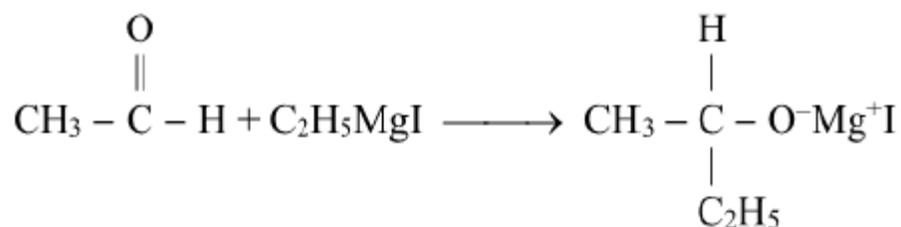
(vii) Fehling's Reagent

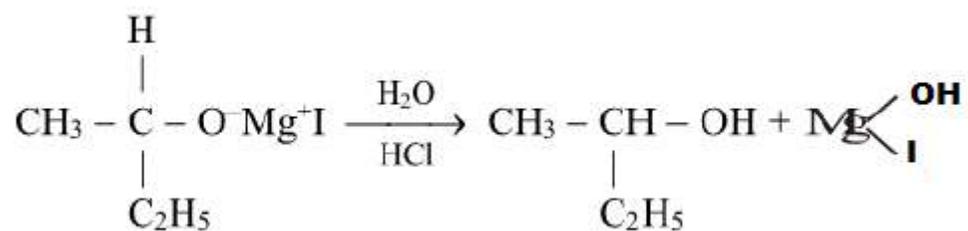


31. How does acetaldehyde react with following?

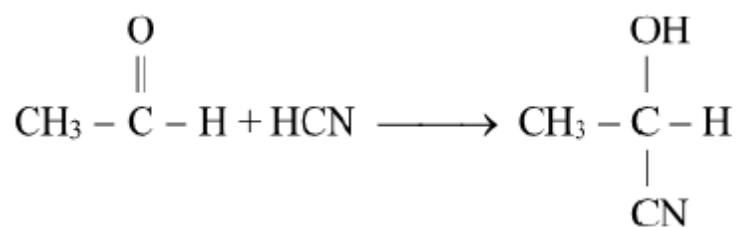
Ans:

(i) $\text{C}_2\text{H}_5\text{MgI}$

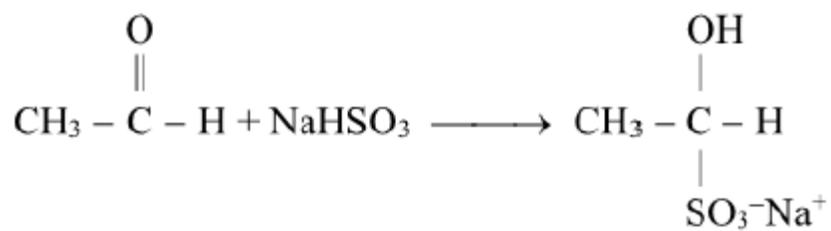




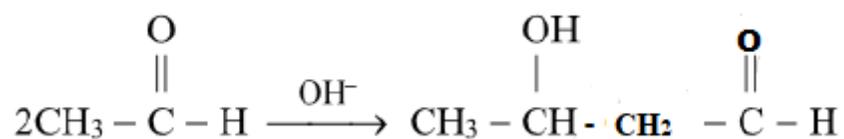
(ii) HCN



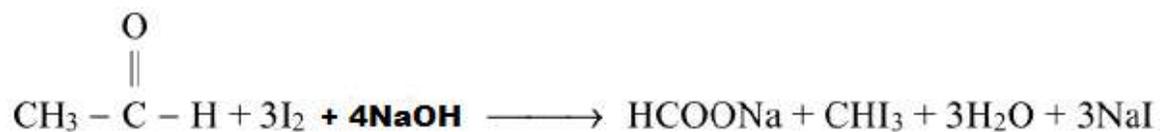
(iii) NaHSO₃



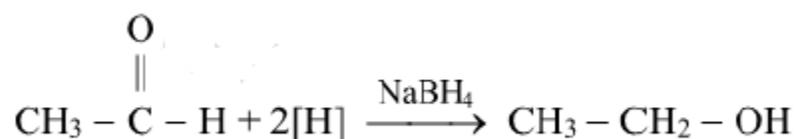
(iv) dil. NaOH



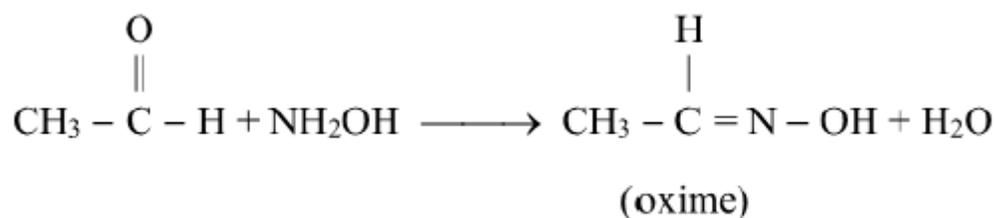
(v) I₂/NaOH



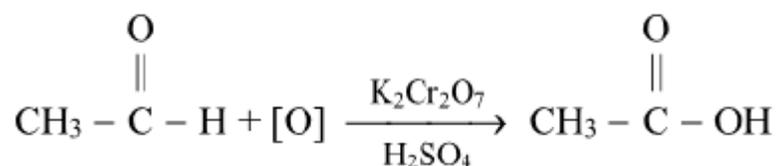
(vi) NaBH₄/H₂O



(vii) NH_2OH



(viii) $\text{K}_2\text{Cr}_2\text{O}_7/\text{H}_2\text{SO}_4$

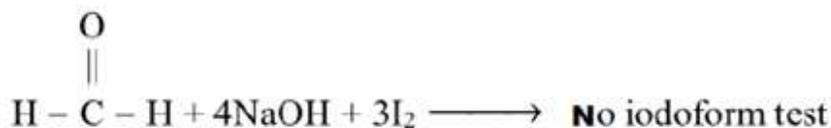
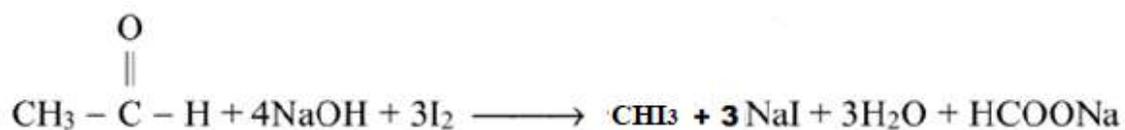


32. How will you distinguish between:

Ans:

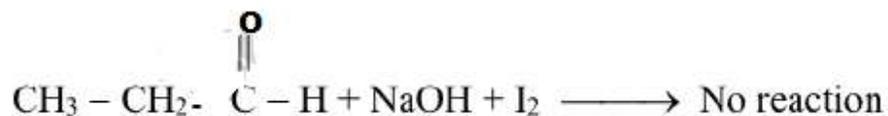
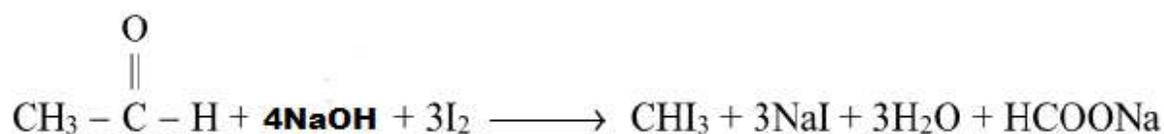
(i) Methanal and Ethanal

Both can be distinguished by iodoform test.



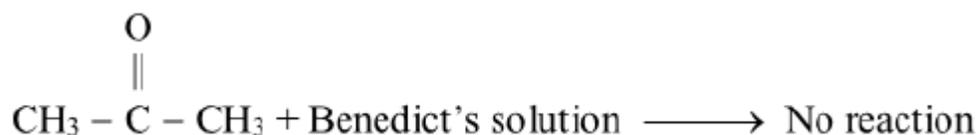
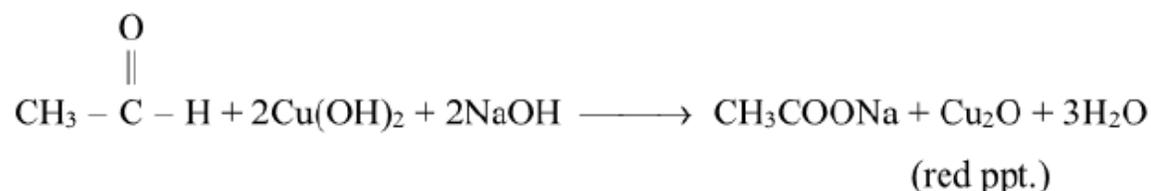
(ii) Ethanal and Propanal

Both can be distinguished by iodoform test.



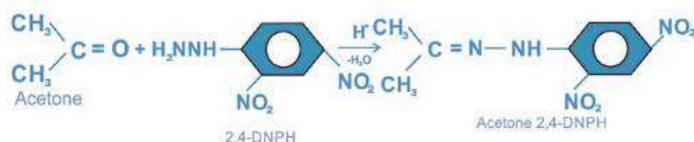
(iii) Ethanal and Propanone

Both can be distinguished by mild oxidizing agent, e.g., Benedict's, Fehling's.



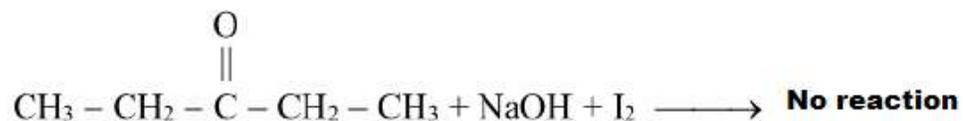
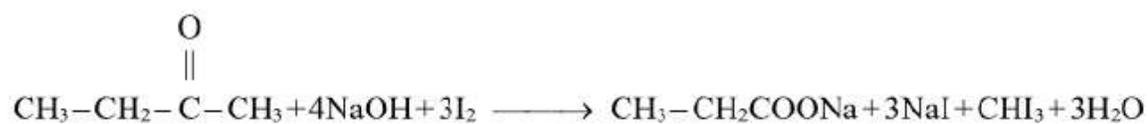
(iv) Acetone and Ethyl alcohol

Both can be distinguished by reacting with phenylhydrazine



(v) Butanone and 3-pentanone

Both can be distinguished by iodoform test



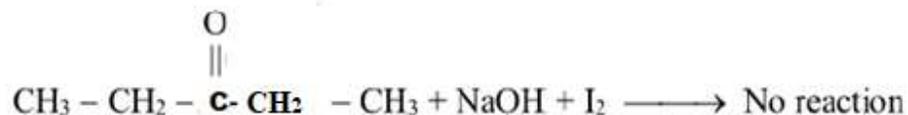
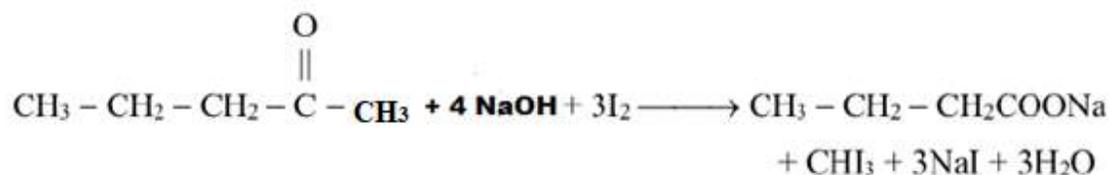
(vi) Acetaldehyde and Benzaldehyde

Acetaldehyde gives iodoform test whereas benzaldehyde gives no iodoform test

Benzaldehyde gives cannizzaro's reaction while acetaldehyde gives aldol product

(vii) 2-pentanone and 3-pentanone

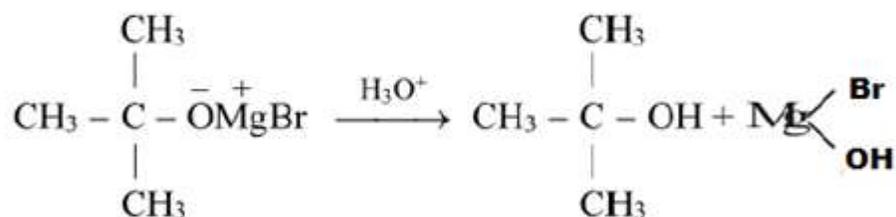
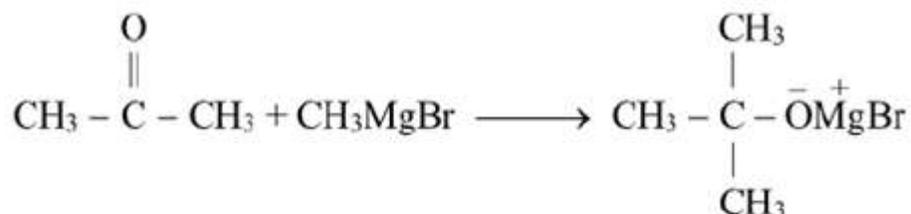
Both can be distinguished by iodoform test



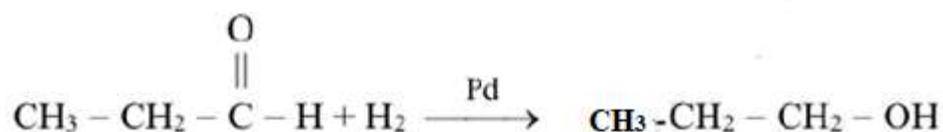
33. How will you bring about the following conversions:

Ans:

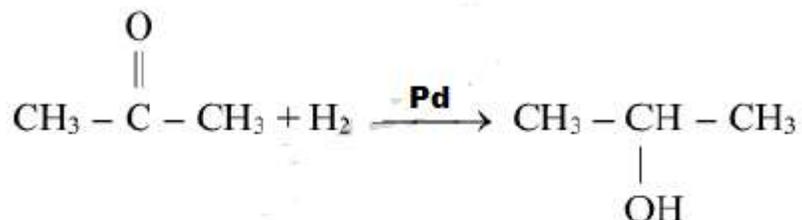
(i) **Acetone** \longrightarrow **t-Butyl alcohol**



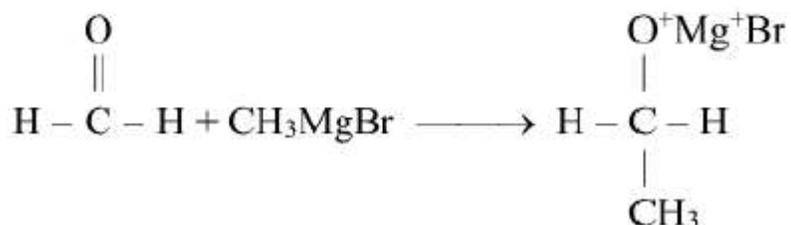
(ii) **Propanal** \longrightarrow **1-propanol:**

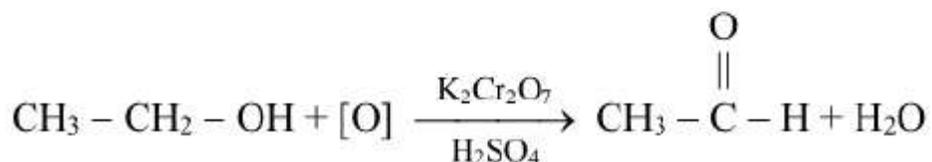
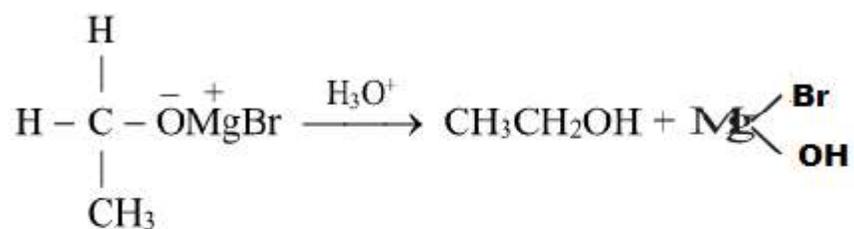


(iii) **Propanone** \longrightarrow **2-propanol**

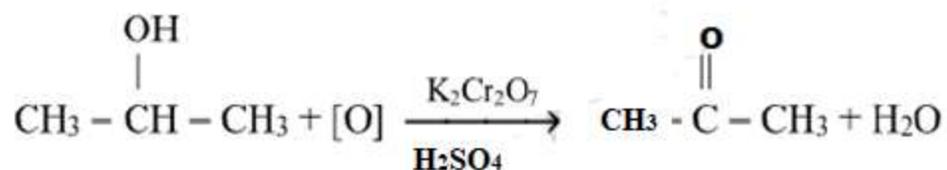
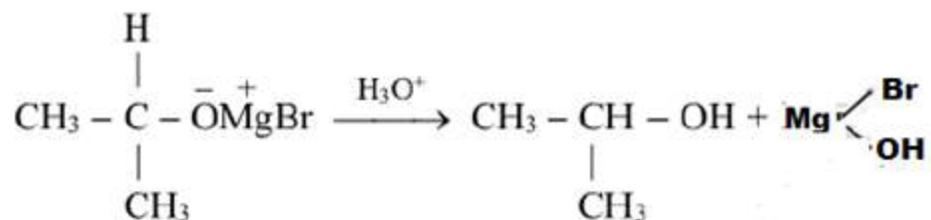
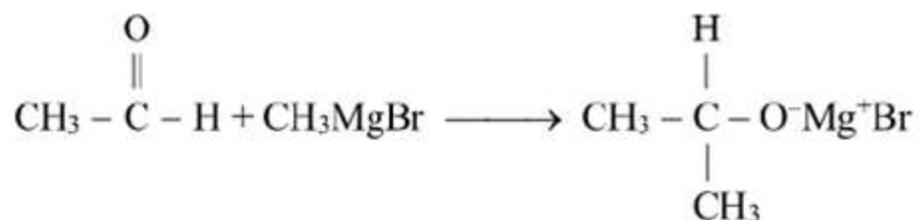


(iv) **Methanal** \longrightarrow **Ethanal:**

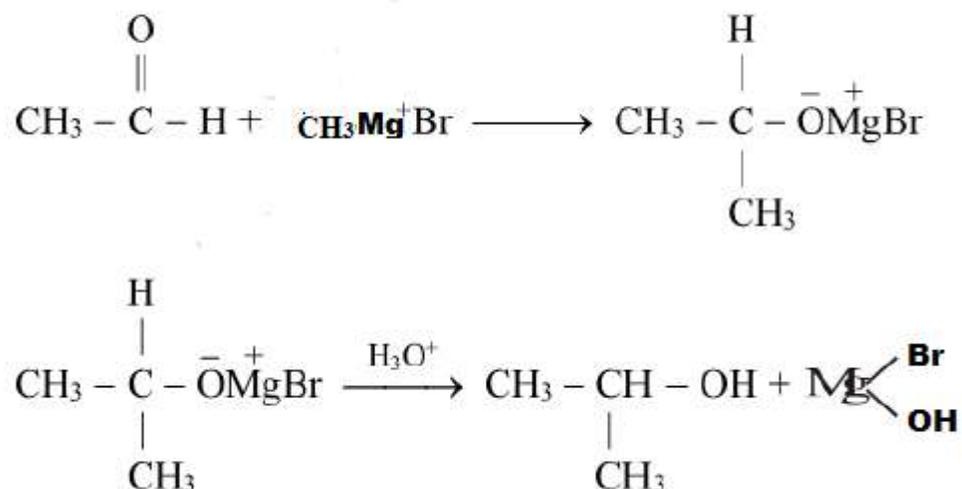




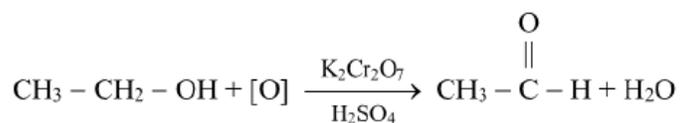
(v) **Ethanal \longrightarrow propanone:**



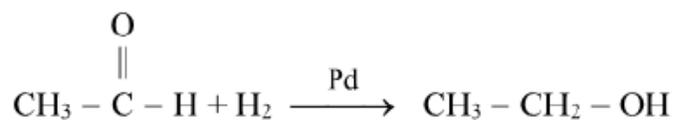
(vi) Ethanal \longrightarrow 2-propanol



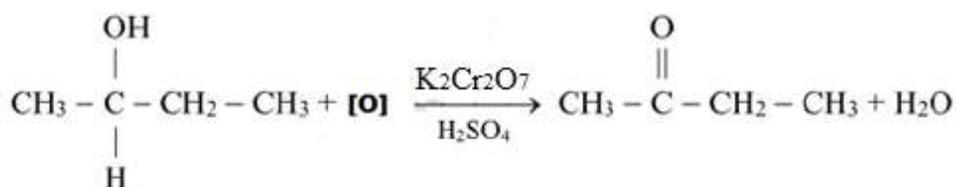
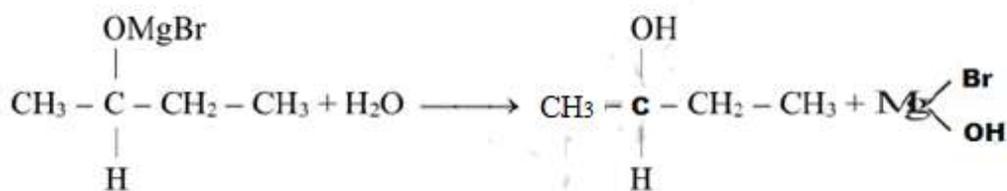
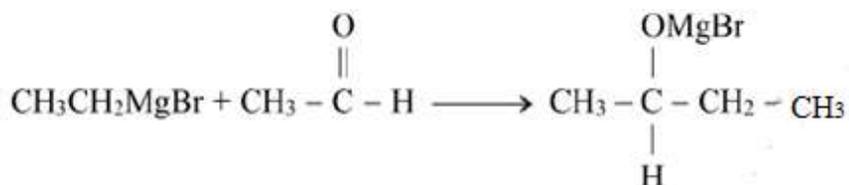
(vii) Ethene \longrightarrow Ethanal:



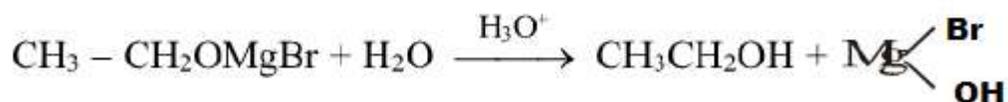
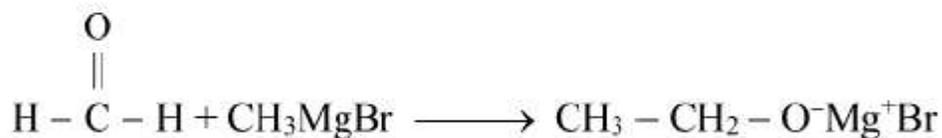
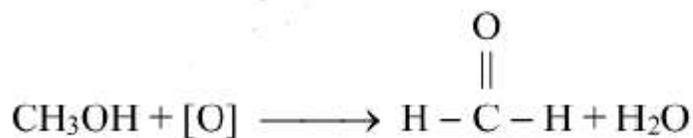
(viii) Ethanal \longrightarrow Ethanol:

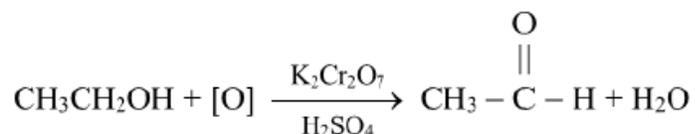


(ix) Ethanol \longrightarrow 2-butanone:

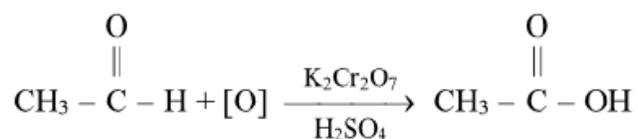


(x) Methanol \longrightarrow Ethanal





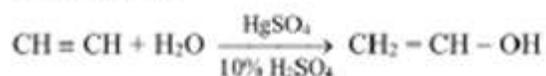
(xi) **Ethanal** \longrightarrow **Ethanoic Acid:**



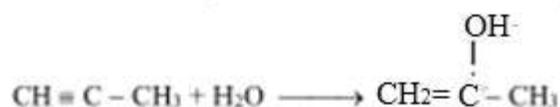
34. *Using ethyne as starting material how would you get acetaldehyde, acetone and ethyl alcohol?*

Ans:

(i) **Acetaldehyde:**



(ii) **Acetone:**



(iii) **Ethyl Alcohol:**



35. *Why carbonyl group is reactive?*

Ans: The carbonyl group has a σ -bond and a π -bond. Thus it can undergo addition reactions. Most reagents react with the carbonyl group by adding to it. As oxygen is more electronegative, it tends to attract the π electrons to itself. This attraction makes the carbonyl group a polar group. The oxygen atom has a partial negative charge on it and is nucleophilic, whereas, the carbon atom has a partial positive charge and is electrophilic.



36. Give mechanism of nucleophilic addition reactions in aldehydes and ketones.

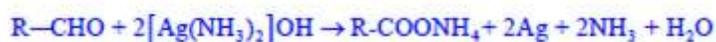


Ans:

37. Mention the tests for the identification of aldehydes.

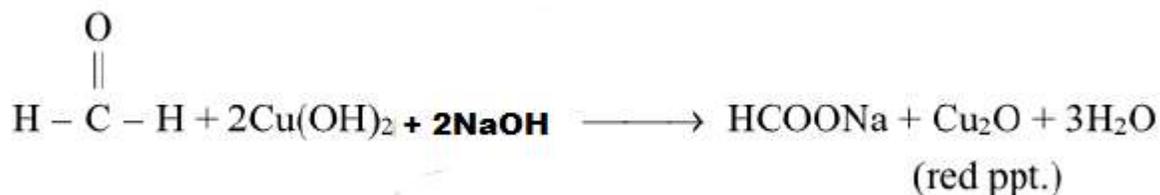
Ans:

Tollen's Test [Silver Mirror Test]: Aldehydes form silver mirror with Tollen's reagent (ammoniacal silver nitrate solution). Add Tollen's reagent to an aldehyde solution in a test tube and warm. A silver mirror is formed on the inside of the test tube. High quality mirrors are manufactured by using this principle. Ketones do not give this test.



Silver mirror

Fehling's Solution Test [an alkaline solution containing a cupric tartrate complex ion]: Aliphatic aldehydes form a brick-red precipitate with Fehling's solution. To an aldehyde solution, add Fehling's solution and boil. A brick red precipitate of cuprous oxide is formed. Ketones do not give this test.



Benedict's Solution Test [an alkaline solution containing a cupric

citrate complex ion]: Aliphatic aldehydes form a brick-red precipitate with Benedict's solution. To an aldehyde solution, add Benedict's solution and boil. A brick-red precipitate of cuprous oxide is formed. Ketones do not give this test.



38. *Mention the tests for the identification of ketones.*

Ans:

Sodium Nitroprusside Test: Ketones produce a wine red or orange red colour on adding alkaline sodium nitroprusside solution dropwise. Aldehydes do not give this test.

39. *Mention the tests for the identification of both aldehydes and ketones.*

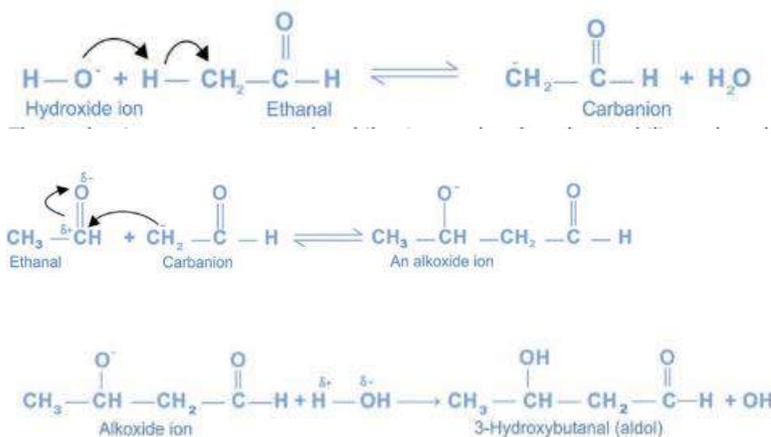
Ans:

1. **2,4 DNPH Test:** Aldehydes and ketones form a yellow or red precipitate with 2,4 dinitrophenylhydrazine solution.

2. **Sodium Bisulphite Test:** Aldehydes and small methyl ketones form a crystalline white precipitate with saturated sodium bisulphite solution.

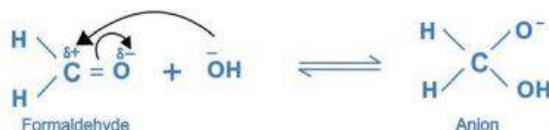
40. *Give mechanism of aldol condensation.*

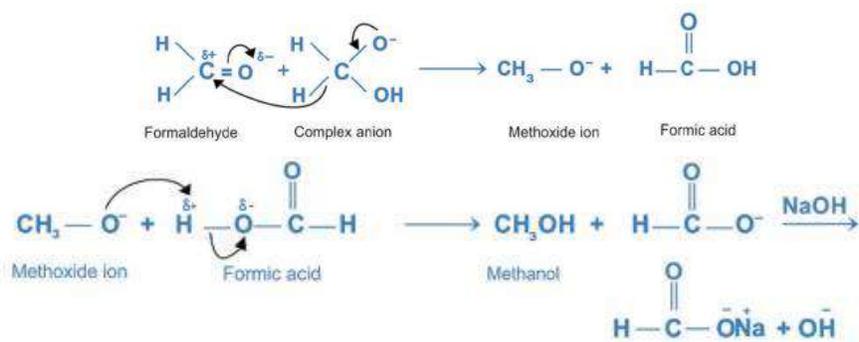
Ans:



41. *Give mechanism of Cannizzaro's reaction.*

Ans:





Chapter#13
Carboxylic Acids

1. How carboxylic acids are classified?

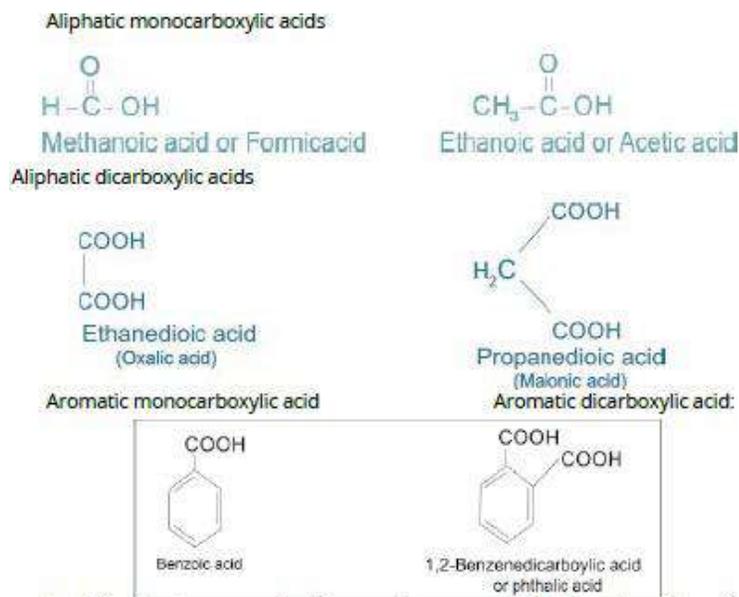
Ans: Carboxylic acid may be aliphatic or aromatic depending upon whether the $-\text{COOH}$ group is attached to an alkyl group (or a hydrogen atom) or an aryl group.

Aliphatic carboxylic acid

RCOOH where $\text{R}=\text{H}$ or an alkyl group

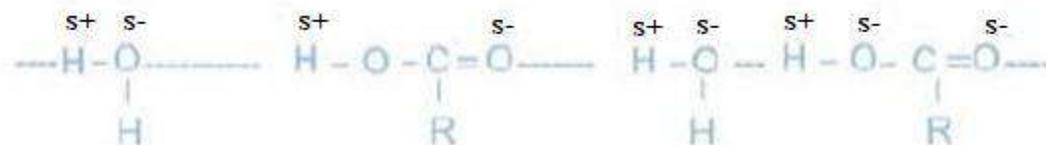
ArCOOH where Ar is a phenyl or an aryl group

Carboxylic acids are further classified as mono, di, tri or poly carboxylic acids as they contain one, two, three or many carboxyl groups respectively in their molecules.



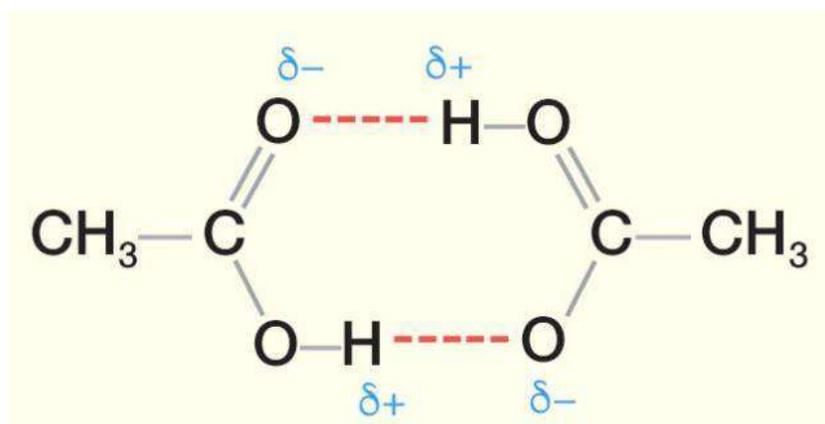
2. Why are lower carboxylic acids soluble in water?

Ans: Among the aliphatic acids, the first four members are very soluble in water due to hydrogen bonding.



3. The boiling points of carboxylic acids are relatively higher. Why?

Ans: The boiling points of carboxylic acids are relatively high due to intermolecular hydrogen bonding. The molecular mass determination in non-polar solvent like benzene shows that carboxylic acids exist as cyclic dimers.



Boiling Points

HCOOH
373K(100°C)

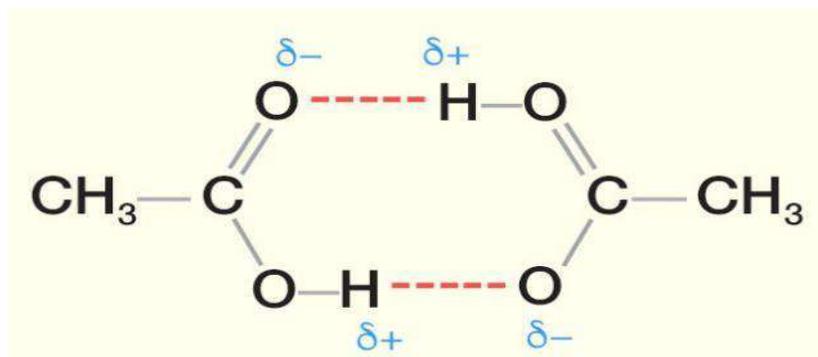
CH₃COOH
391K(118°C)

C₂H₅COOH
424K(141°C)

4. Why do mostly carboxylic acids exist as dimers?

Ans: In pure carboxylic acids Hydrogen bonding can occur between two molecules of acid to produce a dimer. This immediately doubles the size of the molecule and so increases Vander Waals dispersion forces between one of these dimers and its neighbours, resulting in a high

boiling point.



5. Tell about the trend of melting point of carboxylic acids.

Ans: The melting points of carboxylic acids increase irregularly with the increase in molecular mass.

It has been observed that the melting points of carboxylic acids containing even number of carbon atoms are higher than the next lower and higher members containing odd number of carbon atoms

e.g.,

	$\text{CH}_3\text{CH}_2\text{COOH}$	$\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{COOH}$
	(3 carbon)	(4 carbon)	(5 carbon)
Melting points	251K (-22°C)	267 K (-6°C)	237 K (-36°C)

6. Discuss reactivity of carboxylic acids.

Ans: The carboxyl group displays the chemistry of both the carbonyl and the hydroxyl groups. In most reactions of carboxylic acids the carboxyl group is retained, however, the reactivity of these molecules is a consequence of the presence of the carbonyl group. Carboxylic acids undergo the following type of reactions.

- The reactions in which hydrogen atom of the carboxyl group is involved (salt formation).
- The reactions in which OH group is replaced by another group.
- The reactions involving carboxyl group as a whole.

7. What type of reactions do carboxylic acids give?

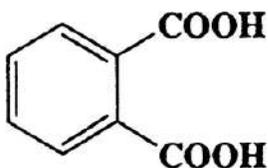
Ans: Carboxylic acids undergo the following type of reactions.

- a) The reactions in which hydrogen atom of the carboxyl group is involved (salt formation).
- b) The reactions in which OH group is replaced by another group.
- c) The reactions involving carboxyl group as a whole.

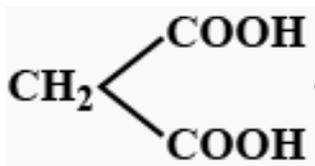
8. Write structural formula of Phthalic and Malonic acid.

Ans:

Phthalic acid



Malonic acid



9. What is glacial acetic acid?

Ans: The pure, anhydrous acetic acid, forming ice-like crystals at temperatures below 16.7°C, is called glacialacetic acid. (CH₃COOH).

10. Give uses of acetic acid (Mention any four as answer to short question)

Ans: Acetic acid is used:

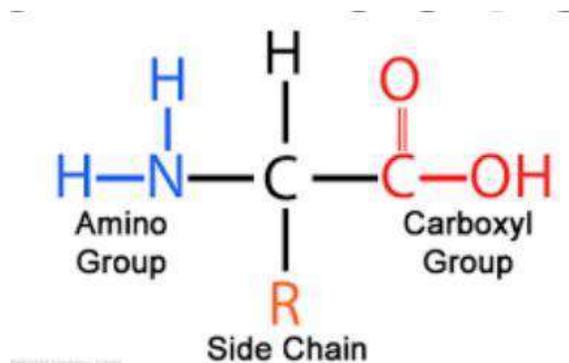
- i) As a coagulant for latex in rubber industry.
- ii) In the manufacture of plastics (polyvinyl acetate) rayon (cellulose acetate) and silk.
- iii) In medicine as a local irritant.
- iv) As a solvent in the laboratory for carrying out reactions.

v) In the manufacture of pickles.

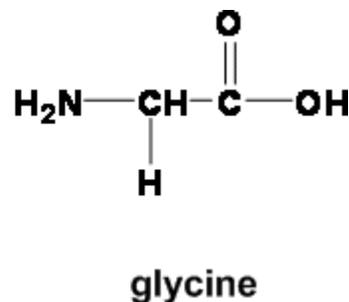
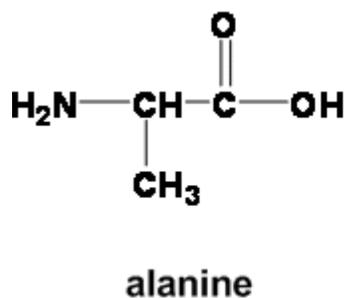
vi) In the manufacture of many organic compounds like acetone, acetates and esters.

11. Define amino acids? Give examples.

Ans: Amino acids are organic compounds containing both amino and carboxyl groups. They are represented by the general formula:



Examples are glycine and alanine.



12. What is the difference between essential and non-essential amino acids?

Ans:

Essential amino acid

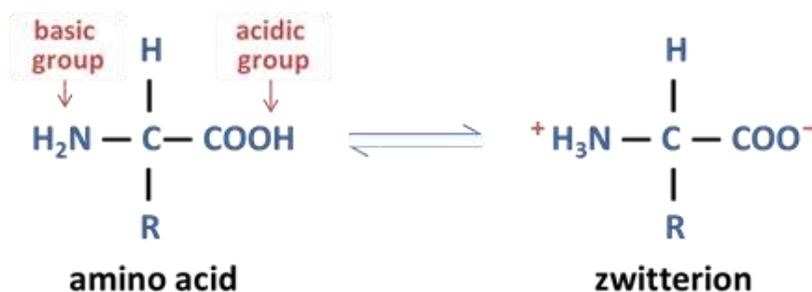
1. The amino acids which our body can't prepare are called essential amino acids.
2. These we have to take in to our diet for proper health and growth.

Non-essential amino acids

1. The amino acids which our body can prepare are called non-essential amino acids.
2. These are not required in diet.

13. Discuss structure of amino acids OR What is a zwitter ion Or What is internal salt?

Ans: The amino acids exist as dipolar ion called Zwitter ion. It has positive as well as negative ends within the same molecule. In the formation of Zwitter ion, the proton goes from the carboxyl group to amino group. The Zwitter ionic structure of an amino acid may be written as:

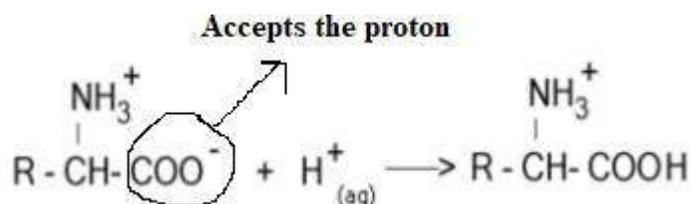


The dipolar structure is also called internal salt. All α - amino acids exist largely in dipolar ionic forms.

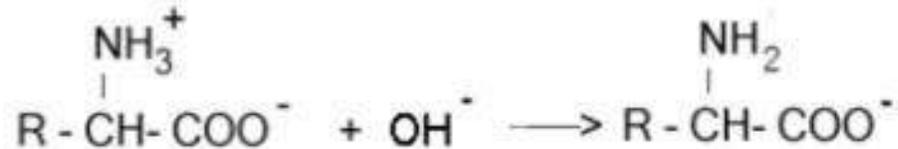
14. Discuss acidic and basic character of amino acids.

Ans: On the basis of dipolar ion structure, the acidic and basic reactions of amino acids may be represented as:

1. When an acid is added to an amino acid the carboxylate ion accepts the proton and, therefore, the basic character is due to this group.



2. When an alkali is added to an amino acid, NH_3 group releases the proton and therefore the acidic character is due to this group.



15. Differentiate between acidic and basic amino acids.

Ans:

Acidic amino acid

1. The amino acids which contain two carboxyl groups are called acidic amino acids.
2. For example, Glutamic acid and Aspartic acid.

Basic amino acid

1. The amino acids which contain two amino groups are called basic amino acids.
2. For example, Lysine and Histidine.

16. Define neutral amino acid with example.

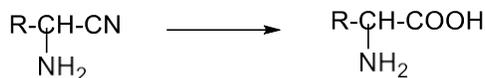
Ans: Since an amino acid has both an amine and acid group which have been neutralized in the zwitter ion, the amino acid is neutral unless there is an extra acid or base on the side chain. If neither is present then the whole amino acid is neutral. eg. glycine, alanine, valine etc.

17. How amino acid is prepared by Strecker's synthesis?

Ans: When hydrogen cyanide is added to an aldehyde in the presence of ammonia α -amino acid is obtained:

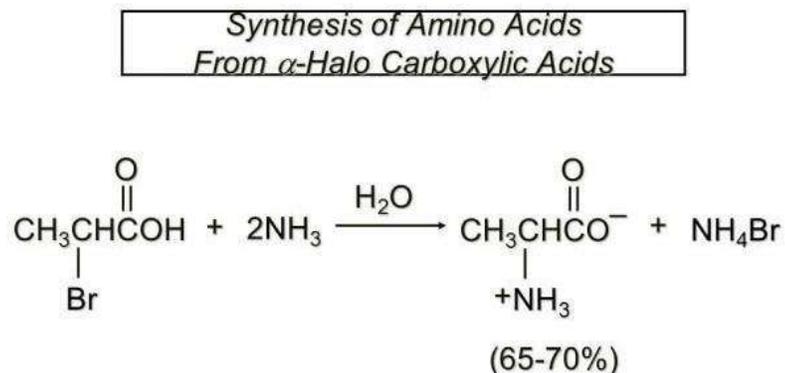


α -amino nitrile on acid hydrolysis yields an α -amino acid.



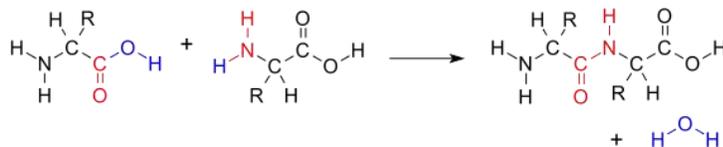
18. How carboxylic acids can be converted in to α -amino acid?

Ans: Amino acids can be synthesized by the reaction of α -bromo acid with ammonia.



19. Define peptides.

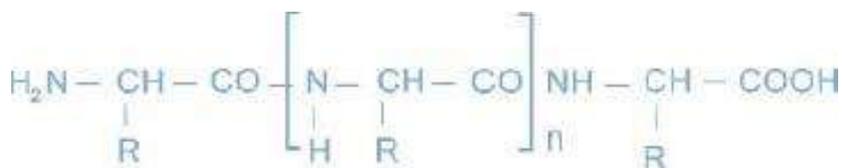
Ans: Peptides are the compounds formed by the condensation of two or more same or different α -amino acids.



The condensation occurs between amino acids with the elimination of water. In this case, the carboxyl group of one amino acid and amino group of another amino acid gets condensed with elimination of water. The resulting $-\text{CO}-\text{NH}$ linkage is called a peptide linkage.

20. Define polypeptide.

Ans: If a large number of amino acids (hundreds to thousands) are joined by peptide bonds, the resulting polyamide is called a polypeptide.



21. Define protein.

Ans: The formation of peptide bonds can continue until a molecule containing several hundred thousand amino acids is formed. Such a molecule is called polypeptide or protein.

22. What is the difference between a protein and a polypeptide?

Ans: A peptide having molecular mass up to 10,000 is called a polypeptide while a peptide having a molecular mass more than 10,000 is called a protein.

23. What are α -amino acids, proteins and peptides? How are they related?

Ans:

α -Amino Acids

The acids in which amino groups are attached to α -carbon are called α -amino acids. Example



Proteins

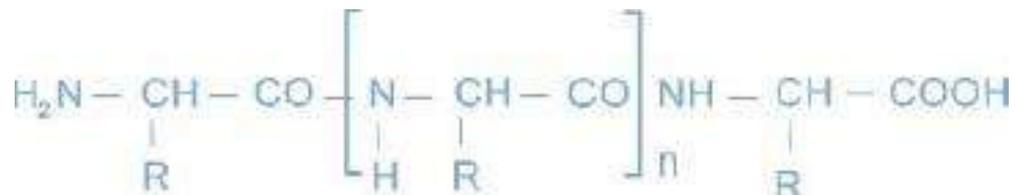
If the molecular mass of a polypeptide chain is more than 10000 then it is called proteins

Peptide

If the molecular mass of a polypeptide chain is up to 10000 then it is called peptide.

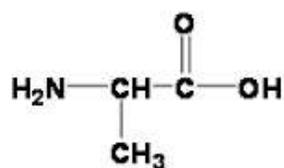
Relation

When amino acids link with each other through a peptide bond a long chain of polypeptide is formed.

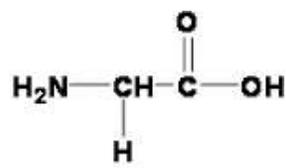


24. Write formulae of glycine and alanine.

Ans:



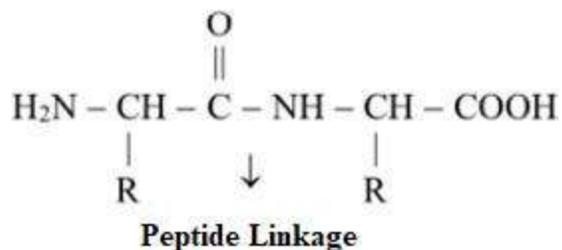
alanine



glycine

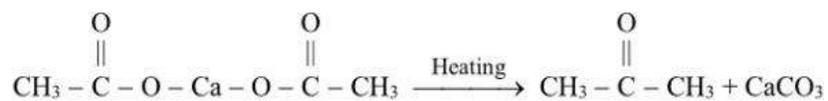
25. Write down the formula of a dipeptide.

Ans: Following is the formula of a dipeptide:



26. What happens when calcium acetate is heated?

Ans: Calcium acetate on heating produce acetone.



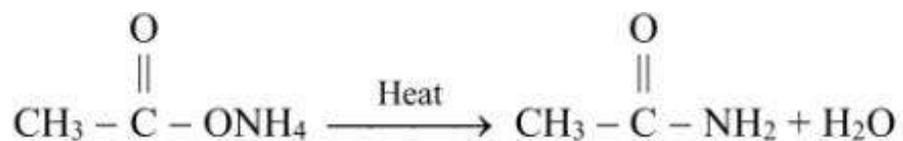
27. What happens when sodium formate and soda lime are heated?

Ans: Sodium formate on heating with soda lime produces sodium carbonate and hydrogen.



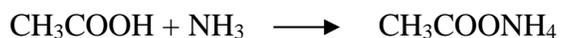
28. What happens when ammonium acetate is heated?

Ans: Ammonium acetate on heating produces acetamide.



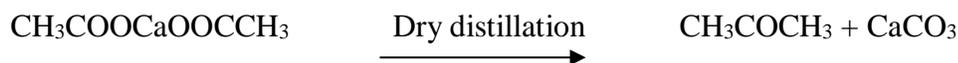
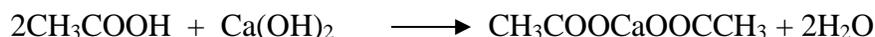
29. How will you convert acetic acid in to acetamide?

Ans: Acetic acid react with ammonia to form ammonium salts which on heating produce acetamide



30. How will you convert acetic acid to acetone?

Ans: This conversion involves two steps:

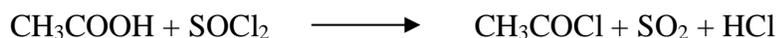


31. What are Fatty acids? How acid chlorides are made by them?

Ans: The aliphatic mono carboxylic acids are commonly called fatty acids, because higher members of this series such as palmitic acid, stearic acid etc. are obtained by the hydrolysis of fats and oils.

Formation of acid chlorides:

Acid chlorides can be made by reacting mono carboxylic acids with phosphorous penta chloride or with thionyl chloride as follows.



32. Write reactions of acetic acid with HI/red P and NH₃/heat.

Ans:

HI/red phosphorus:

Acetic acid on reduction with HI and red phosphorus give ethane.



NH₃/ heat :

Acetic acid react with ammonia to form ammonium salts which on heating produce acid amides

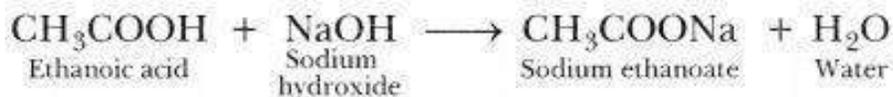


33. How will you convert acetic acid in to methane and acetic anhydride?

Ans:

Acetic acid to Methane:

Acetic acid is treated with sodium hydroxide to form sodium acetate and water.



Then, sodium ethanoate is heated with sodalime to get methane.



Acetic acid to acetic anhydride:

Acetic acid dehydrates on heating strongly in the presence of phosphorus pentaoxide.

Ans:

Name	Structural Formula
Valeric acid	$\text{H}_3\text{C} - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{COOH}$
Propionic acid	$\begin{array}{c} \text{O} \\ \\ \text{H}_3\text{C} - \text{CH}_2 - \text{C} - \text{OH} \end{array}$
Oxalic acid	$\begin{array}{c} \text{COOH} \\ \\ \text{COOH} \end{array}$
Benzoic acid	$\begin{array}{c} \text{O} \\ \\ \text{C}_6\text{H}_5 - \text{C} - \text{OH} \end{array}$
Acetic anhydride	$\begin{array}{c} \text{O} \quad \text{O} \\ \quad \\ \text{H}_3\text{C} - \text{C} - \text{O} - \text{C} - \text{CH}_3 \end{array}$
Acetyl chloride	$\begin{array}{c} \text{O} \\ \\ \text{H}_3\text{C} - \text{C} - \text{Cl} \end{array}$

37. Write down the names of the following compounds by IUPAC.

Ans:

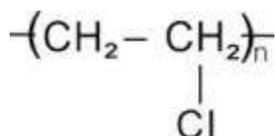
Structure	IUPAC Name
$\text{HOOC} - \text{CH}_2 - \text{COOH}$	1, 3-propane dioic acid.
	1, 3-benzene dicarboxylic acid
$\begin{array}{c} \text{O} \\ \\ \text{H} - \text{C} - \text{OH} \end{array}$	Methanoic acid
$\text{CH}_3 - \text{COOC}_2\text{H}_5$	Ethyl acetate
$\text{NH}_2 - \text{CH}_2 - \text{COOH}$	α -aminoethanoic acid
HCOOC_3H_7	n-propyl formate

Chapter#14
Macromolecules

1. Define macromolecules.

Ans: Macromolecules or polymers are described as large molecules built up from small repeating units called monomers.

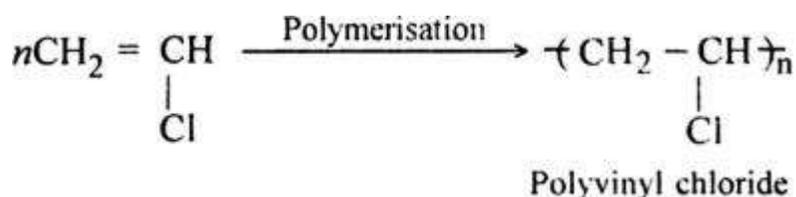
For Example: Polyvinyl Chloride is a macromolecule.



2. Define polymerization.

Ans: Polymerization is a process of reacting monomer molecules together in a chemical reaction to form polymer chains or three-dimensional networks.

Example:

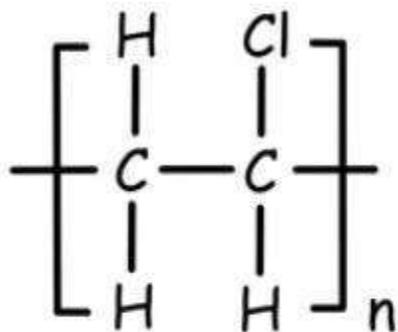


3. What are polymers? Give two examples.

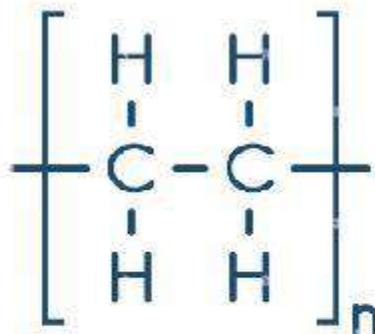
Ans: The word polymer is derived from Greek word, poly means **many** and mer means **parts**. Polymers or macromolecules are defined as large molecules build up from small repeating units called monomers. The repetition may be linear or branched or interconnected to form three

dimensional network. Examples are artificial fibres, plastics, synthetic varnish etc.

Examples:



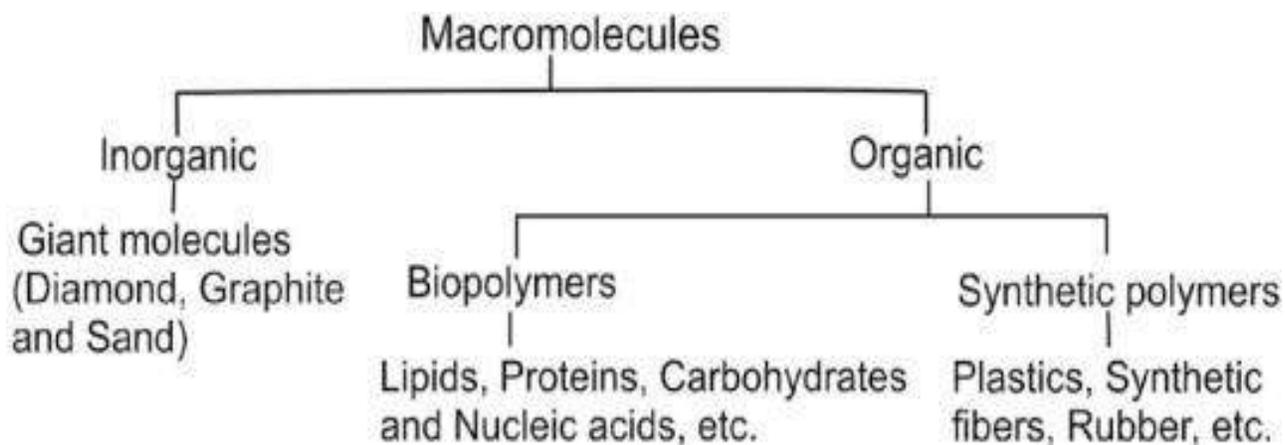
Polyvinyl Chloride
(PVC)



polyethylene

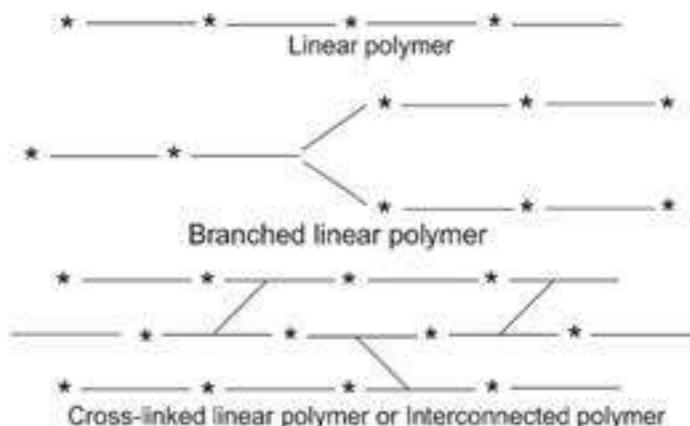
4. Give classification of macromolecules.

Ans:



5. Mention the three ways of polymerization.

Ans: In some cases the repetition is linear while in others, it is branched or interconnected to form three dimensional network.

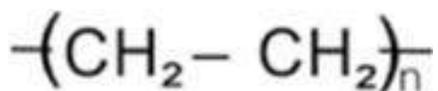


6. Define degree of polymerization.

Ans: The length of the polymer chain is specialized by the number of repeating units in the chain known as the degree of polymerization (DP), for example, in linear polythene.



The repeating unit is

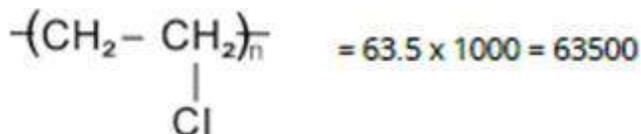


Where, n is called degree of polymerization and it is usually a large number.

7. How is the molecular mass of the polymer calculated?

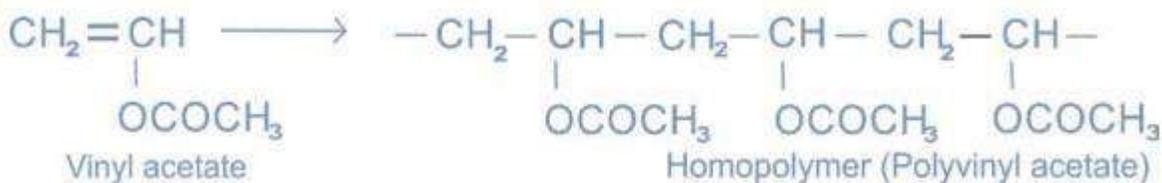
Ans: The molecular mass of the polymer is the product of the molecular mass of the repeating unit and the DP For example, polyvinyl chloride, a polymer of DP 1000, has a molecular mass.

$$\text{Mol. mass} = \text{Mol. mass of the repeating unit} \times \text{DP}$$



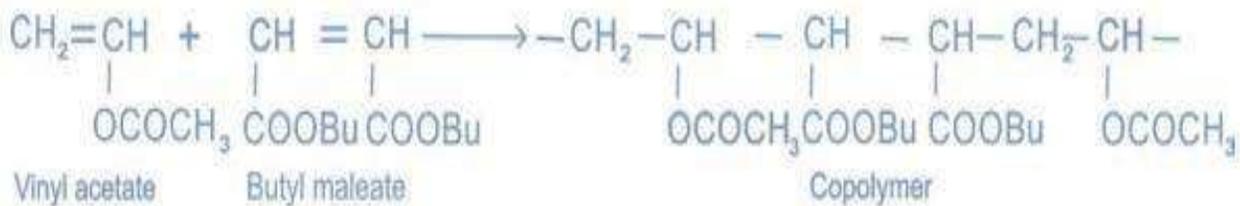
8. What is a homopolymer?

Ans: A homopolymer is formed by the polymerization of a single type of monomer. For example, the polymerization of vinyl acetate.



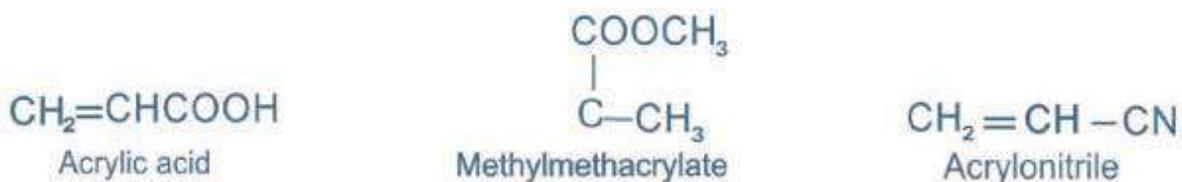
9. Why is a copolymer?

Ans: A copolymer is formed by the polymerization of two monomers together, e.g; vinyl acetate reacts with butyl maleate to give a copolymer.



10. What is a terpolymer?

Ans: In terpolymer three different monomers are polymerized and the polymerization reaction is carefully controlled. For example, combination of butyl acrylate, methacrylate and acrylonitrile monomers gives a highly tough polymer which serves as a weather-resistant paint.



11. What is the classification of polymers based on thermal properties?

Ans: Based on thermal properties polymers are of two types:

1. Thermoplastic

A thermoplastic polymer is one which can be softened repeatedly when heated and hardened when cooled with a little change in properties. For example; PVC pipes, plastic toys, etc.

2. Thermosetting plastic

The polymers which become hard on heating and cannot be softened again are called thermosetting polymers. A thermosetting polymer, on heating, decomposes instead of melting. For example, synthetic varnish, epoxy resins, etc.

12. What is a thermoplastic polymer?

Ans: A thermoplastic polymer is one which can be softened repeatedly when heated and hardened when cooled with a little change in properties.

Examples: PVC pipes, plastic toys, etc.

13. What is a thermosetting plastic?

Ans: The polymers which become hard on heating and cannot be softened again are called thermosetting polymers. A thermosetting polymer, on heating, decomposes instead of melting.

Examples: synthetic varnish, epoxy resins, etc.

14. What are the types of polymerization process?

Ans: There are two types of polymerization process:

1. Addition polymerization

It is a free-radical addition reaction which involves initiation, propagation and termination steps. For example, polymerization of styrene. Addition of polymerization is catalyzed by thermal or photochemical decomposition of organic peroxides to give free radicals.

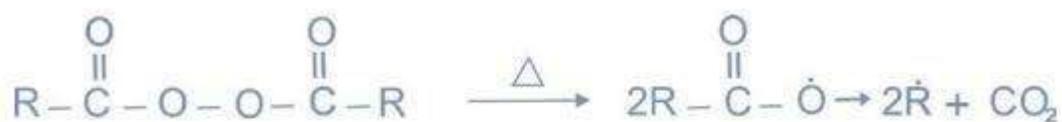
2. Condensation polymerization

This type of polymerization results from the mutual reaction of two functional groups. The reaction usually involves the removal of a water molecule or a methanol molecule. It takes place at both ends of the growing chain. For example, dicarboxylic acids or esters combine with diols to get the desired polymer like nylon and polyester fibre. Such polymerizations are generally ionic in nature.

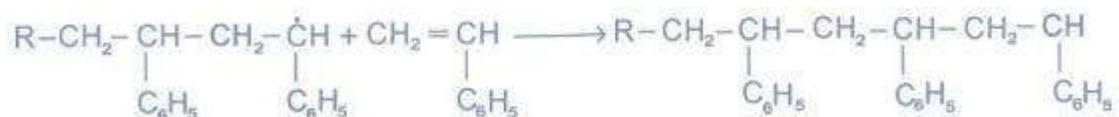
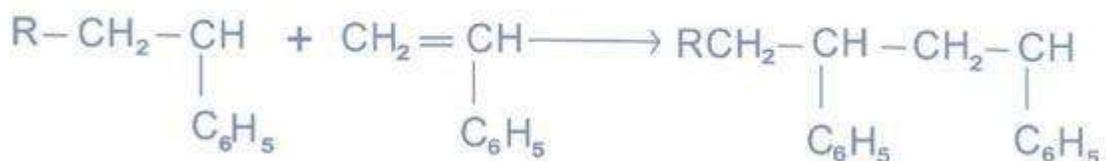
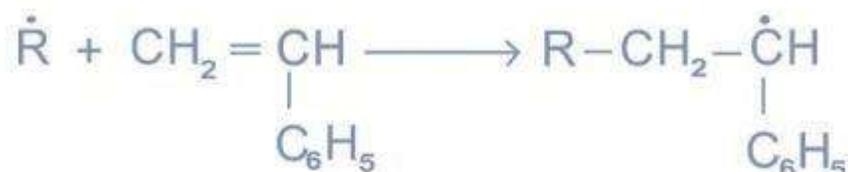
15. Give mechanism of addition polymerization.

Ans: It is a free-radical addition reaction which involves initiation, propagation and termination steps. For example, polymerization of styrene. Addition of polymerization is catalyzed by thermal or photochemical decomposition of organic peroxides to give free radicals.

Initiation

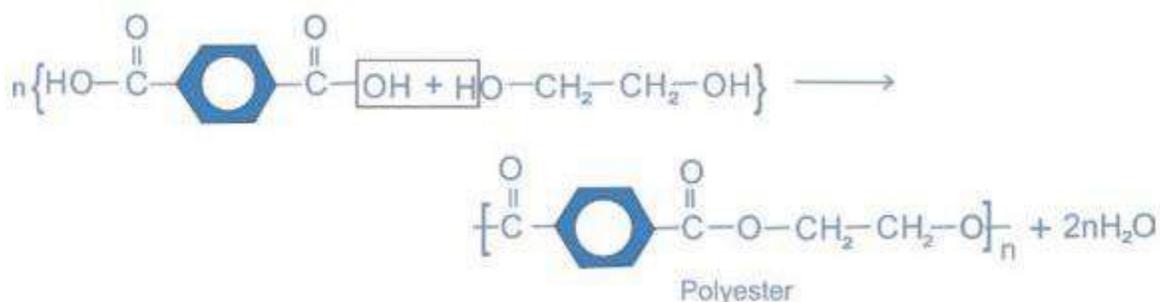


Propagation



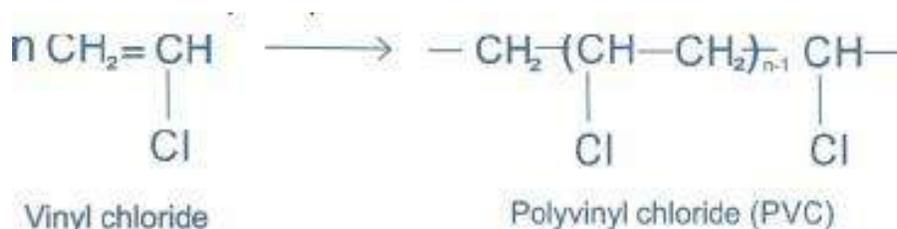
16. Give mechanism of condensation polymerization.

Ans: This type of polymerization results from the mutual reaction of two functional groups. The reaction usually involves the removal of a water molecule or a methanol molecule. It takes place at both ends of the growing chain. For example, dicarboxylic acids or esters combine with diols to get the desired polymer like nylon and polyester fibre. Such polymerizations are generally ionic in nature.



17. How polyvinyl chloride is prepared?

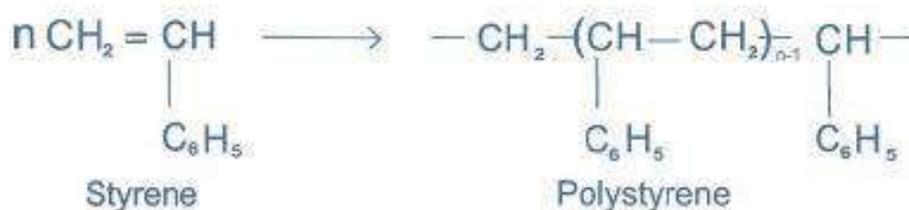
Ans: It is an addition polymer obtained by polymerizing vinyl chloride at 52°C and 9 atmospheric pressure.



Addition of a plasticizer improves the flexibility of the polymer. It is widely used in floor coverings, in pipes, in gramophone recorders, etc.

18. How polystyrene is prepared?

Ans: It is also an addition polymer and is obtained by the polymerization of styrene in the presence of a catalyst. Polystyrene is used in the manufacture of food containers, cosmetic bottles, toys and packing material, etc.

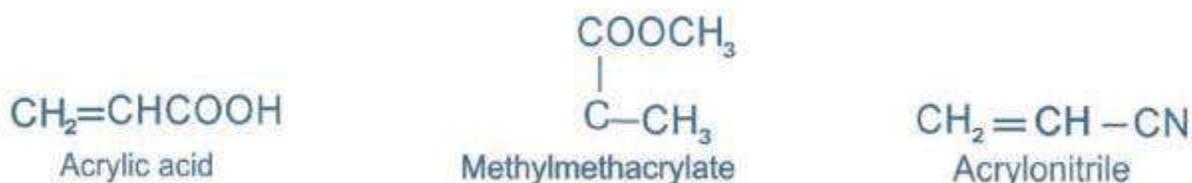


19. What do you know about polyvinyl acetate?

Ans: PVA is a colourless, non-toxic resin. It is supplied in a number of grades differing in the degree of polymerization. The resin has a characteristic odour. It is mostly used as an adhesive material and as a binder for emulsion paints.

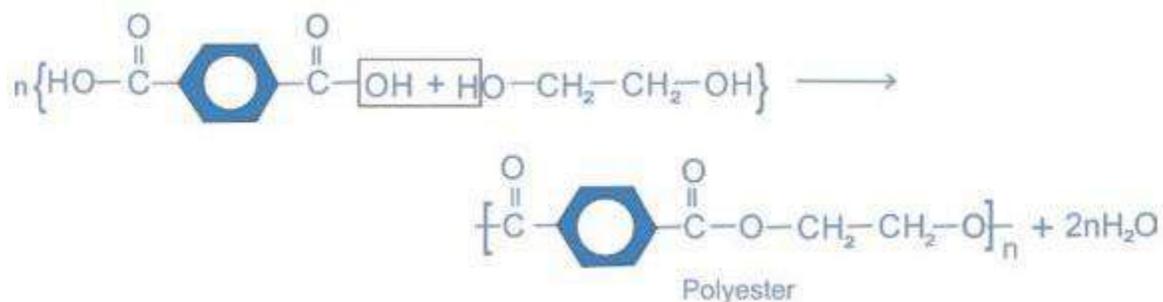
20. What are acrylic resins? Give an example.

Ans: These are closely related to the vinyl resins. The most important monomers of acrylic resins are methylmethacrylate, acrylic acid and butyl acrylate. The acrylic fibres are based largely on acrylonitrile. Acrylic resins are used in the manufacture of plastics, paints for car industry and water based weather resistant paints.



21. What is polyester? Give an example.

Ans: Polyester resins are the product of the reaction of an alcohol (ethane 1, 2 diol) and aromatic bi-functional acids (benzene 1,4-dicarboxylic acid). This product has a large number of uses in clothing. Polyester is often blended with cotton or wool for summer and winter clothing. Polyester resins are also used for making water tanks, etc.

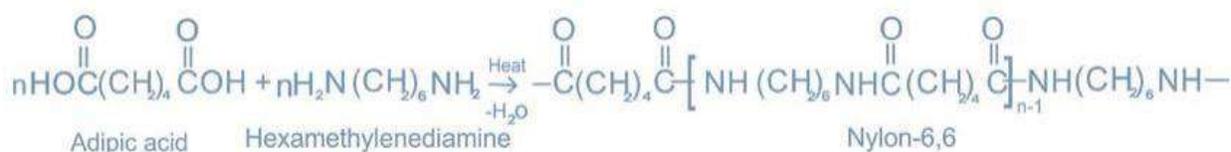


22. What are polyamide resins? Give an example.

Ans: These resins are formed by the condensation of polyamines with aliphatic dicarboxylic acids.

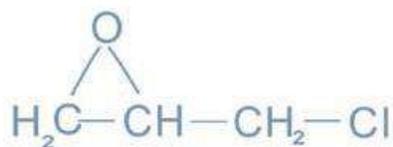
One of the most famous condensation polymers discovered is Nylon.

The word Nylon has been accepted as a generic name for synthetic polyamides. Nylon 6, 6 is the most important polyamide. It is obtained by heating adipic acid (hexanedioic acid) with hexamethylene diamine. Nylon 6,6 derives its name from its starting materials adipic acid and hexamethylene diamine, both of which have six carbon atoms. Nylon is mainly used as a textile fibre. It has a combination of high strength, elasticity, toughness and abrasion resistance.

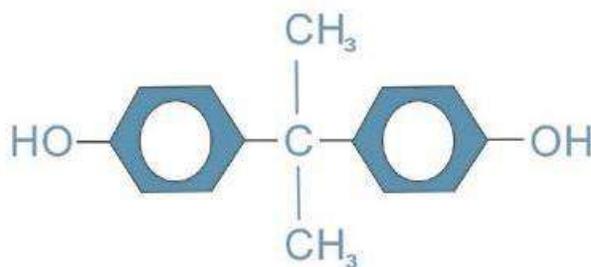


23. What are epoxy resins?

Ans: The epoxy resins are fundamentally polyethers but retain their name on the basis of their starting materials and the presence of epoxide group in the polymer. The epoxy resin is made by condensing epichlorohydrin with diphenylol propane.



Epichlorohydrin



Diphenylolpropane

The major use of epoxy resins is in coating materials which give toughness, flexibility, adhesion and chemical resistance. Industrial materials, thermal power stations, packing materials are coated with epoxy paints. Dams, bridges, floors, etc. are painted with epoxy resins.

24. What are biopolymers?

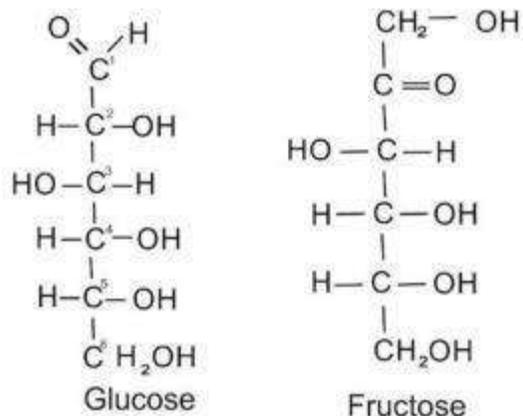
Ans: The polymers of biological origin i.e. animal and plant origin are called biopolymers. Examples are carbohydrates, lipids, proteins.

25. What are carbohydrates? Why are they called so?

Ans: The term carbohydrate is applied to a large number of relatively heterogeneous compounds. They are the most abundant biomolecules on earth. The name carbohydrate (hydrate of carbon) is derived from the fact that the first compound of this group which was studied had an empirical formula $C_x(H_2O)_y$. They are commonly called 'sugars' and are 'polyhydroxy compounds' of aldehydes and ketones.

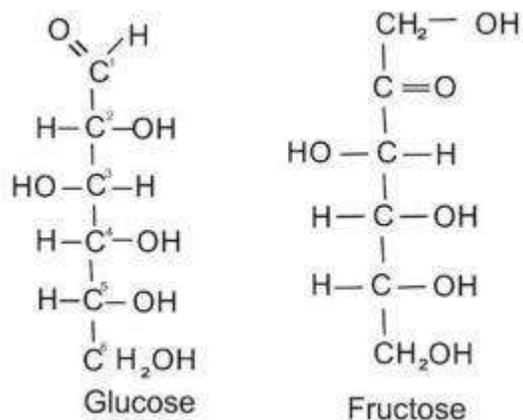
26. What are monosaccharides?

Ans: These are simple sugars which cannot be hydrolyzed. They have an empirical formula $(CH_2O)_n$ where $n = 3$ or some large number. Monosaccharides are either aldoses (aldehydic group) or ketoses (ketonic group). Common examples are glyceraldehyde, glucose, fructose, etc.



27. What are hexoses and pentoses?

Ans: Sugars with five carbon atoms are called pentoses and those with six carbon atoms are called hexoses. They are more stable as cyclic structures than as open chain structures. Glucose and fructose are very common examples of hexoses, both of which have molecular formula, $\text{C}_6\text{H}_{12}\text{O}_6$.

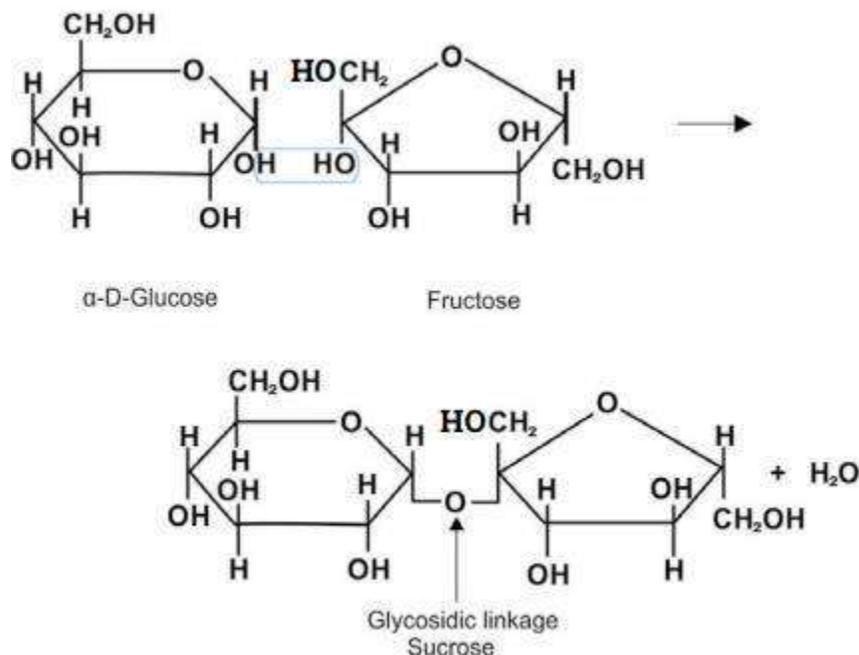


28. What are disaccharides and oligosaccharides?

Ans: When two units of monosaccharides combine they form disaccharides. On hydrolysis they yield monosaccharides. Examples are sucrose, lactose, maltose.

The oligosaccharides are formed when two to nine monosaccharide units combine by the loss of

water molecules. This results in the formation of a glycosidic linkage. For example, sucrose which is a common table sugar, is a disaccharide of glucose and fructose. Conversely, hydrolysis of an oligosaccharide by water in the presence of an acid or by enzymes yields two or more monosaccharide units.



29. What are trisaccharides?

Ans: Trisaccharides, which yield three monosaccharide molecules on hydrolysis, have molecular formula, $C_{18}H_{32}O_{16}$, for example, raffinose.

30. What are polysaccharides?

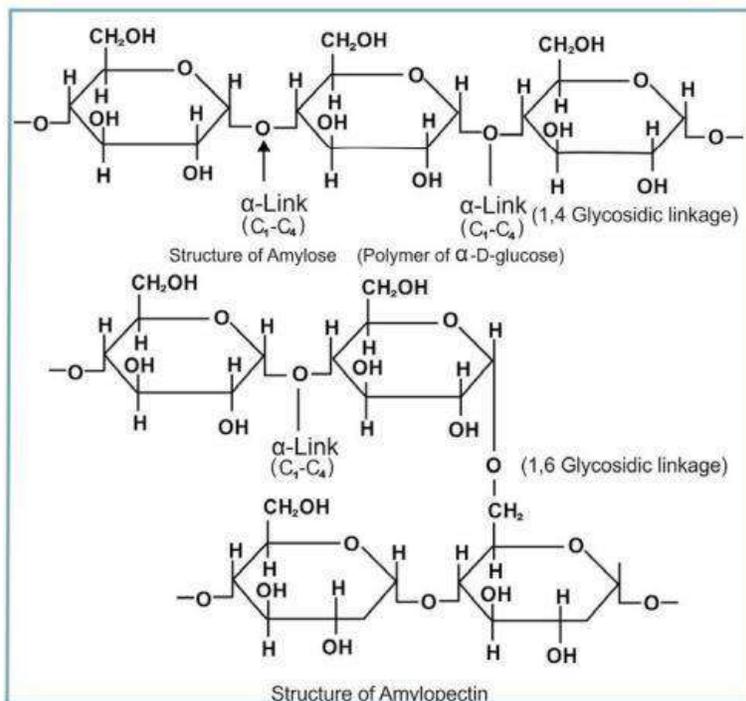
Ans: The polysaccharides are carbohydrates of high molecular mass which yield many monosaccharide molecules on hydrolysis. Examples are, starch and cellulose, both of which have molecular formula, $(C_6H_{10}O_5)_n$. The polysaccharides are amorphous solids, insoluble in water and tasteless and are called 'non-sugars'.

31. What are the functions of polysaccharides?

Ans: Polysaccharides perform two principal functions in animals and plants. They are used as energy storage compounds and for building structural elements of cells. Plants store glucose as starch and animals store glucose in the form of a highly branched polymer known as glycogen. Glycogen is stored in the liver and muscles.

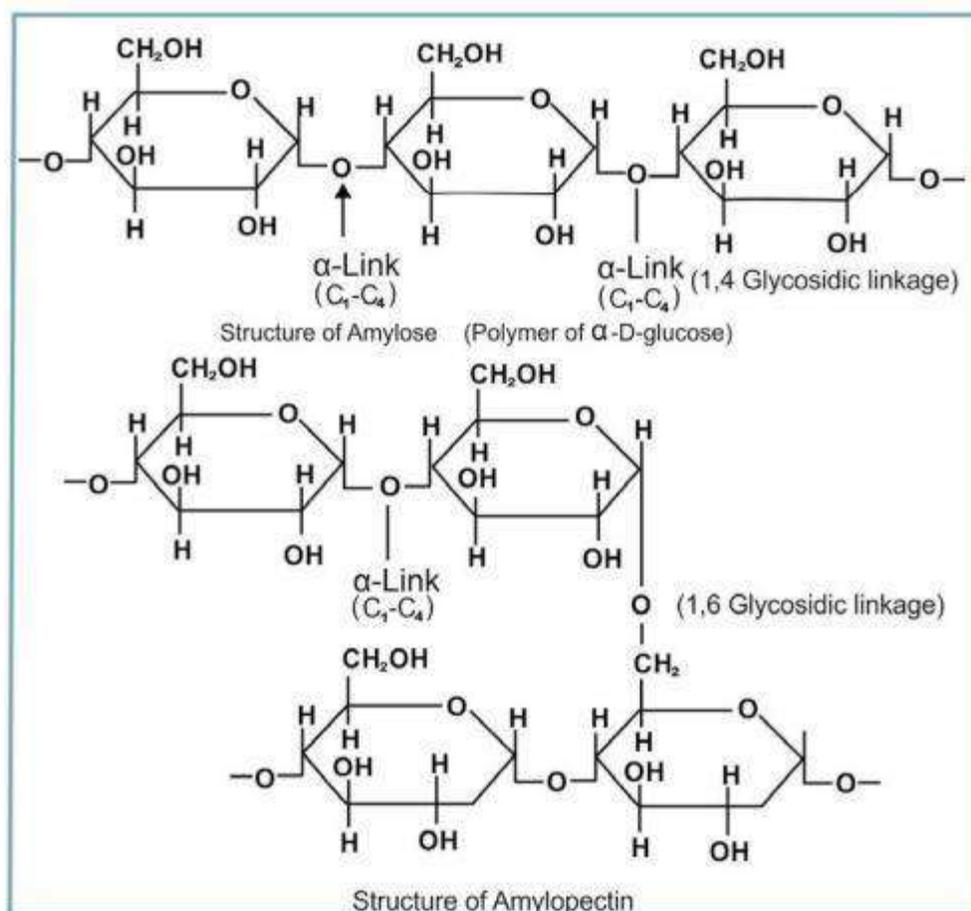
32. What is starch?

Ans: Starch is the most important source of carbohydrates in human diet. The chief commercial sources of starch are wheat, rice, maize, potatoes and barley. Starch is a polymer of α -D-glucose. Starch is not a pure compound. It is a mixture of two polysaccharides, amylose and amylopectin which can be separated from one another. Amylose is soluble in water and gives a deep blue colour with iodine while amylopectin is insoluble and gives no colour. Natural starch consists of 10 to 20% amylose and 80 to 90% amylopectin. It is used in coating and sizing of paper to improve the writing qualities. It is also used in laundering and in the manufacture of glucose and ethyl alcohol.



33. What is the difference between amylase and amylopectin?

Ans: Starch is not a pure compound. It is a mixture of two polysaccharides, amylose and amylopectin which can be separated from one another. Amylose is soluble in water and gives a deep blue colour with iodine while amylopectin is insoluble and gives no colour. Natural starch consists of 10 to 20% amylose and 80 to 90% amylopectin.



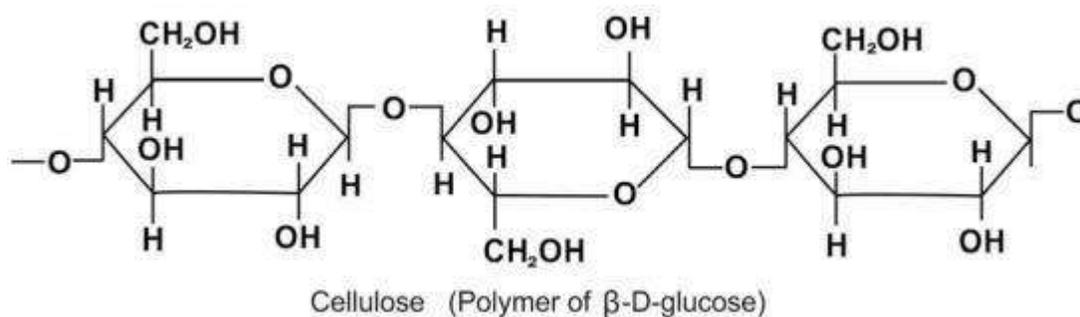
34. What are the uses of starch?

- Ans:**
1. It is used in coating and sizing of paper to improve the writing qualities.
 2. It is also used in laundering and in the manufacture of glucose and ethyl alcohol.

35. What is the difference between cellulose and glycogen?

Ans: Cellulose:

The most abundant structural polysaccharide is cellulose. Some 100 billion tons of cellulose are produced each year by plants. For example, cotton is 99% cellulose and the woody parts of trees are generally more than 50% cellulose. It is a polymer of β -D-glucose. It is present mainly in the plant kingdom but also occurs in some marine animals. It is an unbranched polymer consisting of a large number (up to 2500) of glucose residues joined to each other through β -1 \rightarrow 4 linkages.

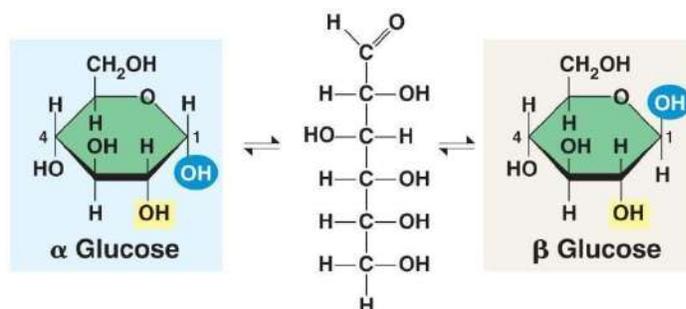


Glycogen:

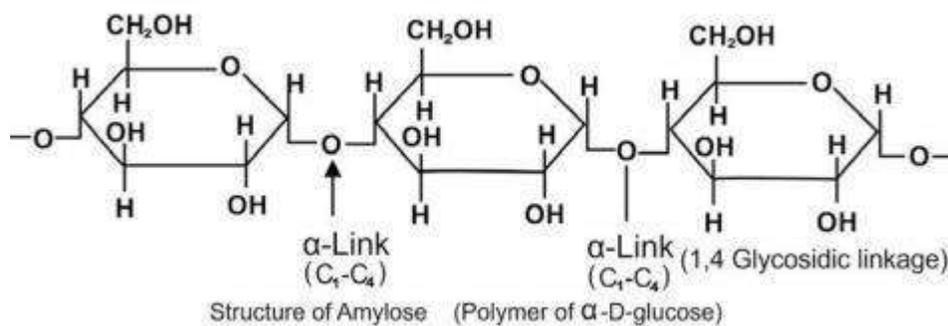
It occurs mainly in the liver and muscles where it represents the main storage polysaccharide in the same way as starch functions in plant cells. Glycogen is therefore also called ‘animal starch’. Its structure closely resembles with that of amylopectin having 1 4 and 1 6 glycosidic linkages. Human glycogen is a much more branched molecule than amylopectin. On hydrolysis it yields glucose units.

36. Justify by writing the structural formulas that amylase is condensation polymer of α -Dglucose and cellulose is polymer of β -D glucose.

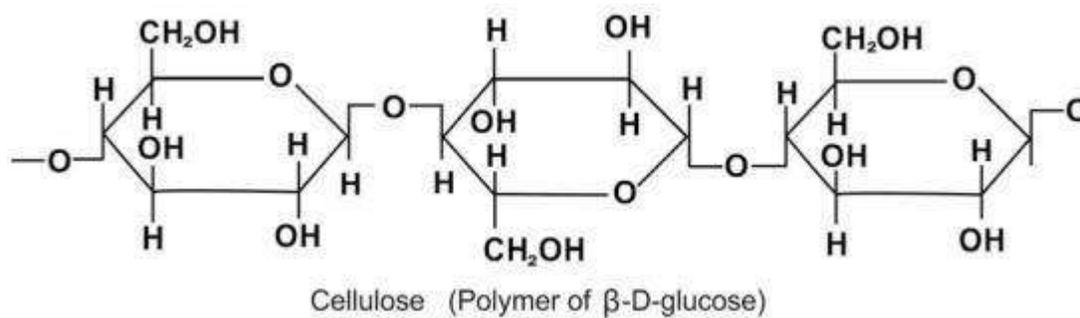
Ans:



Amylose is a condensation polymer of α -D Glucose.

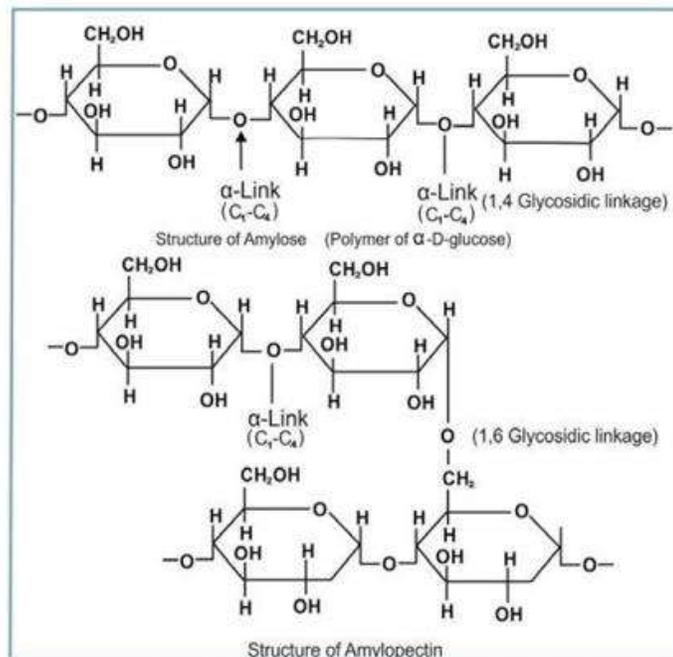


Cellulose is a condensation polymer of β -D glucose .



37. Write the structure of starch.

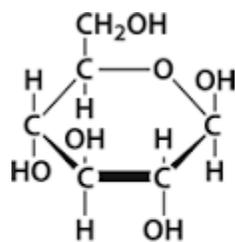
Ans:



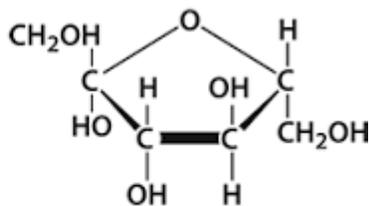
38. What is difference between glucose and fructose?

Ans: The difference in glucose and fructose is their chemical structure. Both are sugars, but

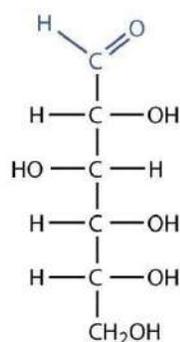
1. Glucose forms a 6 membered ring in solution, while fructose makes a 5 membered ring.
2. Glucose contains an aldehydic functional group whereas fructose contains a ketonic functional group.
3. Structures of Glucose & Fructose



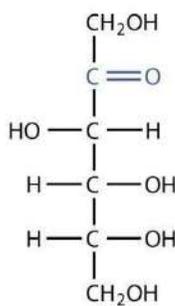
glucose



fructose



Glucose
(an aldohexose)



Fructose
(a ketohexose)

39. What are proteins?

Ans: The name protein is derived from the Greek word proteios meaning of prime importance. Thus proteins may be defined as the high molecular weight organic materials, which upon complete hydrolysis, yield amino acids.

40. What are the characteristics of proteins?

Ans:

1. Proteins are present in all living organisms and without proteins life would not be possible.
2. They are present in muscles, skin, hair and other tissues that make up the bulk of the body's non-bony structure.

3. All proteins contain the elements carbon, hydrogen, oxygen and nitrogen. They may also contain phosphorus and traces of other elements like iron, copper, iodine, manganese, sulphur and zinc. Proteins are very high molecular weight macromolecules.
4. All proteins yield amino acids upon complete hydrolysis.

41. How are proteins classified?

Ans: Based on the physico-chemical properties, proteins may be classified into three types:

1. Simple proteins

These proteins on hydrolysis yield only amino acids or their derivatives. For example, albumins, globulins, legumin, collagen, etc.

2. Compound or Conjugated proteins

In these molecules the protein is attached or conjugated to some non- protein groups which are called prosthetic groups. For example, phospho-proteins are conjugated with phosphoric acid, lipoproteins are conjugated with lipid substances like lecithin, cholesterol and fatty acids.

3. Derived proteins

This class of protein includes substances which are derived from simple and conjugated proteins. For example, proteoses enzymes, peptones, oligopeptides, polypeptides, etc.

42. What are simple proteins? Give an example.

Ans: These proteins on hydrolysis yield only amino acids or their derivatives. For example, albumins, globulins, legumin, collagen, etc. Globulins are insoluble in water but soluble in dilute salt solutions. They are found in animals, e.g lactoglobulin is found in muscles and also in plants. Legumin and collagen proteins are present in the connective tissues throughout the body. They are the most abundant proteins in the animal kingdom forming some 25 to 35% of body protein.

43. What are compound proteins? Give an example.

Ans: In these molecules the protein is attached or conjugated to some non- protein groups which are called prosthetic groups. For example, phospho-proteins are conjugated with phosphoric acid, lipoproteins are conjugated with lipid substances like lecithin, cholesterol and fatty acids.

44. What are derived proteins? Give an example.

Ans: This class of protein includes substances which are derived from simple and conjugated proteins. For example, proteases enzymes, peptones, oligopeptides, polypeptides, etc. Based on their functions, proteins may also be classified as regulatory or hormonal proteins, structural proteins, transport proteins, genetic proteins, etc.

45. Explain structure of proteins OR What is the difference between primary, secondary, tertiary and quaternary protein?

Ans: Proteins assume at least three levels of structural organization.

- (i) Primary structure
- (ii) Secondary structure
- (iii) Tertiary structures

Some proteins also possess a fourth structure called the quaternary structure.

The sequence of the amino acids combined in a peptide chain is referred to as the primary structure.

The secondary structure of a protein is a regular coiling or zigzagging of polypeptide chains caused by hydrogen bonding between $>NH$ and $>C=O$ groups of amino acids near each other in the chains.

The three dimensional twisting and folding of the polypeptide chain results in the tertiary structure of proteins.

46. How proteins are denatured?

Ans: The structure of proteins can be disrupted easily by heat, change in pH and under strongly oxidizing or reducing conditions. Under such conditions the proteins undergo denaturation. The most familiar example of denaturation is the change that takes place in albumin, the principal component

of egg white, when it is cooked. In this particular case the change is irreversible.

47. What is the importance of proteins?

Ans: Following are the points showing importance of proteins:

1. Proteins take an essential part in the formation of protoplasm which is the essence of all forms of life.
2. Nucleoproteins which are complexes of proteins with nucleic acids serve as carriers of heredity from one generation to the other.
3. Enzymes which are biological catalysts are protein in nature. Without them life is not possible.
4. Many proteins have specialized functions. Haemoglobin acts as a carrier of O₂. Some proteins act as hormones which have regulatory functions, for example; insulin, thyroxine etc.

48. Define lipids.

Ans: Lipids (Greek, lipos means fat) are naturally occurring organic compounds of animals and plants origin which are soluble in organic solvents and belong to a very heterogeneous group of substances.

Examples: Fats & Oils

49. What are the characteristics of lipids?

Ans: Lipids have the following characteristics:

1. They are insoluble in water and soluble in non-polar solvents e.g. ether, chloroform and benzene, etc.
2. Their primary building blocks are fatty acids, glycerol and sterols.
3. They are utilized by the living organisms.

50. What are the sources of fats and oils?

Ans: Fats and oils come from a variety of natural sources like animals, plants and marine organisms.

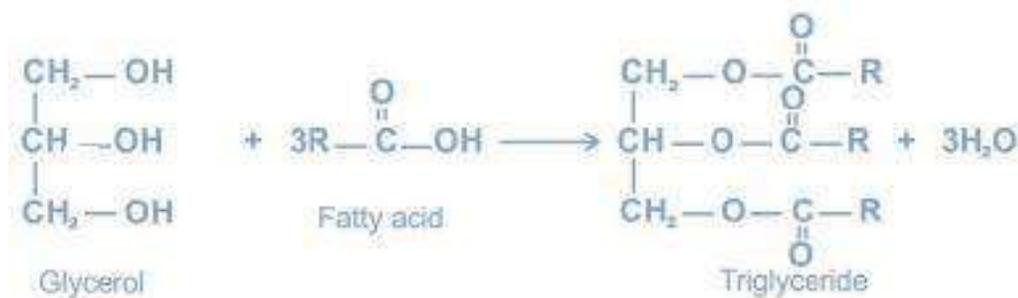
Animal fats are located particularly in adipose tissue cells. Butter and ghee are a special type of

animal fats which are made from milk. Vegetable oils are chiefly present in seeds and nuts of plants.

Marine oils are obtained from sea animals like salmons and whales etc.

51. What is the structure of fats OR How fats are synthesized?

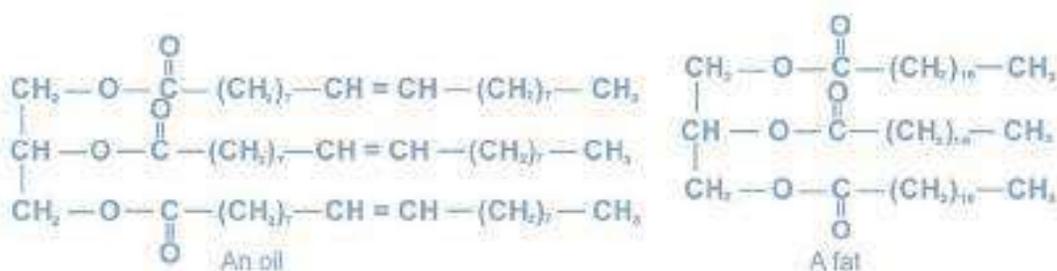
Ans: Fats and oils are triesters formed from glycerol and long chain acids called fatty acids.



Triester of glycerol is called a triglyceride or glyceride.

52. What is the difference between a fat and an oil?

Ans: The degree of unsaturation of the constituent fatty acid determines whether a triglyceride will be a solid or a liquid. The glycerides in which long chain saturated acid components predominate tend to be solid or semi-solid and are termed as fats. On the other hand, oils are glycerol esters which contain higher proportion of unsaturated fatty acid components and are in liquid form at room temperature.



53. How are lipids classified? (Only give names of types as answer to this question. Separate question can come for each type. Then give detail of that specific type there)

Ans: Lipids are classified as:

1. Simple Lipids

These are esters of fatty acids with glycerol. For example, common fats and oils.

2. Compound Lipids

These contain radicals in addition to fatty acids and alcohol and include glycerol phospholipids, sphingolipids, lipoproteins and lipopolysaccharides.

3. Derived or Associated Lipids

They are the hydrolytic products of the above mentioned compounds. Sterols, vitamin D and terpenes belong to this class of lipids.

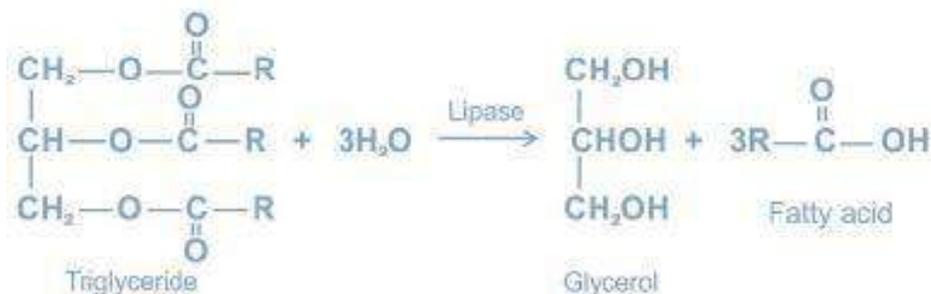
54. What are the characteristics of lipids? (Mention any four as answer to short question)

Ans: Following are the characteristics of lipids:

1. Oils and fats may either be liquid or non-crystalline solids at room temperature.
2. When pure they are colourless, odourless and tasteless.
3. They are insoluble in water and readily soluble in organic solvents like diethyl ether, acetone, carbon tetrachloride and carbon disulphide.
4. They readily form emulsions when agitated with H₂O in the presence of soap or other emulsifiers.
5. They are poor conductor of heat and electricity and therefore serve as excellent insulator for the animal body.

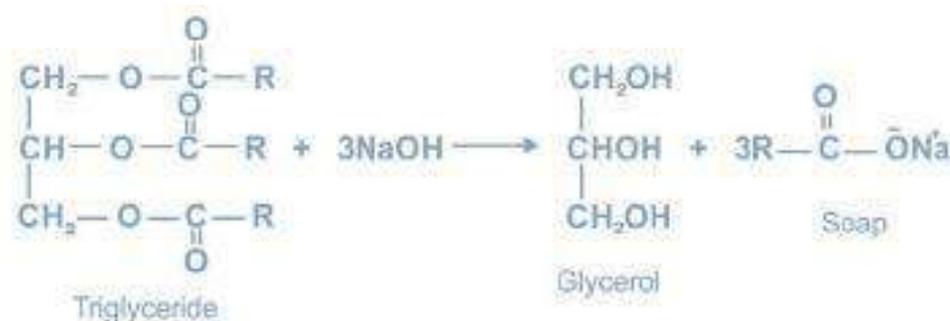
55. How are lipids hydrolyzed?

Ans: Triglycerides are easily hydrolyzed by enzymes called lipases to fatty acids and glycerol.



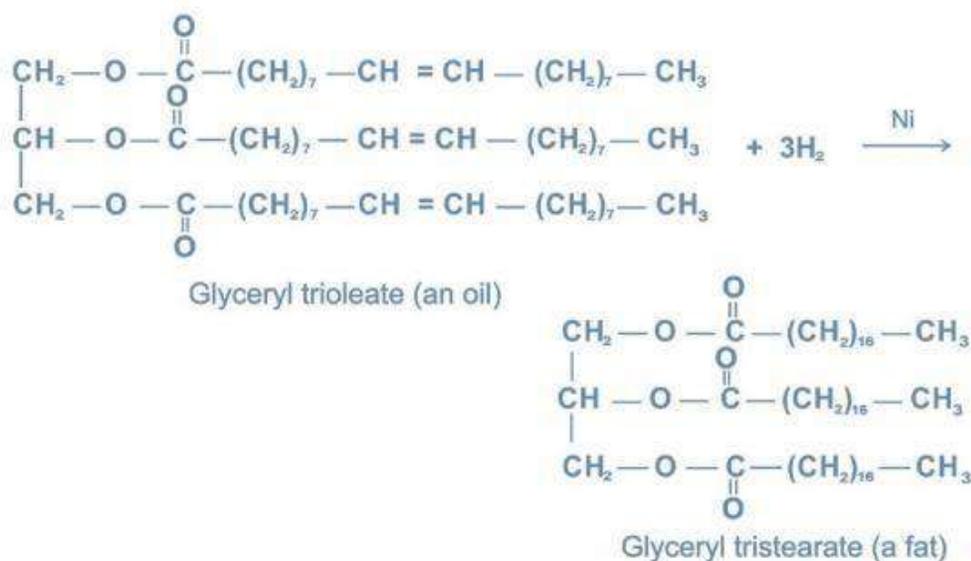
56. How are lipids saponified?

Ans: It is the hydrolysis of a fat or an oil with an alkali to form soap (salt of fatty acid) and glycerol.



57. What is meant by hardening of oils?

Ans: Unsaturated glycerides react with hydrogen in the presence of a metal catalyst to give saturated glycerides. The result is the conversion of a liquid glyceride (an oil) into a semi-solid glyceride (a fat).



58. What is saponification number? Give an example.

Ans: It is defined as the number of milligrams of potassium hydroxide or sodium hydroxide required to saponify one gram of the fat or oil. For example, one mole of glycerol tripalmitate (mol. wt = 807) requires 168,000 mg of KOH for saponification. Therefore, one gram of fat will require 168000/807

mg of KOH. Hence the saponification number of glycerol tripalmitate is 208.

59. What is rancidity of fats and oils?

Ans: Fats or oils are liable to spoilage and give off an odour known as rancidity. It is mainly caused by the hydrolytic or oxidative reactions which release foul smelling aldehydes and fatty acids. Oils from sea animals which contain a relatively high proportion of unsaturated acid chains deteriorate rapidly.

60. What is iodine number? Give an example.

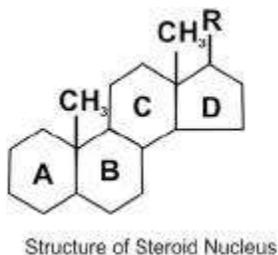
Ans: The extent of unsaturation in a fat or an oil is expressed in terms of its iodine number. It is defined as the number of grams of iodine which will add to 100 grams of a fat or an oil. The value of iodine number depends on the number of double bonds present in the acid component of the glycerides. The glycerides with no double bonds have zero iodine number.

61. What is acid number?

Ans: The acid number of a fat or an oil tells the amount of free fatty acids present in it. It is expressed as the number of milligrams of potassium hydroxide required to neutralize one gram of fat.

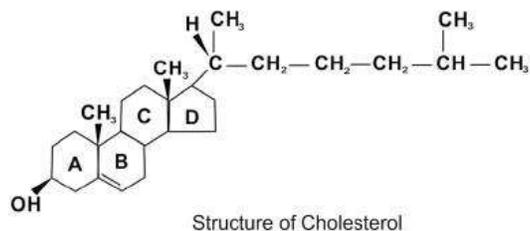
62. What are steroids?

Ans: Steroids are naturally occurring lipids. Their parent nucleus has perhydrocyclopentanophenanthrene component which consists of three six-membered rings (A, B and C) and one five-membered ring (D). These rings are joined or fused to each other and have a total of 17-C atoms.



63. What is the function of cholesterol? Draw its structure.

Ans: Cholesterol is present both in the free as well as esterified form in the blood, animal tissues, egg, yolk, various oils and fats and nerve tissues. Its increased quantities in blood makes plaque like deposits in the arteries causing blood pressure and other heart diseases.



64. What is ergosterol?

Ans: It is the sterol of fungi and yeasts. When irradiated with ultraviolet rays, it is converted into ergocalciferol or vitamin D₂.

65. What are phospholipids?

Ans: Phospholipids are molecules of enormous biological importance. In the compounds, two of the hydroxyl groups are esterified with fatty acids and third forms a link with phosphoric acid or a derivative of phosphoric acid.

66. What is the importance of lipids?

Ans: Following are the points showing importance of lipids:

1. They are good source of energy and make the food more palatable.
2. They exert an insulating effect on the nervous tissues.
3. They are good energy reservoirs in the body.
4. Lipids are an integral part of cell protoplasm and cell membranes.
5. Some lipids act as precursors of very important physiological compounds. For example, cholesterol is the precursor of steroid hormones.

67. What are enzymes?

Ans: Enzymes can be defined as the reaction catalysts of biological systems produced by living cells and are capable of catalyzing chemical reactions.

68. What is apoenzyme and co-factor?

Ans: The protein component of the enzyme is called apoenzyme and the non-protein component is called the co-factor or co-enzyme. The co-factors include inorganic ions and complex organic or metallo-organic molecules. Important inorganic co-factors along with their respective enzymes include Fe^{2+} (chrome oxidase) Zn^{2+} (carbonic anhydrase) and Mg^{2+} (glucose 6- phosphatase), etc. Many enzymes contain vitamins as their co-factors, for example; nicotinamide adenine dinucleotide contains nicotinamide vitamin and thiamine pyrophosphatase contains vitamin B1.

69. How are enzymes classified?

Ans:

1. Oxidoreductases

These enzymes catalyze oxidation-reduction reactions. Common examples are oxidase, dehydrogenase and peroxydase.

2. Transferases

These enzymes bring about an exchange of functional group such as phosphate or acyl between two compounds. For example, phospho-transferases, etc.

3. Hydrolases

These enzymes catalyze hydrolysis. They include proteases called protolytic enzymes.

4. Lyases

These enzymes catalyze the addition of ammonia, water or carbon dioxide to double bonds or removal of these to form double bonds, for example phospho-glyceromutases.

5. Isomerases

These enzymes catalyze the transfer of groups within molecules to yield isomeric forms of the substrate. An example is the conversion of fumaric acid to maleic acid in the presence of fumarase enzyme.

6. Ligases

These enzymes link two molecules together through the breaking of high energy bonds, for example; acetyl S COH, a carboxylase and succinic thiokinase.

70. What are the properties of enzymes? OR Discuss any two properties of enzymes.

Ans: Following are the properties of enzymes:

1. Enzymes are specific in their action which means that an enzyme will act on only one substrate or a group of closely related substrates.
2. Enzymes with few exceptions are protein in nature.
3. Most enzymatic reactions are reversible.
4. The enzymes from the same organisms which catalyze the same reaction but are chemically and physically distinct from each other are called isoenzymes.

71. Mention the factors affecting enzyme activity.

Ans: Following are the factors affecting enzyme activity:

1. Enzyme concentration
2. Temperature
3. Effect of pH
4. Presence of co-enzymes, activators, inhibitors
5. Radiation

72. What is the effect of enzyme concentration on enzyme activity?

Ans: The rate of an enzymatic reaction is directly proportional to the concentration of the substrate. The rate of reaction is also directly proportional to the square root of the concentration of enzyme.

It means that the rate of reaction also increases with the increasing concentration of enzyme.

73. What is the effect of temperature on enzyme activity?

Ans: The enzymatic reaction occurs best at or around 37 °C which is the average normal body temperature. The rate of chemical reactions is increased by a rise in temperature but this is true only over a limited range of temperature. The enzymes usually destroy at high temperature. The activity of enzymes is reduced at low temperature. The temperature at which an enzyme reaction occurs the fastest, is called its optimum temperature.

74. What is the effect of pH on enzyme activity?

Ans: Just like temperature, there is also an optimum pH at which an enzyme will catalyze the reaction at the maximum rate. For example, the optimum pH of salivary amylase is 6.4 to 6.9.

75. What is the effect of co-enzymes, activators and inhibitors on activity of enzymes?

Ans: The enzyme action is also increased or decreased in the presence of some other substances such as co-enzymes, activators and inhibitors. For example, some enzymes consist of simple proteins only such as insulin. Most of the enzymes are, however, the combination of a coenzyme and an apoenzyme. Activators are the inorganic substances which increase the enzyme activity. For example; Mg^{2+} and Zn^{2+} ions are the activators of phosphatase and carbonic anhydrase enzymes respectively. Inhibitors are the substances which reduce the enzyme activity.

76. Briefly describe the two factors that affect the activity of enzymes.

Ans:

Factors affecting enzyme activity:

1. Enzyme concentration:

The rate of an enzymatic reaction is directly proportional to the concentration of the substrate. The rate of reaction is also directly proportional to the square root of the concentration of enzyme. It

means that the rate of reaction also increases with the increase in the concentration of enzyme.

2. Temperature:

The enzymatic reaction occurs best at or around 37°C which is the average normal body temperature. The rate of chemical reactions is increased by a rise in temperature but this is true only over a limited range of temperature. Enzymes usually destroy at high temperature. The activity of enzymes is reduced at low temperature. The temperature at which an enzymic reaction occurs the fastest is called its optimum temperature.

77. What is denaturation of proteins?

Ans:

The structure of proteins can be disrupted easily by heat, change in PH and under strong oxidizing and reducing conditions. Under such conditions the proteins undergo denaturation. The most familiar example of denaturation is the change that takes place in albumin, the principle component of egg white, when it is cooked. In this particular case the change is irreversible.

78. What is the effect of radiation on activity of enzyme?

Ans: Generally enzymes are readily inactivated by exposure to ultraviolet light, beta rays, gamma rays and X-rays.

79. What is the importance of enzymes?

Ans: Enzymes are of great biological importance and are of great help in the diagnosis of certain diseases. Some examples are, alkaline phosphatase is raised in rickets and obstructive jaundice, lactic dehydrogenase or LDH-1 is raised in heart diseases. Many enzymes have proved very useful as drugs. For example; thrombin is used locally to stop bleeding. Many enzymes are used for cancer treatment, for example, L-asparaginase has proved very useful in the treatment of blood cancer in children.

80. What are nucleic acids? What is their function?

Ans: Nucleic acids were first demonstrated in the nuclei of pus cells in 1868 and in sperm heads in 1872 by Friedrik Miescher. They are present in every living cell as well as in viruses and have been found to be the essential components of the genes. They contain in their structure the blue-prints for the normal growth and development of each and every living organism.

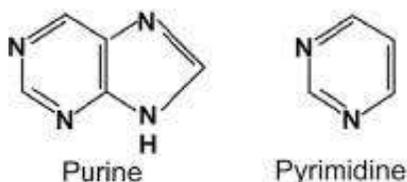
The nucleic acids are responsible for the two fundamental functions which are common to all living organisms, these are (a) their ability to reproduce, store and transmit genetic information and (b) to undergo mutation.

81. What are the types of nucleic acids?

Ans: Two types of nucleic acids have been discovered, deoxyribonucleic acid (DNA) and ribonucleic acid (RNA). In the body nucleic acids occur as part of the conjugated proteins called nucleoproteins.

82. What are the components of nucleic acids?

Ans: Both DNA and RNA are formed by joining together a large number of nucleotide units and mononucleotides units, each of which is a nitrogenous base sugar phosphoric acid complex.



Nitrogenous bases are either purine or pyrimidine derivatives. Purines include adenine and guanine whereas pyrimidines include, cytosine, uracil and thymine. A nucleoside is a combination of nitrogenous base (purine or a pyrimidine) with a sugar (ribo or deoxyribose). Depending upon the presence of ribo or a deoxyribo, nucleoside can either be a ribonucleoside or deoxyribonucleoside.

Deoxyribonucleic acid (DNA) carries the genetic information and ribonucleic acid (RNA) is involved in putting this information to work in the cell.

83. What is the difference between DNA and RNA?

Ans:

DNA	RNA
1. DNA is Deoxyribonucleic acid .	1. RNA is ribonucleic acid.
2. It carries genetic information.	2. It puts this information to work in cell
3. Sugar in DNA is 2-deoxyribose	3. Sugar in RNA is ribose.
4. It is double stranded .	4. It is single stranded.
5. Four bases are found in DNA. Cytosine, Thymine, Adenine & Guanine.	5. In RNA thymine is replaced by Uracil

84. What is the repeating unit in each of the following polymers?

(a) Polystyrene

(b) Nylon 6,6

(c) Teflon

(d) Orlon

Ans:

(a) In polystyrene repeating unit is styrene ($\text{H}_2\text{C}=\text{CH}-\text{C}_6\text{H}_5$)

(b) In nylon 6,6 repeating units are adipic acid and hexamethylene diamine

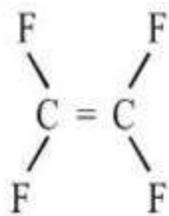
Adipic acid



Hexamethylene diamine



(c) In Teflon repeating unit is tetrafluoro ethene



(d) In Orlon repeating unit is acrylonitrile $\text{CH}_2=\text{CH}-\text{CN}$

85. Point out one difference between the compounds in each of the following pairs:

a. Glucose and Fructose

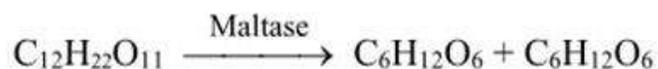
b. Sucrose and maltose

c. Cellulose and starch

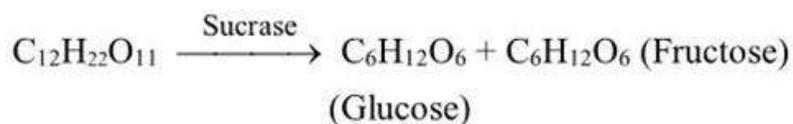
Ans:

a. Glucose is polyhydroxy aldehyde and fructose is polyhydroxy ketone (Detail given in answer of Q no. 38).

b. Maltose on hydrolysis gives glucose



Sucrose on hydrolysis gives glucose and fructose



c. Starch is a polymer of α -D Glucose and cellulose is a polymer of β -D glucose (Detail given in answer of Q no. 32 & 36).

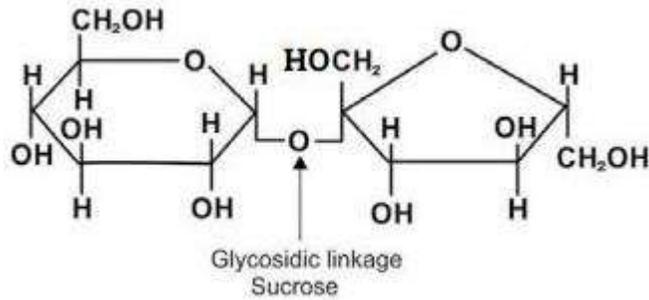
86. What is the difference between a glycosidic linkage and a peptide linkage?

Ans:

Glycosidic linkage

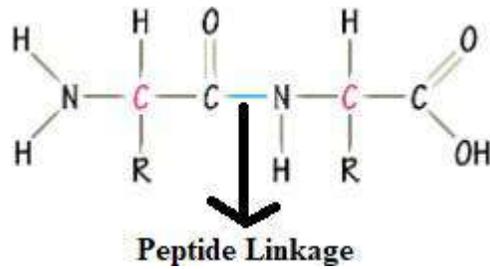
This is present in oligosaccharides and polysaccharides. Monosaccharides combine with the

release of water molecule forming a glycosidic linkage. For example, in sucrose molecule.



Peptide linkage

Amino acids combine with the release of water molecule thereby forming a peptide bond. For example,



Chapter#15
Common Chemical Industries in Pakistan

1. What are fertilizers?

Ans: Fertilizers are the substances added to the soil to make up the deficiency of essential elements like nitrogen, phosphorus and potassium (NPK) required for the proper growth of plants. Fertilizers enhance the natural fertility of the soil or replenish the chemical elements taken up from soil by the previous crops.

2. Classify elements essential for plant growth.

Ans: Elements essential for the growth of plants are classified as:

- i. Micro-nutrients
- ii. Macro-nutrients

Micro-nutrients (Trace elements):

Elements required in very small amount for the growth of plants are considered as micro-nutrients. These include Boron, Copper, Iron, Manganese, Zinc, Molybdenum and Chloride. These are required in range from 6grams to 200grams per acre.

Macro-nutrients:

Elements required in large amount are considered as macro-nutrients. These include Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, Sulphur, Carbon, Hydrogen and Oxygen. These are required in range from 5kg to 200kg per acre.

3. What are micro-nutrients?

Ans: The nutrients which are required in a very small amount for the growth of plant are called micro-nutrients. These include Boron, Copper, Iron, Manganese, Zinc, Molybdenum and Chlorine. Only minute amounts of these elements are needed for healthy plant growth and it may be dangerous to add too much quantity because they are poisonous in larger quantities. These are generally required in quantities ranging from 6 grams to 200 grams per acre.

4. What are macro-nutrients?

Ans: The nutrients which are required in a large amount for the growth of plants are called macro-nutrients. These include Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, Sulphur, Carbon, Hydrogen and Oxygen. These are generally required in quantities ranging from 5 kg to 200 kg per acre.

5. What is meant by the requirement of a fertilizer?

Ans: Every compound of the desired elements cannot be a fertilizer. The desired elements should be present in the compound in a water soluble form (so that the plant can take it up) readily available to the plants. The compound employed as fertilizer should be stable in soil as well as in storage e.g., it should not be deliquescent or set to hard stony materials with time. Above all it should be cheap to manufacture.

6. What are the essential qualities of a good fertilizer?

Ans: The essential requisites of a good fertilizer are:

1. The nutrient elements present in it must be readily available to the plant.
2. It must be fairly soluble in water so that it thoroughly mixes with the soil.
3. It should not be injurious to plant.
4. It should be cheap.
5. It must be stable so that it is available for a longer time to the growing plant.
6. It should not alter the pH of the soil.
7. By rain or water, it should be converted into a form, which the plant can assimilate easily.

7. Mention any four essential qualities of a good fertilizer.

Ans: The essential requisites of a good fertilizer are:

1. The nutrient elements present in it must be readily available to the plant.
2. It must be fairly soluble in water so that it thoroughly mixes with the soil.
3. It should not be injurious to plant.
4. It should be cheap.

8. Mention the classification of fertilizers.

Ans: The fertilizers are classified as:

- a. Nitrogenous fertilizers
- b. Phosphatic fertilizers
- c. Potassium fertilizers

9. What is the importance of nitrogen in plant growth?

Ans: Nitrogen is required during the early stage of plant growth for the development of stems and leaves. It is the main constituent of protein, imparts green colour to the leaves and enhances the yield and quality of the plants.

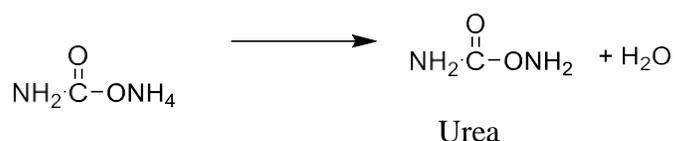
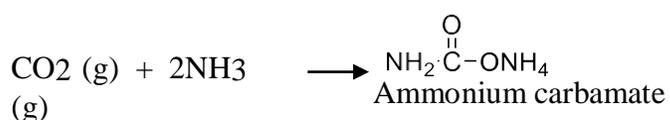
10. Mention the steps involved in the manufacturing of urea.

Ans: Following are the steps involved in the manufacturing of urea:

- i. Preparation of hydrogen and carbon dioxide
- ii. Preparation of ammonia
- iii. Preparation of ammonium carbamate
- iv. Preparation of urea
- v. Concentration of urea
- vi. Prilling

11. Which reactions are involved in the manufacturing of urea?

Ans: Following reactions are involved in the manufacturing of urea:



12. Draw flow sheet diagram for the manufacture of urea.

Ans:



13. Mention the chemical reaction involved in the manufacturing of ammonium nitrate.

Ans: It is manufactured by the neutralization reaction between ammonia and nitric acid as given below.



After neutralization, the water is evaporated. The solid ammonium nitrate is melted and then sprayed down from a tall tower. The falling droplets are dried by an upward current of air. The fertilizer solidifies as tiny, hard pellets called prills. Prills of fertilizers are free of dust, easy to handle and easy to spread on the field. Ammonium nitrate contains 33-33.5% nitrogen.

14. What is the role of phosphorus in plant growth?

Ans: Phosphorus is required to stimulate early growth to accelerate the seed and fruit formation during the later stages of growth. It also increases resistance to diseases.

15. Mention the chemical reaction for the preparation of diammonium phosphate.

Ans: This compound of fairly high purity is prepared by continuous process that consists of reacting anhydrous ammonia gas and pure phosphoric acid at 60 - 70 °C and pH 5.8 - 6.0.



It is an exothermic reaction. The heat of reaction vaporizes water from the liquor and the crystals of diammonium phosphate are taken out, centrifuged, washed and dried. It contains 16% nitrogen and 48% P₂O₅. This product contains about 75% plant nutrients and is deemed suitable for use either alone or in mixed with other fertilizers.

16. What is the role of potassium in plant growth?

Ans: Potassium is required for the formation of starch, sugar and the fibrous material of the plant. They increase resistance to diseases and make the plants strong by helping in healthy root development. They also help in ripening of seeds, fruits and cereals. Potassium fertilizers are especially useful for tobacco, coffee, potato and corn.

17. Mention the chemical reaction involved in the manufacturing of potassium nitrate.

Ans: On industrial scale it is prepared by the double decomposition reaction between sodium nitrate and potassium chloride.



A concentrated hot solution of sodium nitrate is prepared and solid potassium chloride is added into it. On heating, the potassium chloride crystals change into sodium chloride crystals, and the hot potassium nitrate is run through the sodium chloride crystals at the bottom of the kettle. A little water is added to prevent further deposition of sodium chloride as the solution is cooled, which results into a good yield of pale yellow solid potassium nitrate. It contains 13% nitrogen and 44% potash.

18. What is meant by prilling of urea?

Ans: The molten urea is sprayed at the prilling tower by means of prilling bucket where it is cooled by the air rising upward. Molten droplets solidify into the form of prills.

19. Give preparation of Portland cement as carried out by Joseph Aspdin. Why it is named so?

Ans: Cement is a very important building material which was first introduced by an English Mason Joseph Aspdin. He found it when strongly heated mixture of limestone and clay was mixed with water and allowed to stand, it hardened to a stone like mass which resembled Portland rock; a famous building stone of England. Since then the name of Portland Cement is given to the mixture of lime (obtained from limestone), silica, iron oxide and alumina.

20. Define cement.

Ans: Cement is the material obtained by burning an intimate mixture of calcareous and argillaceous materials at sufficiently high temperature to produce clinkers. These clinkers are then ground to a fine powder. The essential constituents are lime (obtained from limestone) silica and alumina (present in clay).

21. Which raw materials are used for the manufacturing of cement?

Ans: The important raw materials used for the manufacturing of cement are:

1. Calcareous material (limestone, marble, chalks, marine shell) as source of CaO.
2. Argillaceous material (clay, shale, slate, blast furnace slag) They provide acidic components such as aluminates and silicates.
3. Other raw material being used is gypsum.

22. Give percentage composition of cement/Give percentage composition of Portland cement.

Ans: Following is the percentage composition of cement:

Compound	%age
Lime (CaO)	62
Silica (SiO ₂)	22
Alumina (Al ₂ O ₃)	7.5
Magnesia (MgO)	2.5
Iron oxide (Fe ₂ O ₃)	2.5
Sulphur trioxide (SO ₃)	1.5
Sodium oxide (Na ₂ O)	1.0
Potassium oxide (K ₂ O)	1.0

23. Which factors decide about the manufacturing process of cement?

Ans: The choice of dry or wet process depends on the following factors:

1. Physical condition of the raw materials.
2. Local climatic conditions of the factory.
3. The price of the fuel.

24. Enlist the steps involved in wet process.

Ans: In this process grinding is done in the presence of water. There are five stages in the manufacture of Portland cement:

1. Crushing and grinding of the raw material.
2. Mixing the material in correct proportion.
3. Heating the prepared mixture in a rotary kiln.
4. Grinding the heated product known as clinker.
5. Mixing and grinding of cement clinker with gypsum.

25. Give different zones in the rotary kiln and their temperature ranges.

Ans: There four different zones:

(a) Drying or Pre-heating Zone (Minimum temperature zone): In this zone the temperature is kept at 500°C, whereby the moisture is removed and the clay is broken into Al₂O₃, SiO₂, and Fe₂O₃.

(b) Decomposition Zone (Moderate temperature zone): Here the temperature goes up to 900°C In this zone the limestone (CaCO₃) decomposes into lime (CaO) and CO₂



(c) Burning Zone (Maximum temperature zone): In this zone, the temperature goes up to 1500°C and the oxides, e.g. CaO, SiO₂, Al₂O₃ and Fe₂O₃ combine together and form calcium silicate, calcium aluminate and calcium ferrite.

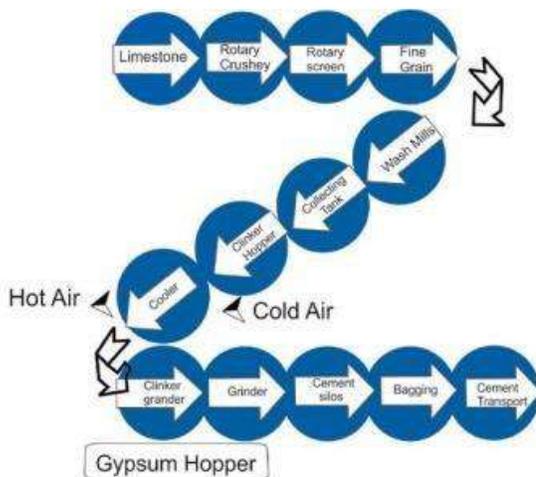
(d) Cooling Zone: This is the last stage in the kiln where the charge is cooled up to 150-200°C.

26. What is clinker formation?

Ans: The resulting product obtained from the kiln is known as cement clinker. This has the appearance of greenish black or grey colored balls varying in size from small nuts to peas.

27. Draw flow sheet diagram for the manufacturing of cement by wet process.

Ans:



28. What is meant by setting of cement? Mention the reactions involved in setting of cement.

Ans: When cement is mixed with water it sets to a hard mass when allowed to stand for some time. This is called setting of cement.

The reactions involved in the setting of cement are described as follows:

(i) Reactions Taking Place in First 24 Hours.

A short time after the cement is mixed with water, tri-calcium aluminate absorbs water (hydration) and forms a colloidal gel of the composition, $3\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot 6\text{H}_2\text{O}$, (hydrated tricalcium aluminate). This gel starts crystallizing slowly, reacts with gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) to form the crystals of calcium sulfo-aluminate ($3\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot 3\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$).

(ii) Reactions Taking Place Between 1 to 7 Days

Tricalcium silicate ($3\text{CaO} \cdot \text{SiO}_2$) and tri-calcium aluminate ($3\text{CaO} \cdot \text{Al}_2\text{O}_3$) get hydrolyzed to produce calcium hydroxide and aluminium hydroxide. The calcium hydroxide, thus formed, starts changing into needle-shaped crystals, which get studded in the colloidal gel and impart strength to it. Aluminium hydroxide, on the other hand,

fills the interstices resulting in hardening the mass. The gel formed starts losing water partly by evaporation and sets to a hard mass.

29. Define paper.

Ans: Paper is defined in term of its method of production that is a sheet material made up of a network of natural cellulosic fibres which have been deposited from an aqueous suspension. The product obtained is a network of intertwining fibres.

30. Mention non-woody raw materials used in paper industry.

Ans: Names of the non-woody materials are:

- i. Wheat straw
- ii. Cotton stalk
- iii. Rice straw
- iv. Cotton linter
- v. Bagasse
- vi. Kahi grass
- vii. Bamboo
- viii. Grasses
- ix. Rag

31. Mention woody raw materials used in paper industry.

Ans: Names of the woody materials are:

- (i) Poplar (hard wood)
- (ii) Eucalyptus (hard wood)
- (iii) Douglas fir (soft wood)

32. Write down two woody and two non-woody raw materials for paper pulp manufacture.

Ans: Woody Raw materials

- (i) Poplar
- (ii) Eucalyptus (hard wood)

Non-Woody Raw materials

- (i) Wheat straw
- (ii) Bagasse

33. What is meant by NSSC? Why it is commonly used in Pakistan?

Ans: The term NSSC stands for neutral sulphite semi chemical process. The neutral sulphite semi chemical process has come to occupy the dominant position because of the advantages in chemical recovery and pulp strength.

34. Briefly describe process of neutral sulphite semi chemical process.

Ans: The process utilizes sodium sulphite cooking liquor which is buffered with sodium carbonate or NaOH to neutralize the organic acid liberated from the raw materials.

35. Mention the steps involved in neutral sulphite semi chemical process.

Ans: The steps involved in neutral sulphite semi chemical process are:

- i. Cutting of the raw materials
- ii. Dry cleaning
- iii. Wet cleaning
- iv. Screening
- v. Digestion
- vi. Blow tank
- vii. Pulp washing
- viii. Bleaching
- ix. Paper making machine
- x. Stock preparation plant

36. Write down digestion process for the preparation of pulp.

Ans: As the raw material enters into the digester, steam is introduced at the bottom and a liquor containing sodium sulphite is injected simultaneously to cover the raw material. Sodium sulphite used is buffered with sodium carbonate or sodium hydroxide to maintain its pH 7-9. The digester is closed carefully. It is revolved at 2.5 RPM and a temperature of 160- 180°C is maintained. The digester takes 45 minutes to attain the desired temperature after which it gets switched off automatically and pressure is released.

37. Why lignin is removed from pulp?

Ans: Lignin is an aromatic polymer and causes paper to become brittle. That is why it is removed from pulp.

38. What are the common bleaching agents used in paper industry in Pakistan?

Ans: In Pakistan, bleaching is done with chlorine or sodium hypochlorite and hydrogen peroxide.

39. Mention the parts of paper making machine.

Ans: Following are the parts of paper making machine:

- (a) Flow Spreader
- (b) Head Box
- (c) Fourdrinier Table
- (d) Press Section
- (e) Dryer Section
- (f) Calendar Stock
- (g) Reel

Chapter#16
Environmental Chemistry

1. Define environmental chemistry.

Ans: Environmental chemistry deals with the chemicals and other pollutants in the environment. In this we study the sources, reactions, transportation of the chemicals and other toxic substances especially created by human activity in the environment and their adverse effects on human beings. This branch of chemistry is interrelated with all other branches of science, i.e. biology, physics, medicine, agriculture, public health and sanitary engineering, etc.

2. Write the names of components of environment.

Ans: Environment consists of following four components:-

- i. Atmosphere
- ii. Hydrosphere
- iii. Lithosphere
- iv. Biosphere/Ecosphere
- e

3. Define atmosphere. What is the composition of atmosphere?

Ans: The layer of gases surrounding the earth is called atmosphere. It consists of various gases in different proportions i.e., N₂ (78%), O₂ (21%), Ar (0.9%), CO₂ (0.03 %) and trace amounts of H₂, O₃, CH₄, CO, He, Ne, Kr and Xe. It also contains varying amounts of water vapours.

4. What is the role of atmosphere?

Ans: The gases in the atmosphere absorb most of the cosmic rays and the major portion of the harmful electromagnetic radiation coming from the sun. The absorption of these harmful radiations protects the life on the earth.

The gases present in the atmosphere are essential for sustaining life on earth i.e., O₂ is required for breathing, CO₂ is required for plant photosynthesis, N₂ is used by nitrogen fixing bacteria and water vapours are responsible for sustaining various forms of life on the earth. Atmosphere also maintains the heat balance of the earth.

5. What is hydrosphere?

Ans: The hydrosphere includes all water bodies, mainly oceans, rivers, streams, lakes, polar ice caps, glaciers and ground water reservoirs (water below earth surface).

6. What is the composition of hydrosphere?

Ans: Oceans contain 97% of earth's water but because of high salt contents this water cannot be used for human consumption. The polar ice caps and glaciers consist of 2% of the earth's total water supply. Only 1% of the total earth's water resources are available as fresh water i.e., surface water; river, lake, stream and ground water. The fresh water is being used by agriculture (69%), industry (23%) and for domestic purposes (8%).

7. What is lithosphere? Give its composition.

Ans: It consists of rigid rocky crust of earth and extends to the depth of 100 km. The mantle and core are the heavy interior of the earth, making up most of the earth's mass.

8. Give composition of lithosphere.

Ans: The 99.5 % mass of the lithosphere is made of 11 elements, which are oxygen (~46.60%), Si (~27.72%), Al (8.13%), Fe (5.0%), Ca (3.63%), Na (2.83%), K (2.59%), Mg (2.09%) and Ti, H₂ and P (total less than 1%). The elements present in trace amounts (0.1 to 0.02%) are C, Mn, S, Ba, Cl, Cr, F, Zr, Ni, Sr and V. These elements mostly occur in the form of minerals.

9. What is biosphere?

Ans: Biosphere is the region of earth capable of supporting life. It includes lower atmosphere, the oceans, rivers, lakes, soils and solid sediments that actively interchange materials with all types of living organisms i.e., human beings, animals and plants.

10. What is ecosystem?

Ans: Ecosystem is a smaller unit of biosphere which consists of community of organisms and their interaction with environment i.e., animals, plants and microorganisms which lie in a definite zone and depend on the physical factors such as soil, water, and air.

11. Define environmental pollutant.

Ans: Any substance in the environment which adversely affects the human health, quality of life and the natural functioning of ecosystem, is known as environmental

pollutant.

12. What are the primary pollutants?

Ans: The waste products given out from chimneys of industrial units and exhaust of automobiles may contain gases such as sulphur dioxide, sulphur trioxide, nitrogen oxides, carbon monoxide, hydrocarbons, ammonia, compounds of fluorine and radioactive materials. These waste products are called primary pollutants.

13. What are the secondary air pollutants?

Ans: The primary pollutants in the atmosphere through various reactions produce secondary pollutants such as sulphuric acid, carbonic acid, hydrofluoric acid, peroxyacetyl-nitrate (PAN), ozone, aldehydes, ketones and peroxybenzoyl.

14. CO is a highly poisonous gas. Justify.

Ans: Carbon monoxide is highly poisonous gas and causes suffocation if inhaled. It binds blood haemoglobin more strongly than oxygen thus excluding oxygen from normal respiration. The CO poisoning can be reversed by giving high pressure oxygen. Exposure to high concentration of CO results in headache, fatigue, unconsciousness and eventually death (if such exposure is sustained for longer period).

15. What are the natural sources of carbon monoxide?

Ans: Natural sources of carbon monoxide emission are volcanic eruption, natural gas emission and oxidation of methane in the atmosphere.

16. How is carbon monoxide released through human activities?

Ans: Fuel burning in various types of transportation i.e., motor vehicles, railways and aircrafts is the major source (75%) of carbon monoxide in the atmosphere. Other sources of carbon monoxide emission are forest fires, combustion of fossil fuel and agricultural products. Carbon monoxide is also emitted from industries in which any type of fuel is burnt in air.

These industries include iron and steel, petroleum, cement, brick kilns, paper and pulp, etc. Incomplete combustion and dissociation of CO₂ at high temperature also produces CO.

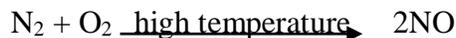
17. What are the natural sources of nitrogen oxides?

Ans: The natural source of nitrogen oxides is the bacterial action which produces

nitrogen oxides mainly NO.

18. How are nitrogen oxides produced through human activities?

Ans: Nitrogen oxides are generally produced by combustion of coal, oil, natural gas and gasoline. Both oxides result from the oxidation of nitrogenous compounds present in fossil fuel. The burning of fuel in the presence of air in internal combustion engine also produces NO.



Nitrogen dioxide is produced when nitric oxide reacts with oxygen

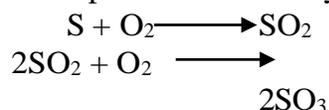


19. What are the natural sources of sulphur oxides?

Ans: On global scale most of sulphur dioxide is produced by volcanoes (67%) and by oxidation of sulphur containing gases produced by decomposition of organic matter.

20. How sulphur oxides are produced through human activities?

Ans: Air is polluted with SO₂ due to combustion of coal (containing 1-9% S), crude oil and other fossil fuel in power plants and petroleum industry, etc.



21. What are the natural sources of hydrocarbons?

Ans: Large quantities of hydrocarbons are emitted by different trees and plants in the atmosphere. Paddy fields produce a significant amount of methane in the atmosphere. Another natural source of methane is the anaerobic decomposition of organic matter by bacteria in water sediments and in soils. Methane has a mean residence time of about 3-7 years in the atmosphere.



22. How are the hydrocarbons produced through human activities?

Ans: Automobiles are the major source of hydrocarbons emission. In addition to this, petroleum, coal, wood, incinerators, refuse burning and solvent evaporator also contribute towards the emission of hydrocarbons into the atmosphere.

23. What is meant by acid rain?

Ans: The precipitation which is more acidic than natural rain is considered acid rain or acid deposition. The rain water which has pH less than 5 is considered truly acidic.

24. Write down the adverse effects of acid rain.

Ans: Acidification of the soil and rocks can leach metals like aluminium, mercury, lead and calcium and discharges them into water bodies. These heavy metals are accumulated in the fishes and are health hazards for humans and birds as they eat these fishes. The elevated concentration of aluminium is harmful for fish as it clogs the gills thus causing suffocation. Acidification of the soil can also leach nutrients thus damaging leaves and plants and growth of forest. It also damages building materials such as steel, paint, plastic, cement, masonry work and sculptural materials especially of marble and limestone.

25. Define smog.

Ans: The word smog is a combination of smoke and fog.

26. What is reducing smog?

Ans: If smog contains high contents of SO₂ it is chemically reducing in nature and is known as 'reducing smog'. The main cause of reducing smog is combustion of coal.

27. What is oxidizing/photochemical smog?

Ans: Photochemical smog consists of higher concentrations of oxidants like ozone and is also termed as oxidizing smog, it is a yellowish brownish grey haze which is formed in the presence of water droplets and chemical reactions of pollutants in the air. It has unpleasant odour because of its gaseous components. The main reactants of photochemical smog are nitric oxide NO and unburnt hydrocarbons. Nitric oxide is oxidized to nitrogen dioxide within minutes to hours depending upon the concentration of pollutant gas. The yellow colour in photochemical smog is due to the presence of nitrogen dioxide.

The overall result of photochemical smog in afternoon is the built up of oxidizing agents such as H₂O₂, HNO₃, peroxyacetyl nitrate (PAN) and ozone in the air. PAN is an eye irritant and is also toxic to plants.

28. Which conditions are required for the formation of smog?

Ans: The following conditions are required for the formation of smog:

1. There must be sufficient NO, hydrocarbons and volatile organic compounds (VOC) emitted by the vehicular traffic.
2. Sunlight, so that some of the chemical reactions may occur at a rapid rate.

3. The movement of air mass must be little so that reactions are not disturbed.

29. What is the role of ozone layer?

Ans: The ozone layer, 25 - 28 km high, in the stratosphere surrounds the globe and filters most of the harmful ultraviolet (UV) rays in the sunlight before they could reach on the earth.

30. What are the harmful effects of ozone as a pollutant?

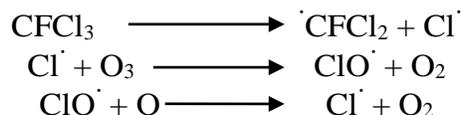
Ans: Ozone is produced in most of the tropical regions by the photochemical reactions of oxygen, from where it is transported to Polar Regions. It acts as a pollutant and causes various health problems i.e., damages eyes and aggravates asthma, decreases the elasticity of lung tissues, coughing, chest discomfort, etc. It is harmful to the plants and other materials i.e., attacks rubber, reduces durability and appearance of paint and causes fabric dyes to fade.

31. What is ozone hole?

Ans: The region in which ozone depletes substantially in every year during Sep-Nov is now termed as "ozone hole".

32. What is the role of chlorofluorocarbons in destroying ozone layer?

Ans: Chlorofluorocarbons used as refrigerants in air conditioning and in aerosol sprays are inert in the troposphere but slowly diffuse into stratosphere, where they are subjected to ultraviolet radiation generating Cl[·] free radicals. Chlorofluorocarbons (CFCs) play an effective role in removing O₃ in the stratosphere due to following reactions.



A single chloride free radical can destroy up to 100,000 ozone molecules.

33. What are the harmful effects of pesticides/organic chemicals?

Ans: Some organic chemicals may have no detrimental effects at low concentrations, but many compounds can have serious and substantial health risks, even at very low concentrations. At even higher concentrations, most of the compounds are tasteless and

odourless. Many of the light molecular weight chlorinated hydrocarbons in drinking water are carcinogens and they have no safe levels.

When synthetic organic chemicals are ingested through food or drinking water, they can cause health problems. At high concentrations they can cause nausea, dizziness, tremors, and blindness. At lower concentrations, at which these compounds become tasteless and odourless, humans may develop skin eruptions or central nervous system impairment. At still lower concentrations when ingested over months or years, the compounds can cause health problems. With human or animal carcinogens, there is often a long period of time between exposure and manifestation of the disease.

34. How livestock waste causes water pollution?

Ans: Mostly the livestock waste is either being dumped on the open land or is discharged into sewage, canals or rivers. This practice pollutes the surface and ground water posing serious health problems to the population. Chemical and bacterial contents in livestock waste can contaminate surface and ground water causing such infectious diseases as dysentery, typhoid and hepatitis.

35. How oil spillage causes threat to aquatic life?

Ans: Sea water gets polluted by accidental oil spills and leakage from cargo oil tankers in sea, tanker trucks, pipelines leakage during off shore exploration and leakage of underground storage tanks. Many petroleum products are poisonous and pose serious health problems to humans, animals and aquatic life. Hydrocarbons particularly polycyclic aromatics are known to be carcinogenic even at very low concentrations. The marine organisms are severely affected by soluble aromatic fractions of oil (C-10 or less). The spilled oil damages the marine life often causing death. The light transmission through surface of water is affected by oily layer on it thus photosynthesis of the plants and dissolved oxygen in water is decreased.

36. What are the components of industrial waste effluents?

Ans: The industrial waste pollutants may contain organic chemicals including highly toxic synthetic organic compounds and heavy metals i.e., Pb, Cd, Cr, Hg, As, Sb etc. oils and greases, mineral acids, etc.

37. What are the harmful effects of industrial waste effluents?

Ans: The toxic organic compounds and heavy metals and metalloids results in contamination of both surface and ground water used for irrigation and potable water supply. This also causes irreversible degradation of the environment causing serious health problems for public and marine life. The heavy metals such as Pb, Cd, Cr, As, Hg, etc. are highly toxic and do not have any safe limits; they have accumulation effects when ingested through food or water and cause various health problems like anemia, kidney diseases, nervous disorder, high blood pressure, etc.

38. How detergents pose threat to aquatic life?

Ans: The waste water containing detergents when discharged in rivers or sea, greatly affects the aquatic life. Detergent contents of waste water mobilize the bound toxic ions of heavy metals such as Pb, Cd and Hg from sediments into water.

39. Which pollutant is produced in leather tanneries?

Ans: Leather tanneries use large quantities of chromium (VI) salts for leather tanning. They are producing good variety of exportable leather, but only some units have the facility of waste water treatment by reducing Cr (VI) into trivalent state followed by alkaline precipitation of Cr (OH)₃.

The effluents are discharged onto the open land or put into the sewage system. These industries are the big source of chromium (VI) pollution in the environment. Chromium (VI) is highly toxic and is known to cause cancer.

40. What is dissolved oxygen (DO)?

Ans: In water the most important oxidizing agent is dissolved molecular oxygen (O₂) the concentration of which ranges from 4 - 8 ppm. The organic matter is oxidized with the help of this dissolved oxygen in water. It is a parameter to determine the quality of water. The dissolved oxygen value less than 4 ppm indicates that water is polluted.

41. What is biochemical oxygen demand (BOD)? How is it determined?

Ans: It is the capacity of organic matter in natural water to consume oxygen within a period of five days. The value of BOD is the amount of oxygen consumed as a result of biological oxidation of dissolved organic matter in the sample.

The oxidation reaction is catalyzed by microorganisms which are already present in the natural water. It is measured experimentally by calculating the concentration of oxygen at the beginning and at the end of five days period, in which a sealed water sample is maintained in the dark at constant temperature either at 20 °C or 25 °C.

42. What is chemical oxygen demand (COD)? How is it determined?

Ans: The organic content of water which consumes oxygen during chemical oxidation is evaluated by its chemical oxygen demand. The oxygen demand of water can be determined directly by treating it with dichromate ions CrO_7^{2-} which is a powerful oxidizing agent. The organic matter in water is oxidized, while the remaining dichromate is determined volumetric titration. Value of COD is a direct measure of chemically oxidizable matter in water. Higher values of COD will indicate more pollution.

43. Name the stages of water purification.

Ans: Following are the stages of water purification:

- a. Aeration
- b. Coagulation
- c. Chlorination

44. Tell about the aeration technique used in purification of water.

Ans: The quality of raw water is improved by aeration. In this process air is passed through water to remove the dissolved gases such as foul smelling H_2S , organosulphur compounds and volatile organic compounds. Some of the organic materials in the raw water which could be easily oxidized with air produce CO_2 in the aeration process. The remaining portions of organic material if necessary are removed by passing water over activated carbon. Aeration process also oxidizes water soluble Fe^{2+} to Fe^{3+} which then forms insoluble $\text{Fe}(\text{OH})_3$ and can be removed as solid. Aeration also improves the oxygen level of raw water.

45. Tell about the coagulation technique used in the purification of water.

Ans: The materials which are suspended or present in the colloidal form in raw water are removed by coagulation. The coagulant such as aluminium sulphate or alum is added to the raw water, which causes the precipitation of suspended impurities. For example, aluminium hydroxide is precipitated when alum is added to water in alkaline medium i.e.,



Many suspended particles get adsorbed on the surface of gelatinous aluminium hydroxide precipitate. Ferric salts are also commonly used as coagulants but they are difficult to handle because an insoluble ferric oxide is produced in the pH range from 3.0 to 13.0.

The process of coagulation can remove more than 80% of the suspended solids in the raw water. The surface or ground water may also contain calcium and magnesium salts which make the water hard. The hard water is then appropriately treated to remove Ca^{2+} and Mg^{2+} .

46. How water is disinfected by chlorine?

Ans: Chlorine is frequently used to disinfect water. Chlorine treatment is very effective in killing the pathogens that may cause serious water-borne diseases such as typhoid and cholera which have killed many thousands of people around the world. The most commonly used disinfecting agent is hypochlorous acid HOCl. This neutral covalent compound kills microorganisms readily by passing through their cell membranes. The hypochlorous acid is not stable thus it cannot be stored, it is therefore generated by either dissolving molecular chlorine gas or sodium and calcium hypochlorites in water. Disinfection by chlorine is inexpensive.



Generating HOCl from sodium or calcium hypochlorites avoids the transportation and use of chlorine cylinders.

47. What are the harmful effects of chlorination of water?

Ans: Harmful effects of chlorination of water are due to its reactions with dissolved ammonia and organic matters present in water. The hypochlorous acid reacts with dissolved ammonia to form chloramines NH_2Cl , NHCl_2 and especially nitrogen trichloride NCl_3 which is a powerful eye irritant.



The alkaline pH can prevent the formation of chloramines. Chlorination of water containing organic materials also forms some organic compounds which are toxic. For example, if phenol is present in water then chlorinated phenols are formed which have offensive odour and taste and are toxic. Chloroform CHCl_3 is formed when hypochlorous acid reacts with organic matter (humic acid) dissolved in water. Chloroform is suspected liver carcinogen and also has negative reproduction and development effects in humans. The risk of bladder and rectal cancer increases by drinking chlorinated water. To avoid the formation of toxic compounds with chlorine, ozone or chlorine dioxide is used for the disinfection of water.

48. What is a landfill?

Ans: The municipal solid waste is mainly disposed off by dumping it in a landfill. The landfill is a large hole in the ground or even a bare piece of land. When the landfill becomes full with waste it is covered by soil or clay.

49. What factors are taken care of during making of a landfill?

Ans: The site of land is selected on a number of factors such as topography, location of the ground, water table, nature of the solid waste, type of soil and rock and location of disposal zone in the surface water and ground water flow system.

50. What is leachate? Give its composition.

Ans: The ground water which seeps in the landfill and liquid from the waste itself all percolate through the refuse producing leachate. The leachate contains dissolved, suspended and microbial contaminants. The gases which are produced in landfills from the waste are methane, ammonia, hydrogen sulphide and nitrogen. The leachate contains volatile organic acids such as acetic acid and various fatty acids, bacteria, heavy metals and salts of common inorganic ions such as Ca^{2+} . The micropollutants present in municipal solid waste include common volatile organic compounds such as toluene and dichloromethane.

51. What is incineration?

Ans: Incineration is a waste treatment process in which solid waste is burned at high temperatures ranging from 900 to 1000 °C.

52. What do you know about incineration?

Ans: Incineration is a waste treatment process in which solid waste is burned at high temperatures ranging from 900 to 1000 °C. The burning of the solid waste in the incinerator consumes all combustible materials leaving behind the non-combustible materials and the ash residues. The ash residues of the incinerator are disposed off on the land or landfills. The incineration may reduce the volume of the waste by two third. The

combustible components of garbage such as paper, plastics and wood provide fuel for the fire. In incineration the heat of combustion may be used in producing steam which runs the turbines to produce electricity.

53. What is meant by recycling of waste? Give its importance.

Ans: In recycling some of the used or waste materials are not discarded after their initial use but are processed so that they can be used again. The purpose of recycling is to conserve sources such as raw material and energy. The volume of the waste is also much reduced by recycling of the materials. The most common domestic materials that are recycled are paper, plastic, glass and aluminium.

54. Name the steps involved in recycling of plastics.

Ans: The steps involved in recycling of plastics are:-

- i. Reprocessing
- ii. Depolymerization
- iii. Transformation



Prayer Before an Examination

Dear Lord, as I take this exam, I thank you that my value

is not based on my performance, but on your great love for me.

Come into my heart so that we can walk through this time together.

Help me, not only with this test, but the many tests of life that are sure to come my way.

As I take this exam, bring back to my mind everything I studied

and be gracious with what I have overlooked.

Help me to remain focused and calm, confident in the facts and in my ability,

and firm in the knowledge that no matter what happens today you are there with me.

- A Salesian Prayer

GOOD

LUCK

DEAR

STUDENTS

