

## HYDROCARBONS

**Q.1.** Write the general formula for alkanes, alkenes and alkynes.

**Ans.** The general formula for alkanes is  $C_nH_{2n+2}$ , where  $n$  stands for number of carbon atoms and  $2n+2$  for number of hydrogen atoms in the molecule.

General formula for alkenes is  $C_nH_{2n}$

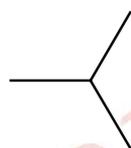
General formula of alkynes is  $C_nH_{2n-2}$ .

**Q.2.** Write structures of different chain isomers of alkanes corresponding to the molecular formula  $C_4H_{10}$  and  $C_5H_{12}$ . Also write their IUPAC names.

**Isomers of  $C_4H_{10}$**

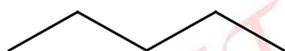


butane

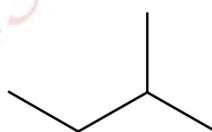


2-Methylpropane

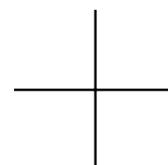
**Isomers of  $C_5H_{12}$**



pentane

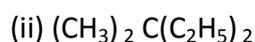


2-methylbutane



2,2-dimethylpropane

**Q.3.** Write IUPAC names of the following compounds :



(iii) tetra - *tert*-butylmethane

**Ans.**(i) 2,2,4,4-tetramethylpentane

(ii) 3, 3-Dimethylpentane

(iii) 3,3-Di-*tert*-butyl -2, 2, 4, 4 - tetramethylpentane

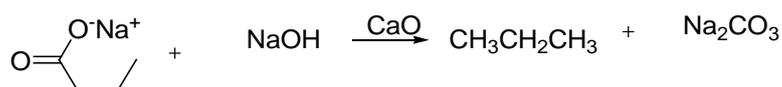
**Q.4.** Write structural formulas of the following compounds:

(i) 3-Methylhexane

(ii) 3-ethyl-2, 2-dimethylpentane

**Q.5.** Sodium salt of which acid will be needed for the preparation of propane ? Write chemical equation for the reaction.

**Ans.** Butanoic acid



**Q.6.** Define conformers/rotamers.

**Ans.** The spatial arrangements of atoms which can be converted into one another by rotation around a C-C single bond are called conformations or conformers or rotamers

**Q.7.** Write IUPAC names of the following compounds:

(i)  $\text{CH}_3 - \text{CH} = \text{CH}_2$

(ii)  $\text{CH}_3 - \text{CH}_2 - \text{CH} = \text{CH}_2$

(iii)  $\text{CH}_3 - \text{CH} = \text{CH} - \text{CH}_3$

Ans:

(i) Propene

(ii) But-1-ene

(iii) But-2-ene

**Q.8.** Out of pentane, 2-methylbutane and 2,2-dimethylpropane which has the highest boiling point and why?

**Ans.** Pentane having a continuous chain of five carbon atoms has the highest boiling point (309.1K) whereas 2,2 - dimethylpropane boils at 282.5K. With increase in number of branched chains, the molecule attains the shape of a sphere. This results in smaller area of contact and therefore weak intermolecular forces between spherical molecules, which are overcome at relatively lower temperatures.

**Q.9.** Calculate number of sigma ( $\sigma$ ) and pi ( $\pi$ ) bonds in the following

(i)  $\text{CH}_2 = \text{C} (\text{CH}_2\text{CH}_2\text{CH}_3)_2$

(ii)  $\text{CH}_2 = \text{CH} - \text{CH} - \text{CH}_3$

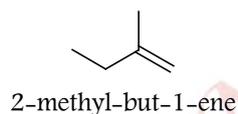
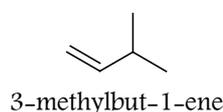
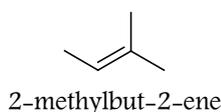
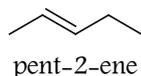
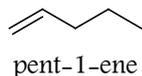


(iii)  $\text{CH}_3 - \text{CH} = \text{CH} - \text{CH}_3$

- (i) Sigma bonds=23, pi bonds=1  
(ii) Sigma bonds=14, pi bonds=1  
(iii) Sigma bonds=11, pi bonds=1

**Q.10.** Write structures and IUPAC names of different structural isomers of alkenes corresponding to  $C_5H_{10}$ .

**Ans.**



**Q.11.** Discuss about structural isomerism and stereoisomerism.

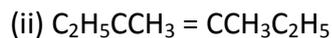
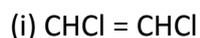
**Ans. Structural Isomerism:** Compounds having the same molecular formula but different structure i.e. different arrangement of atoms within the molecule are called structural isomers and the phenomenon is called as structural isomerism.

**Types:**

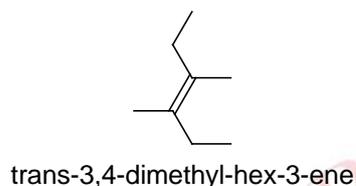
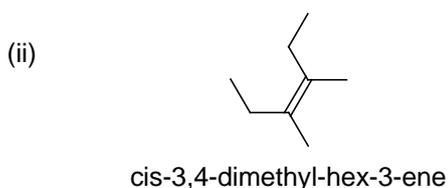
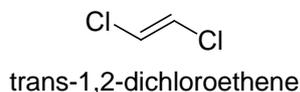
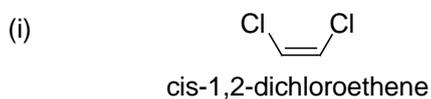
- Chain isomerism
- Position isomerism
- Functional isomerism
- Metamerism
- Tautomerism

❖ **Stereoisomerism:** Isomers which have the same structural formula but have different relative arrangement of atoms or groups in space are called stereoisomers and the phenomenon is called as stereoisomerism.

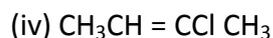
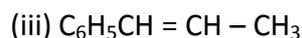
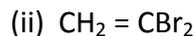
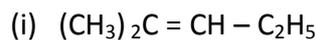
**Q.12.** Draw cis and trans isomers of the following compounds. Also write their IUPAC names  
:



**Ans.**



**Q.13.** Which of the following compounds will show *cis-trans* isomerism?



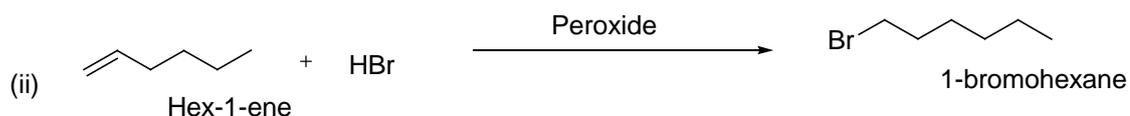
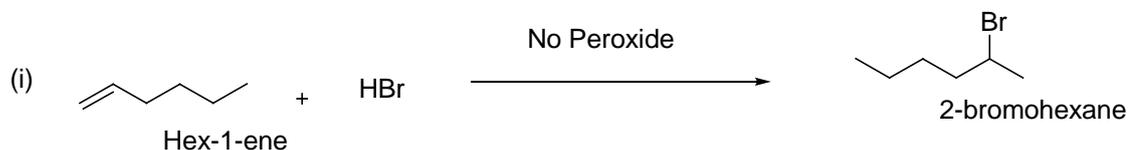
**Ans.** (iii) and (iv). In structures (i) and (ii), two identical groups are attached to one of the doubly bonded carbon atom.

**Q.14.** Write IUPAC names of the products obtained by addition reactions of HBr to hex-1-ene

(i) in the absence of peroxide and

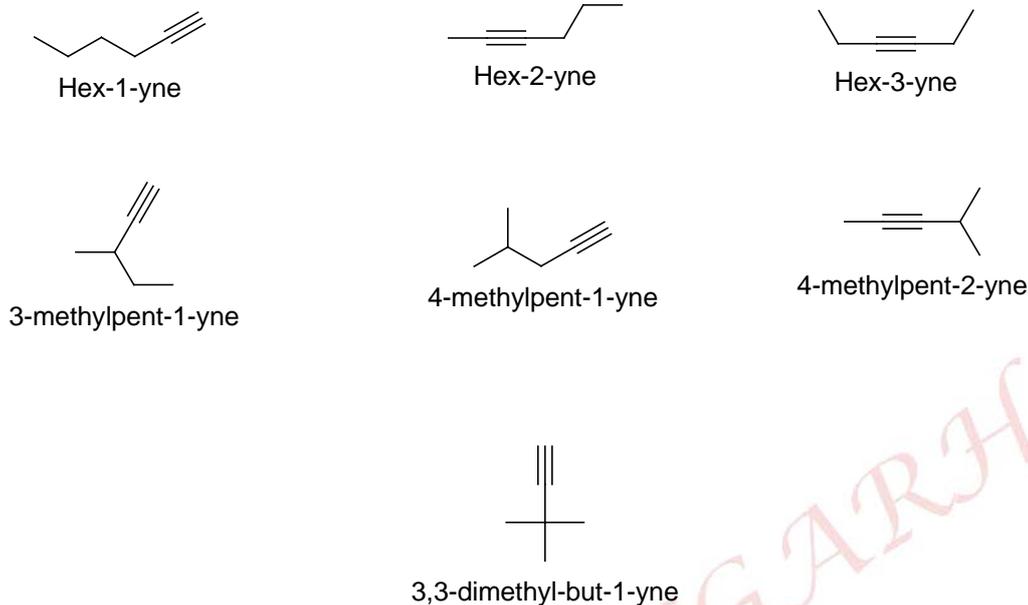
(ii) in the presence of peroxide.

**Ans.**

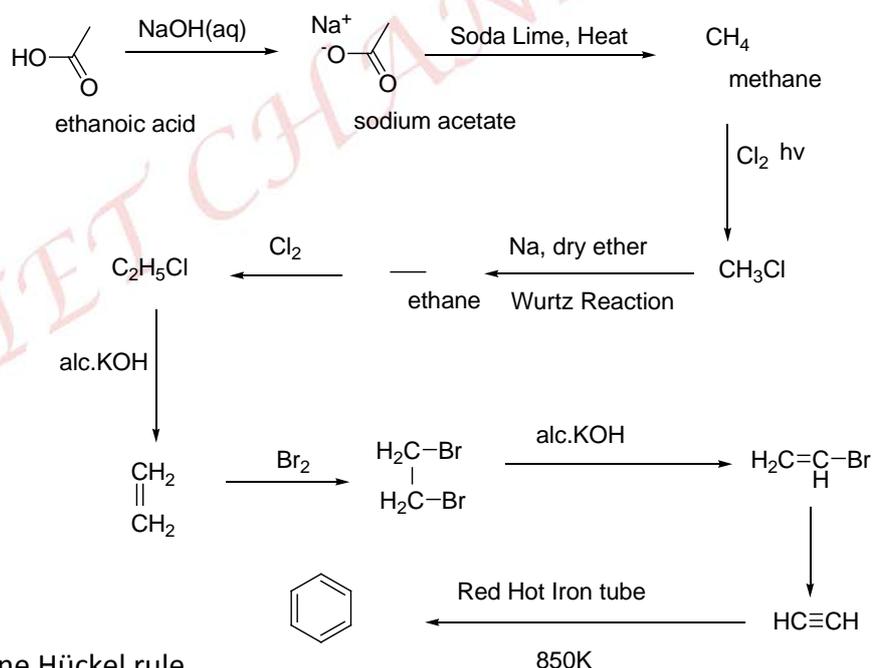


**Q.15.** Write structures of different isomers corresponding to the 5th member of alkyne series. Also write IUPAC names of all the isomers.

**Ans.** 5<sup>th</sup> member of alkyne has the molecular formula C<sub>6</sub>H<sub>10</sub>. The possible isomers are:



**Q.16.** Write down the conversion of ethanoic acid into benzene?



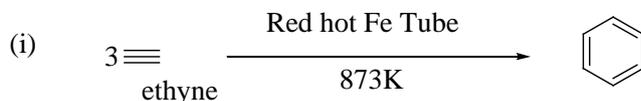
**Q.17.** Define Hückel rule.

**Ans.** Huckel Rule gives information about the aromaticity. According to this rule, the necessary and sufficient conditions for a molecule to be aromatic are:

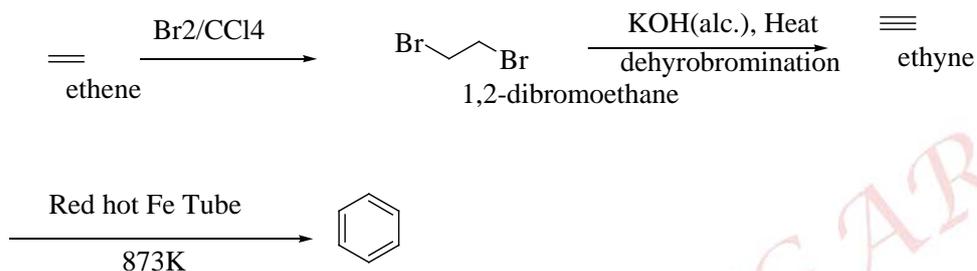
- ❖ Planarity
- ❖ Complete delocalisation of the pi electrons in the ring.
- ❖ Presence of (4n+2) pi electrons in the ring where n is an integer (n= 0,1,2...)

**Q.18.** How would you convert the following into benzene?

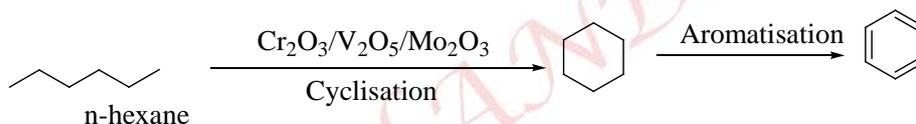
(i) Ethyne      (ii) Ethene      (iii) Hexane



(ii) Ethene is first converted to ethyne and then to benzene :

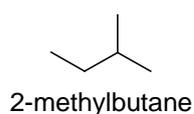


(iii) when vapours of hexane are passed over heated catalyst consisting of  $\text{Cr}_2\text{O}_3$ ,  $\text{Mo}_2\text{O}_3$  and  $\text{V}_2\text{O}_5$  at 773K under 10-20 atm pressure, cyclisation and aromatisation occurs simultaneously to afford benzene.

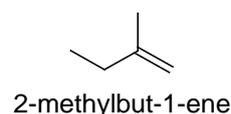
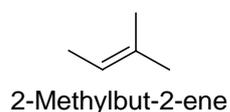
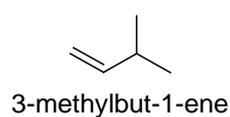


**Q.19.** Write structures of all the alkenes which on hydrogenation give 2-methylbutane?

**Ans.** The basic skeleton of 2-methylbutane is :



On hydrogenation of 2-methylbutane, the structures of various alkenes are:



**Q.20.** Arrange the following set of compounds in order of their decreasing relative reactivity with an electrophile,  $\text{E}^+$

(a) Chlorobenzene, 2,4-dinitrochlorobenzene, *p*-nitrochlorobenzene

(b) Toluene, *p*- $\text{H}_3\text{C}-\text{C}_6\text{H}_4-\text{NO}_2$ , *p*- $\text{O}_2\text{N}-\text{C}_6\text{H}_4-\text{NO}_2$ .

**Ans.** Chlorobenzene > *p*-nitrochlorobenzene > 2,4-dinitrochlorobenzene

Toluene > *p*-H<sub>3</sub>C - C<sub>6</sub>H<sub>4</sub> - NO<sub>2</sub> > *p*-O<sub>2</sub>N - C<sub>6</sub>H<sub>4</sub> - NO<sub>2</sub>

**Q.21.** Out of benzene, *m*-dinitrobenzene and toluene which will undergo nitration most easily and why?

**Ans.** -CH<sub>3</sub> group is electron donating while -NO<sub>2</sub> group is electron withdrawing. Therefore, maximum electron density will be in toluene, followed by benzene and at least in *m*-dinitrobenzene. Therefore, the ease of nitration decreases in the order:

Toluene > benzene > *m*-dinitrobenzene

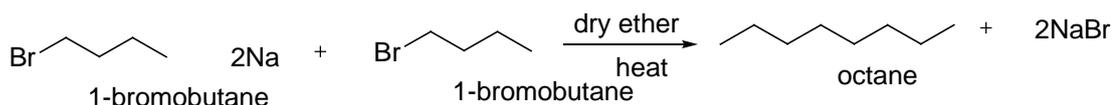
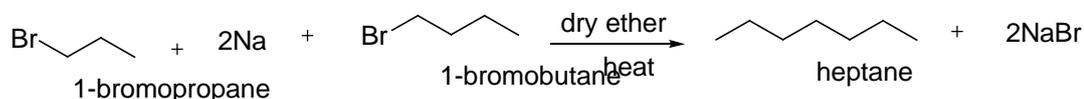
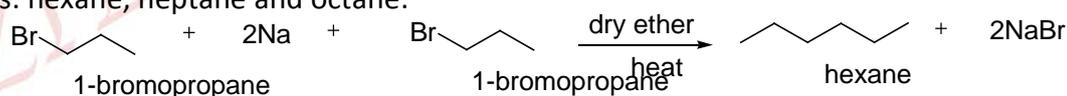
**Q.22.** Suggest the name of a Lewis acid other than anhydrous aluminium chloride which can be used during ethylation of benzene.

**Ans.** Anhydrous FeCl<sub>3</sub>, SnCl<sub>4</sub>, BF<sub>3</sub>.

**Q.23.** What effect does branching of an alkane chain have on its boiling point? **Ans.** As the branching increases, the surface area of an alkane approaches that of a sphere. Since a sphere has minimum surface area, therefore, van der Waal forces of attraction are minimum and hence the boiling point of the alkane decreases with branching.

**Q.24.** Why is Wurtz reaction not preferred for the preparation of alkanes containing odd number of carbon atoms? Illustrate your answer by taking one example.

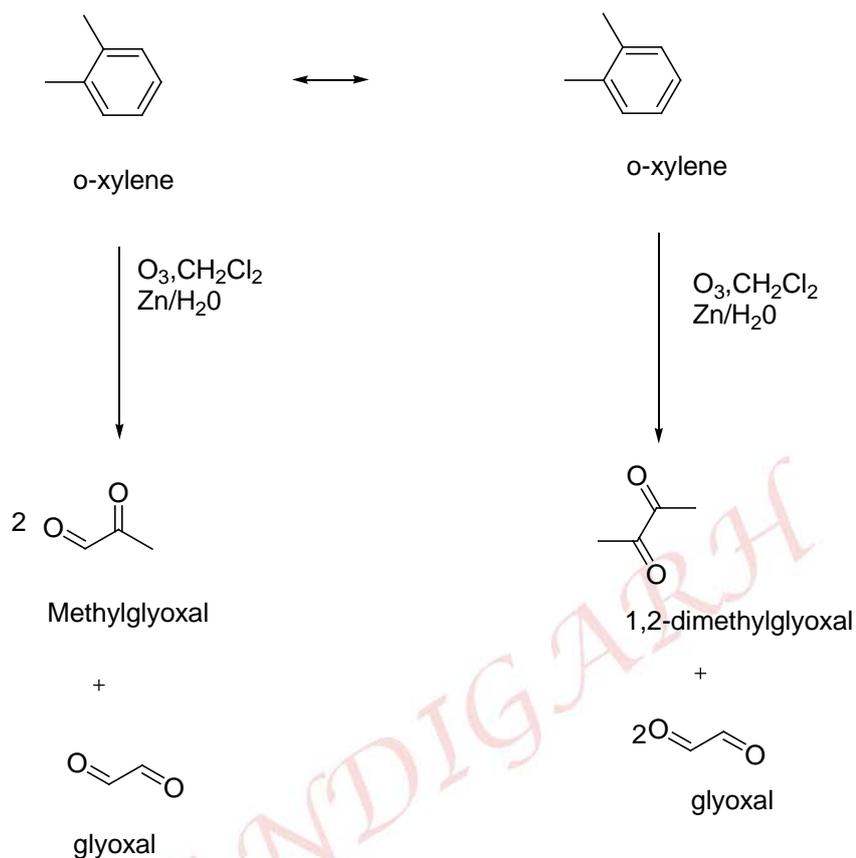
**Ans.** For the preparation of alkanes containing odd number of carbon atoms, a mixture of two alkyl halides has to be used. Since two alkyl halides can react in three different ways, therefore, a mixture of three alkanes instead of the desired alkane would be formed. For eg. Wurtz reaction between *i*-bromopropane and 1-bromobutane gives a mixture of three alkanes: hexane, heptane and octane:



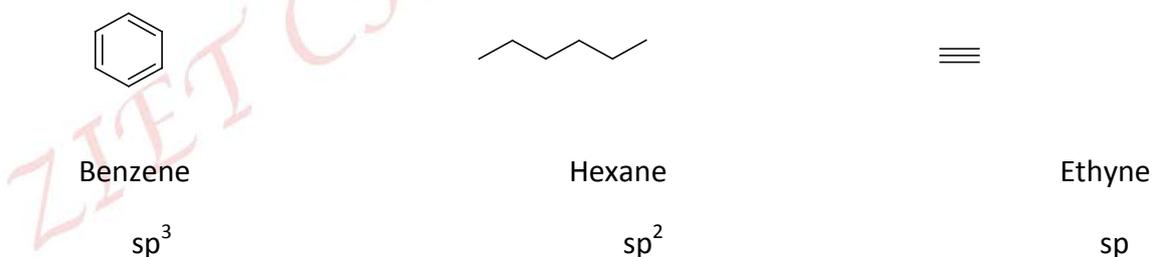
**Q.25.** Addition of HBr to propene yields 2-bromopropane, while in the presence of benzoyl peroxide, the same reaction yields 1-bromopropane. Explain and give mechanism.



**Ans.** O-xylene may be regarded as a resonance hybrid of the following two Kekule structure. Ozonolysis of each one of these gives two products as shown below:



**Q.27.** Arrange benzene, *n*-hexane and ethyne in decreasing order of acidic behaviour. Also give reason for this behaviour.



Since s-electrons are close to the nucleus, therefore as the s-character of the orbital making the C-H bond increases, the electrons of C-H bond lie closer and closer to the carbon atom. In other words, the partial positive charge on the H-atom and hence the acidic character increases as the s character of the orbital increases.

Thus the acidic character decreases in the order:

Ethyne > Benzene > Hexane

**Q.28.** Why does benzene undergo electrophilic substitution reactions easily and nucleophilic substitutions with difficulty?

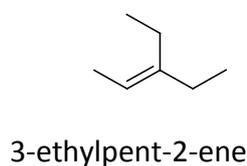
**Ans.** Due to the presence of an electron cloud containing 6 pi electrons above and below the plane of the ring, benzene is a source of electrons. Consequently, it attracts the electrophiles towards it and repels nucleophiles. As a result, benzene undergoes electrophilic substitution reactions easily and nucleophilic substitution with difficulty.

**Q.29.** An alkene 'A' on ozonolysis gives a mixture of ethanal and pentan-3-one. Write structure and IUPAC name of 'A'.

**Ans.** The products obtained from ozonolysis of A



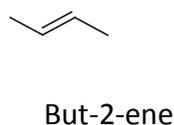
Remove the oxygen atoms and join the two ends by a double bond, the structure of the Alkene is:



**Q.30.** An alkene 'A' contains three C – C, eight C – H  $\sigma$  bonds and one C – C  $\pi$  bond. 'A' on ozonolysis gives two moles of an aldehyde of molar mass 44 u. Write IUPAC name of 'A'.

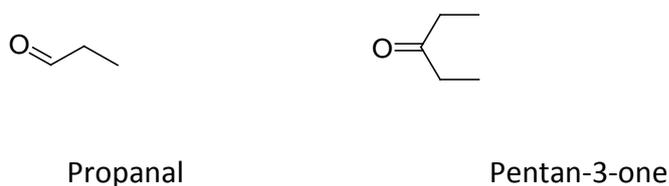
**Ans.** An aldehyde with molar mass of 44u is ethanal,  $\text{CH}_3\text{CH}=\text{O}$ .

By removing the oxygen atoms from the ethanal and join them by a double bond, the structure of alkene is

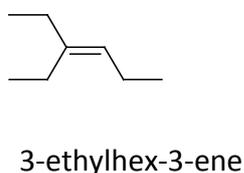


**Q.31.** Propanal and pentan-3-one are the ozonolysis products of an alkene? What is the structural formula of the alkene?

**Ans.** Product obtained from the alkene:

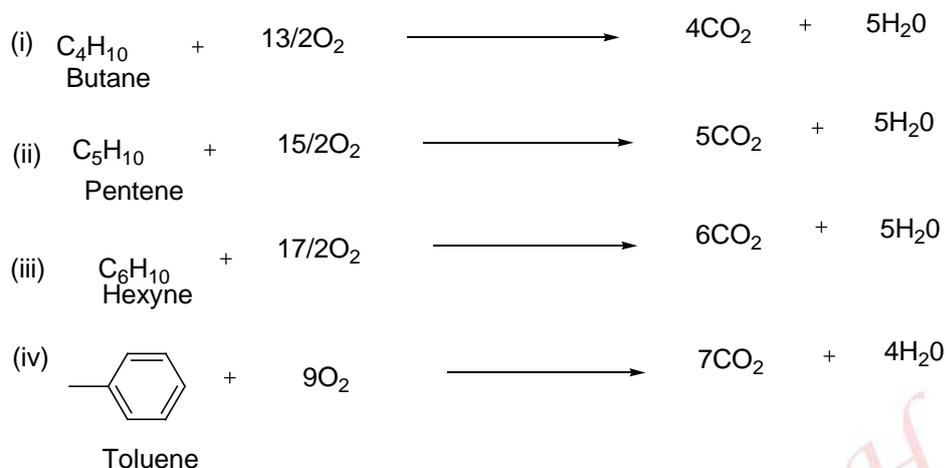


Remove oxygen atoms and joins the two fragments by a double bond, the structure of the alkene is:



**Q.32.** Write chemical equations for combustion reaction of the following hydrocarbons:

(i) Butane (ii) Pentene (iii) Hexyne (iv) Toluene



**Q.33.** Draw the cis and trans structures of hex-2-ene. Which isomer will have higher b.p. and why?

**Ans.**



The dipole moment of a molecule depends upon dipole-dipole interactions. Since cis-isomer has higher dipole moment, therefore it has higher boiling point.

**Q.34.** Explain the extra ordinary stability of benzene though it contains three double bonds?

**Ans.** Resonance or delocalisation of electrons usually leads to stability. Since in benzene all the six pi electrons of the three double bonds are completely delocalised to form one lowest molecular orbital which surrounds all the carbon atoms of the ring, therefore, it is extra-ordinarily stable.

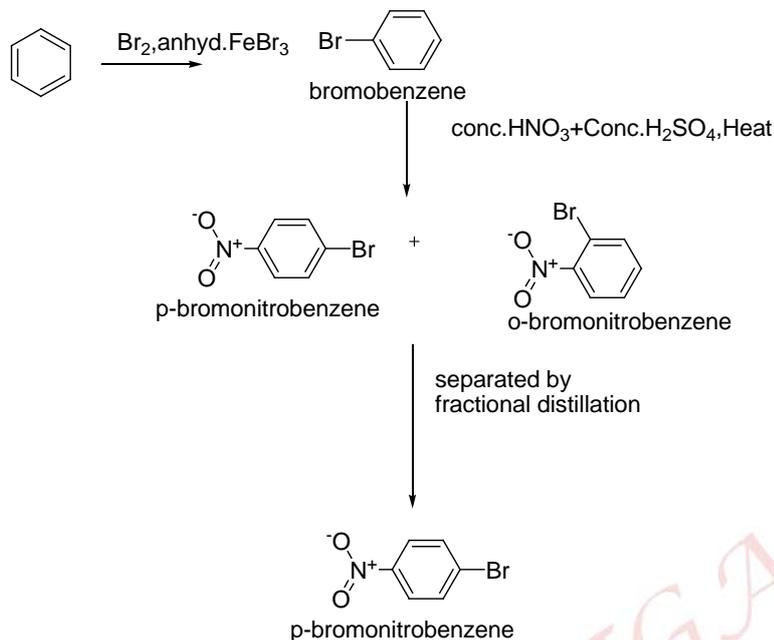
**Q.35.** What are the necessary conditions for any system to be aromatic?

**Ans.** The necessary conditions for a molecule to be aromatic are:

- (i) It should have a single cyclic cloud of delocalised pi electrons above and below the plane of the molecule.
- (ii) It should be planar. This is because complete delocalisation of pi electrons is possible only if the ring is planar to allow cyclic overlap of p-orbitals.
- (iii) It should contain Huckel number of electrons, i.e.  $(4n+2)$  pi electrons where  $n=0,1,2,3,\dots$  etc.

A molecule which does not satisfy any one or more of the above condition is said to be non aromatic

**Q.36.** How will you convert benzene into *p*-nitrobromobenzene ?



**Q.37.** In the alkane  $\text{H}_3\text{C} - \text{CH}_2 - \text{C}(\text{CH}_3)_2 - \text{CH}_2 - \text{CH}(\text{CH}_3)_2$ , identify  $1^\circ, 2^\circ, 3^\circ$  carbon atoms and give the number of H atoms bonded to each one of these.

**Ans.** 15 H attached to five  $1^\circ$  carbon.

4H attached to ten  $2^\circ$  carbons

1H attached to one  $3^\circ$  carbon.

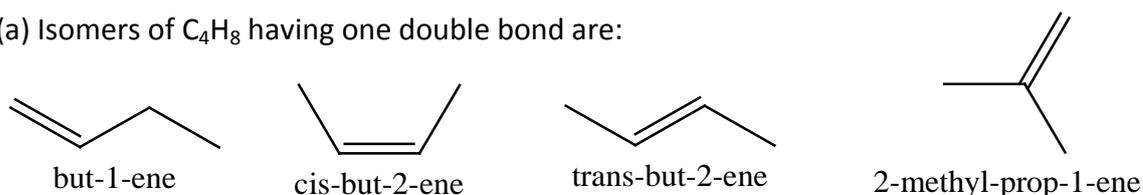
**Q.38.** Name two reagents which can be used to distinguish between ethene and ethyne ?

**Ans.** Tollen's Reagent and ammoniacal  $\text{CuCl}$  solution.

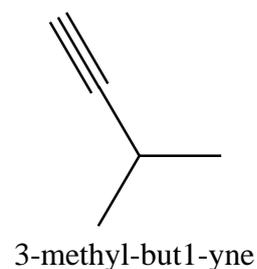
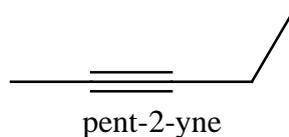
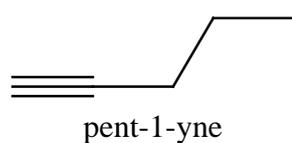
**Q.39.** For the following compounds, write structural formulas and IUPAC names for all possible isomers having the number of double or triple bond as indicated :

(a)  $\text{C}_4\text{H}_8$  (one double bond) (b)  $\text{C}_5\text{H}_8$  (one triple bond)

**Ans.** (a) Isomers of  $\text{C}_4\text{H}_8$  having one double bond are:



(b) Isomers of  $C_5H_8$  having one triple bond are:



**Q.40.** Write IUPAC names of the following compounds :

(a)  $CH_3CH=C(CH_3)_2$  (b)  $CH_2=CH-C\equiv C-CH_3$

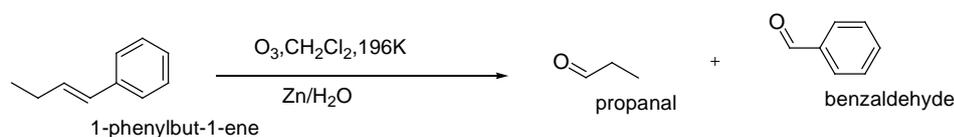
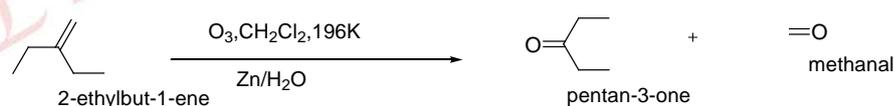
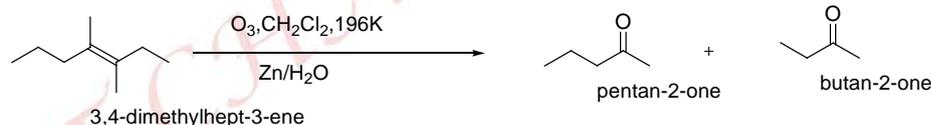
**Ans.** (a) 2-Methylbut-2-ene

(b) Pent-1-en-3-yne

**Q.41.** Write IUPAC names of the products obtained by the ozonolysis of the following compounds :

(i) Pent-2-ene (ii) 3,4-Dimethylhept-3-ene (iii) 2-Ethylbut-1-ene

(iv) 1-Phenylbut-1-ene



**Q.42.** How will you detect the presence of unsaturation in an organic compound?

**Ans.** Either by Baeyer's reagent or by  $Br_2$  in  $CCl_4$

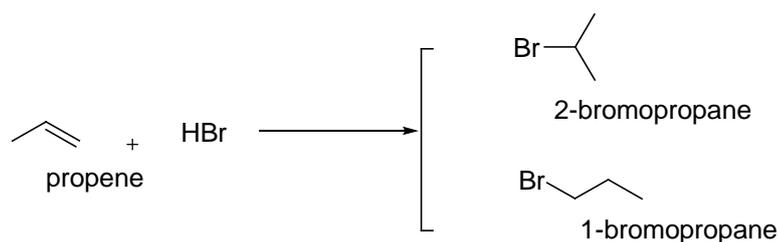
**Q.43.** How will you separate propene from propyne?

**Ans.** By passing the mixture through amm.  $AgNO_3$  solution or ammon.  $CuCl$  solution when propyne reacts while propene passes over.

**Q.44.** Explain briefly Markovnikov's rule.

**Ans.** Markovnikov's rule states that negative part of the adding molecule gets attached to that carbon atom which possesses lesser number of hydrogen atoms.

For Example:



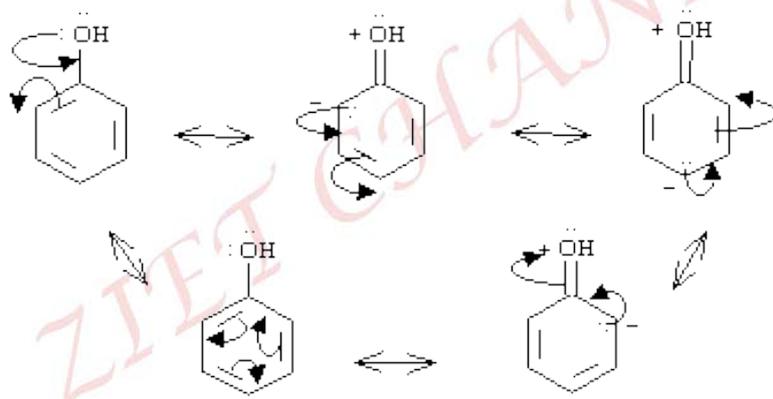
**Q.45.** What is a Lindlar's catalyst? What is it used for?

**Ans.** Pd deposited over  $\text{CaCO}_3$  or  $\text{BaSO}_4$  and partially poisoned by addition of lead acetate or sulphur or quinoline. It is used for partial reduction of alkynes to cis-alkenes.

**Q.46.** Explain the influence of different functional groups on monosubstitution of benzene.

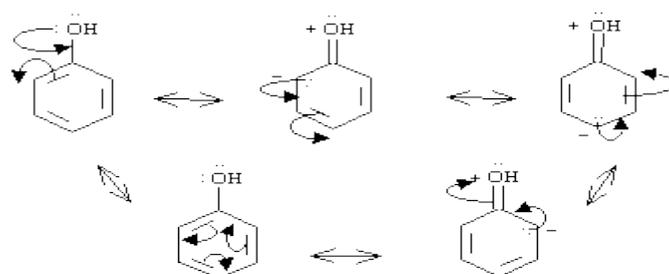
**Ans.** When monosubstituted benzene is subjected to further substitution, three possible disubstituted products are not formed in equal amounts. Two types of behaviour are observed. Either *ortho* and *para* products or *meta* product is predominantly formed.

For example: Phenol gives *ortho* and *para* substitution.



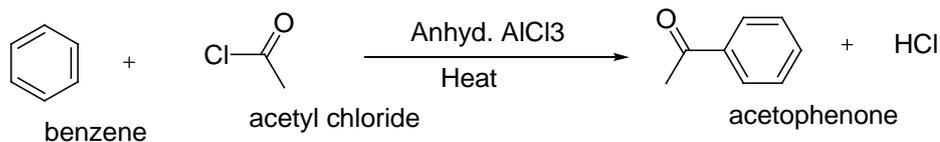
**Q.47.** Give one examples of *o* and *p* directing group.

**Ans.** The groups which direct the incoming group to *ortho* and *para* positions are called *ortho* and *para* directing groups. For example: Phenol



**Q.48.** What is Friedel-Crafts acylation reaction. Explain with example.

**Ans.** The reaction of benzene with an acyl halide or acid anhydride in the presence of Lewis acids ( $\text{AlCl}_3$ ) yields acyl benzene is known as Friedel-Crafts acylation reaction.



**Q.49.** trans-Pent-2-ene is polar while trans-but-2-ene is non polar. Explain.

**Ans.** In trans-but-2-ene, the dipole moment of two C-CH<sub>3</sub> bonds are equal and opposite and hence they exactly cancel out each other. Thus trans-but-2-ene is non polar.

In trans-pent-2-ene, the dipole moments of C-CH<sub>3</sub> and C-CH<sub>2</sub>CH<sub>3</sub> bonds are unequal. Although these two dipoles oppose each other, yet they do not exactly cancel out each other and hence trans-pent-2-ene has a small but finite dipole moment and thus is a polar.

**Q.50.** Out of benzene, m-dinitrobenzene and toluene which will undergo nitration most easily and why?

**Ans.** -CH<sub>3</sub> group is electron releasing while -NO<sub>2</sub> group is electron withdrawing. Therefore, maximum electro density will be in toluene followed by benzene and least in m-dinitrobenzene. Therefore, the ease of nitration decreases in the order:

Toluene > benzene > m-dinitrobenzene

### ORGANIC CHEMISTRY – SOME BASIC PRINCIPLES AND TECHNIQUES

**Q.1.** What is the influence of hybridization on the bond strength and bond length?

**Ans.** Hybridisation influences the bond length and bond enthalpy (strength) in organic compounds. The sp hybrid orbital contains more s character and hence it is closer to its nucleus and forms shorter and stronger bonds than the sp<sup>3</sup> hybrid orbital. The sp<sup>2</sup> hybrid orbital is intermediate in s character between sp and sp<sup>3</sup> and, hence, the length and enthalpy of the bonds it forms, are also intermediate between them.

**Q.2.** How does hybridization affect the electronegativity of carbon?

**Ans.** The greater the s character of the hybrid orbitals, the greater is the electronegativity. Thus, a carbon atom having an sp hybrid orbital with 50% s character is more electronegative than that possessing sp<sup>2</sup> or sp<sup>3</sup> hybridised orbitals. **Q.3.** How many  $\sigma$  and  $\pi$  bonds are present in each of the following molecules?

(a)  $\text{HC}\equiv\text{CCH}=\text{CHCH}_3$  (b)  $\text{CH}_2=\text{C}=\text{CHCH}_3$

Ans. (a)  $\sigma_{C-C}$  : 4;  $\sigma_{C-H}$  : 6;  $\pi_{C=C}$  : 1;  $\pi_{C\equiv C}$  : 2

(b)  $\sigma_{C-C}$  : 3;  $\sigma_{C-H}$  : 6;  $\pi_{C=C}$  : 2

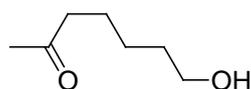
Q.4. What is the type of hybridisation of each carbon in the following compounds?

CH<sub>3</sub>Cl, (b) (CH<sub>3</sub>)<sub>2</sub>CO, (c) CH<sub>3</sub>CN, (d) HCONH<sub>2</sub>, (e) CH<sub>3</sub>CH=CHCN

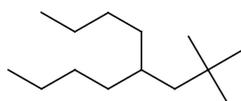
Ans. (a) sp<sup>3</sup>, (b) sp<sup>3</sup>, sp<sup>2</sup>, (c) sp<sup>3</sup>, sp, (d) sp<sup>2</sup>, (e) sp<sup>3</sup>, sp<sup>2</sup>, sp<sup>2</sup>, sp

Q.5. Derive the structure of

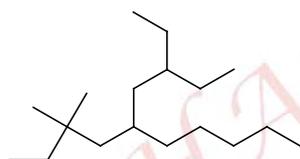
(a) 7-hydroxyheptan-2-one (b) 5-(2,2-Dimethylpropyl)nonane (c) 5-(2-Ethylbutyl)-3,3-dimethyldecane



7-hydroxyheptan-2-one



5-(2,2-Dimethylpropyl)nonane



5-(2-Ethylbutyl)-3,3-dimethyldecane

Q.6. Define electrophile and nucleophile. Give two examples also.

Ans. A reagent that brings an electron pair is called a **nucleophile** (Nu:) i.e., nucleus seeking and the reaction is then called nucleophilic.

**Examples** of nucleophiles are the negatively charged ions with lone pair of electrons such as hydroxide (HO<sup>-</sup>), cyanide (NC<sup>-</sup>) ions and carbanions (R<sub>3</sub>C<sup>-</sup>).

A reagent that takes away an electron pair is called **electrophile** (E<sup>+</sup>) i.e., electron seeking and the reaction is called electrophilic.

**Examples** of electrophiles include carbocations (CH<sub>3</sub><sup>+</sup>) and neutral molecules having functional groups like carbonyl group (>C=O) or alkyl halides (R<sub>3</sub>C-X, where X is a halogen atom).

Q.7. A liquid has three components. Which technique will you employ to separate them.

Ans. Column chromatography

**Q.8.** Explain electromeric effect, resonance effect and hyperconjugation.

❖ **Electromeric effect** is defined as the complete transfer of a shared pair of  $\pi$ -electrons to one of the atoms joined by a multiple bond on the demand of an attacking reagent. It is represented by E and the shifting of the electrons is shown by a curved arrow .

❖ **The resonance effect** is defined as 'the polarity produced in the molecule by the interaction of two  $\pi$ -bonds or between a  $\pi$ -bond and lone pair of electrons present on an adjacent atom'. The effect is transmitted through the chain.

❖ **Hyperconjugation** involves delocalisation of  $\sigma$  electrons of C—H bond of an alkyl group directly attached to an atom of unsaturated system or to an atom with an unshared p orbital. The  $\sigma$  electrons of C—H bond of the alkyl group enter into partial conjugation with the attached unsaturated system or with the unshared p orbital. Hyperconjugation is a permanent effect.

**Q.9.** Explain why  $(\text{CH}_3)_3\text{C}^+$  is more stable than  $\text{CH}_3\text{C}^+\text{H}_2$  and  $\text{C}^+\text{H}_3$  is the least stable cation.

**Ans.** Greater the number of alkyl groups attached to a positively charged carbon atom, the greater is the hyperconjugation interaction and stabilisation of the cation.

**Q.10.** Give atleast two methods of purification of organic compounds.

**Ans.** Sublimation

Crystallization

**Q.11.** Explain Thin layer chromatography (TLC) and Partition chromatography.

**Thin layer chromatography (TLC)** is type of adsorption chromatography, which involves separation of substances of a mixture over a thin layer of an adsorbent coated on glass Plate.

**Partition chromatography** is based on continuous differential partitioning of components of a mixture between stationary and mobile phases.

**Q.12.** Distinguish between qualitative and quantitative analysis.

**Ans. Qualitative analysis** means is to detect the various elements present in it.

**Quantitative Analysis** means is to determine the percentage of each element.

**Q.13.** On complete combustion, 0.246 g of an organic compound gave 0.198g of carbon dioxide and 0.1014g of water. Determine the percentage composition of carbon and hydrogen in the compound.

**Ans.** Percentage of carbon =  $12 \times 0.198 / 44 \times 0.246$

$$= 21.95\%$$

Percentage of hydrogen =  $2 \times 0.1014 / 18 \times 0.246$

$$= 4.58\%$$

**Q.14.** During estimation of nitrogen present in an organic compound by Kjeldahl's method, the ammonia evolved from 0.5g of the compound in Kjeldahl's estimation of nitrogen, neutralized 10 mL of 1 M  $\text{H}_2\text{SO}_4$ . Find out the percentage of nitrogen in the compound.

**Ans.** 1M of 10 mL  $\text{H}_2\text{SO}_4=1\text{M}$  of 20 mL  $\text{NH}_3$

1000 mL of 1M ammonia contains 14 g nitrogen

20 mL of 1M ammonia contains  $14 \times 20 / 1000$  g nitrogen

Percentage of nitrogen =  $14 \times 20 \times 100 / 1000 \times 0.5 = 56.0\%$

**Q.15.** Which of the following represents the correct IUPAC name for the compounds concerned ? (a) 2,2-Dimethylpentane or 2-Dimethylpentane (b) 2,4,7-Trimethyloctane or 2,5,7-Trimethyloctane (c) 2-Chloro-4-methylpentane or 4-Chloro-2-methylpentane (d) But-3-yn-1-ol or But-4-ol-1-yne.

**Ans.** (a) 2,2-Dimethylpentane

(b) 2,4,7-Trimethyloctane

(c) 2-Chloro-4-methylpentane

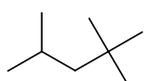
(d) But-3-yn-1-ol

**Q.16.** Give condensed and bond line structural formulas:

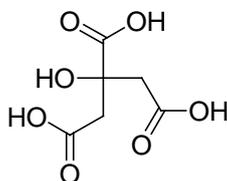
(a) 2,2,4-Trimethylpentane

(b) 2-Hydroxy-1,2,3-propanetricarboxylic acid

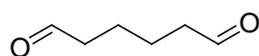
(c) Hexanedial



2,2,4-trimethylpentane



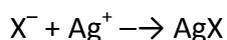
2-Hydroxy-1,2,3-propanetricarboxylic acid



Hexanedial

**Q.17.** Explain the method used for the detection of halogens.

**Ans.** The sodium fusion extract is acidified with nitric acid and then treated with silver nitrate. A white precipitate, soluble in ammonium hydroxide shows the presence of chlorine, a yellowish precipitate, sparingly soluble in ammonium hydroxide shows the presence of bromine and a yellow precipitate, insoluble in ammonium hydroxide shows the presence of iodine.



X represents a halogen – Cl, Br or I.

**Q.18.** Which of the two:  $O_2NCH_2CH_2O^-$  or  $CH_3CH_2O^-$  is expected to be more stable & why ?

**Ans.**  $O_2NCH_2CH_2O^-$  is more stable than  $CH_3CH_2O^-$  because  $NO_2$  group has  $-I$  effect and hence it tends to disperse the negative charge on the oxygen atom. In contrast,  $CH_3CH_2$  has  $+I$  effect. It, therefore, tends to intensify the negative charge and hence destabilizes it.

**Q.19.** Describe the method, which can be used to separate two compounds with different solubilities in a solvent S.

**Ans.** Two compounds with different solubilities in a solvent S can be separated by fractional crystallisation. When a hot saturated solution of these two compounds is allowed to cool, the less soluble compound crystallises out first while the more soluble remains in the solution. The crystals are separated from the mother liquor and the mother liquor is again concentrated and the hot solution is allowed to cool when the crystals of the second compound are obtained. These are again filtered and dried.

**Q.20.** What conclusion would you draw if during Lassaigne's test a blood red coloration is obtained?

**Ans.** The formation of blood red colouration during Lassaigne's Test indicates the presence of both N or S.

**Q.21.** Why is nitric acid added to sodium extract before adding silver nitrate for testing halogens?

**Ans.** Sodium extract is boiled with nitric acid to decompose NaCN and  $Na_2S$ , if present, otherwise these



Will react with  $AgNO_3$  and hence will interfere with test as shown below:



**Q.22.** Explain the reason for the fusion of an organic compound with metallic sodium for testing nitrogen, sulphur and halogens.

**Ans.** The organic compound is fused with sodium metal to convert these elements which are present in the covalent form to ionic form

**Q.23.** Name a suitable technique of separation of the components from a mixture of calcium sulphate and camphor.

**Ans.** A mixture of camphor and  $CaSO_4$  can be separated as:

(a) Camphor is sublimable but  $CaSO_4$  is not, therefore, sublimation of the mixture gives camphor on the sides of the funnel while  $CaSO_4$  is left in the china dish.

(b) Camphor is soluble in organic solvents like  $\text{CHCl}_3$ ,  $\text{CCl}_4$  etc. while  $\text{CaSO}_4$  is not. Therefore, when the mixture is shaken with the solvent, camphor goes into the solution while  $\text{CaSO}_4$  remains as residue. It is filtered and evaporation of the solvent gives camphor.

**Q.24.** An organic compound contains 69% carbon and 4.8% hydrogen, the remainder being oxygen. Calculate the masses of carbon dioxide and water produced when 0.20 g of this substance is subjected to complete combustion.

**Ans.** % of carbon =  $12/44 \times \text{Mass of CO}_2 \text{ formed} / \text{Mass of substance taken} \times 100$

$$69 = 12/44 \times \text{Mass of CO}_2 \text{ formed} / 0.2 \times 100$$

$$\text{Mass of CO}_2 \text{ formed} = 0.506 \text{ g}$$

% of hydrogen =  $2/18 \times \text{Mass of H}_2\text{O formed} / \text{Mass of substance taken} \times 100$

$$4.8 = 2/18 \times \text{Mass of H}_2\text{O formed} / 0.2 \times 100$$

$$= 0.0864 \text{ g}$$

**Q.25.** In the organic compound  $\text{CH}_2 = \text{CH} - \text{CH}_2 - \text{CH}_2 - \text{C} \equiv \text{CH}$ , the pair of hybridised orbitals involved in the formation of:  $\text{C}_2 - \text{C}_3$  bond is: (a)  $\text{sp} - \text{sp}^2$  (b)  $\text{sp} - \text{sp}^3$  (c)  $\text{sp}^2 - \text{sp}^3$  (d)  $\text{sp}^3 - \text{sp}^3$

**Ans.** When both double bond and triple bonds are present, double bond is given preference while numbering the chain.

Thus option © is correct.

**Q.26.** A sample of 0.50 g of an organic compound was treated according to Kjeldahl's method. The ammonia evolved was absorbed in 50 ml of 0.5 M  $\text{H}_2\text{SO}_4$ . The residual acid required 60 mL of 0.5 M solution of NaOH for neutralisation. Find the percentage composition of nitrogen in the compound.

**Ans.** % of nitrogen =  $1.4 \times \text{Molarity of the acid} \times \text{Basicity of the acid} \times \text{Volume of the acid used} / \text{Mass of the substance taken}$

$$= 1.4 \times 1 \times 2 \times 10 / 0.5$$

$$= 56.0$$

**Q.27.** Why is a solution of potassium hydroxide used to absorb carbon dioxide evolved during the estimation of carbon present in an organic compound?

**Ans.**  $\text{CO}_2$  is acidic in nature, therefore, it reacts with the strong base KOH to form  $\text{K}_2\text{CO}_3$ .



The increase in the mass of U-tube containing KOH then gives the mass of  $\text{CO}_2$  produced and from its mass, the percentage of carbon in the organic compound and can be estimated by using the equation:

$$\% \text{ of Carbon} = 12/44 \times \text{Mass of CO}_2 \text{ formed} / \text{Mass of substance formed} \times 100$$

**Q.28.** Why is it necessary to use acetic acid and not sulphuric acid for acidification of sodium extract for testing sulphur by lead acetate test?

**Ans.** For testing sulphur, the sodium extract is acidified with acetic acid because lead acetate is soluble and does not interfere with the test. If  $\text{H}_2\text{SO}_4$  were used, lead acetate itself will react with  $\text{H}_2\text{SO}_4$  to form white ppt. of lead sulphate which will interfere with the test.



**Q.29.** A reaction is carried out using aniline as a reactant as well as solvent. How will you remove unreacted aniline?

**Ans.** Steam of distillation

**Q.30.** An organic compound decomposes below its boiling point. How will you purify it?

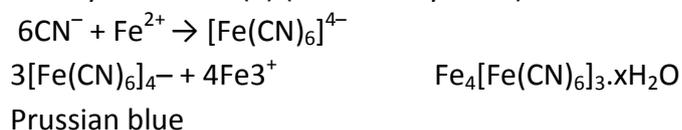
**Ans.** Distillation under reduced pressure, i.e. vacuum distillation

**Q.31.** Write the complete structural formulas for the following compounds ethane (C<sub>2</sub>H<sub>6</sub>), ethene (C<sub>2</sub>H<sub>4</sub>), ethyne (C<sub>2</sub>H<sub>2</sub>) and methanol (CH<sub>3</sub>OH)



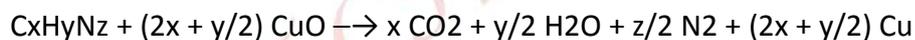
**Q.32.** Give a method for the qualitative detection of nitrogen.

**Ans.** The sodium fusion extract is boiled with iron(II) sulphate and then acidified with concentrated sulphuric acid. The formation of Prussian blue colour confirms the presence of nitrogen. Sodium cyanide first reacts with iron(II) sulphate and forms sodium hexacyanoferrate(II). On heating with concentrated sulphuric acid some iron(II) ions are oxidised to iron(III) ions which react with sodium hexacyanoferrate(II) to produce iron(III) hexacyanoferrate(II) (ferriferrocyanide) which is Prussian blue in colour.



**Q.33.** Differentiate between the principle of estimation of nitrogen in an organic compound by (i) Dumas method and (ii) Kjeldahl's method.

**Ans. Dumas method:** The nitrogen containing organic compound, when heated with copper oxide in an atmosphere of carbon dioxide, yields free nitrogen in addition to carbon dioxide and water.



Traces of nitrogen oxides formed, if any, are reduced to nitrogen by passing the gaseous mixture over a heated copper gauze. The mixture of gases so produced is collected over an aqueous solution of potassium hydroxide which absorbs carbon dioxide. Nitrogen is collected in the upper part of the graduated tube.

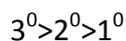
**Kjeldahl Method:** The compound containing nitrogen is heated with concentrated sulphuric acid. Nitrogen in the compound gets converted to ammonium sulphate. The resulting acid mixture is then heated with excess of sodium hydroxide. The liberated ammonia gas is absorbed in an excess of standard solution of sulphuric acid. The amount of ammonia produced is determined by estimating the amount of sulphuric acid consumed in the reaction. It is done by estimating unreacted sulphuric acid left after the absorption of ammonia by titrating it with standard alkali solution. The difference between the initial amount of acid taken and that left after the reaction gives the amount of acid reacted with ammonia.

**Q.34.** What type of reaction intermediates are formed by homolytic cleavage?

**Ans.** Free Radicals

**Q.35.** What is the order of stability of free radicals?

**Ans.** The stability of free radicals is as:

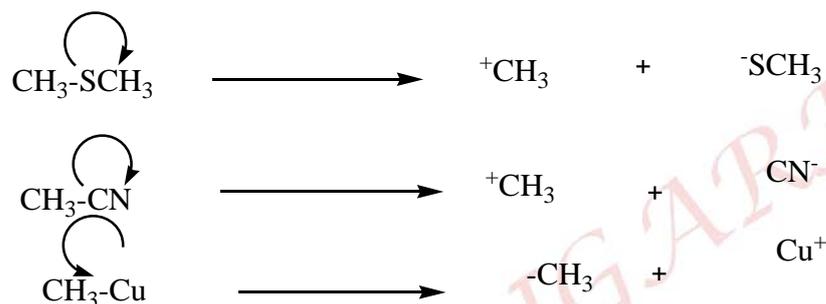


It is explained on the basis of hyperconjugation.

Greater the number of alkyl groups attached to the carbon atom carrying the odd electron, greater is the delocalisation of the odd electron and hence more stable is the free radical.

**Q.36.** Using curved-arrow notation, show the formation of reactive intermediates when the following covalent bonds undergo heterolytic cleavage.

(a)  $\text{CH}_3\text{-SCH}_3$ , (b)  $\text{CH}_3\text{-CN}$ , (c)  $\text{CH}_3\text{-Cu}$



**Q.37.** In Dumas' method for estimation of nitrogen, 0.3g of an organic compound gave 50mL of nitrogen collected at 300K temperature and 715mm pressure. Calculate the percentage composition of nitrogen in the compound. (Aqueous tension at 300K=15 mm).

**Ans.** Volume of nitrogen collected at 300K and 715mm pressure is 50 mL

Actual pressure = 715-15 =700 mm

Volume of nitrogen at STP =  $273 \times 700 \times 50 / 300 \times 760$   
= 41.9 mL

22,400 mL of  $\text{N}_2$  at STP weighs = 28 g

41.9 mL of nitrogen weighs =  $28 \times 41.9 / 22400$ g

Percentage of nitrogen =  $28 \times 41.9 \times 100 / 22400 \times 0.3$   
=17.46%

**Q.38.** In Carius method of estimation of halogen, 0.15 g of an organic compound gave 0.12 g of AgBr. Find out the percentage of bromine in the compound.

**Ans.** Mass of the substance taken=0.15g

Mass of AgBr= 0.12g

1 mole of AgBr=1 g atom of Br

188g of AgBr = 80 g of Br

0.12 g of AgBr contain bromine=  $80/188 \times 0.12$

But this much amount of bromine is present in 0.15g of the organic compound

Therefore, percentage of bromine=  $80 \times 0.12 \times 100 / 188 \times 0.15$   
= 34.04

**Q.39.** In sulphur estimation, 0.157 g of an organic compound gave 0.4813 g of barium sulphate. What is the percentage of sulphur in the compound?

**Ans.** Here, mass of the substance taken = 0.157g

Mass of BaSO<sub>4</sub> ppt. formed = 0.4813g

1 mole of BaSO<sub>4</sub> is equivalent to 1 g atom of S

(137+32+64) = 233g of BaSO<sub>4</sub> = 32g of S

0.4813g of BaSO<sub>4</sub> will contain sulphur =  $32/233 \times 0.4813$

% of sulphur in the compound =  $32/233 \times 0.4813 \times 100/0.157$   
= 42.10

**Q.40.** Explain, why an organic liquid vaporises at a temperature below its boiling point in its steam distillation?

**Ans.** In steam distillation, the mixture consisting of the organic liquid and water boils at a temperature when the sum of the vapour pressure of the liquid (p<sub>1</sub>) and that of water (p<sub>2</sub>) becomes equal to the atmospheric pressure (p) i.e.,  $p = p_1 + p_2$ .

Since the vapor pressure of the water around the boiling point of the mixture is quite high and that of the liquid is quite low (10-15mm), therefore, the organic liquid distils at a pressure much lower than the atmospheric pressure that means, the organic liquid vaporises at a temperature much lower than its normal boiling point.

**Q.41.** Will CCl<sub>4</sub> give white precipitate of AgCl on heating it with silver nitrate? Give reason for your answer.

**Ans.** When CCl<sub>4</sub> is heated with AgNO<sub>3</sub> solution, white ppt. of AgCl will not be formed. The reason being that CCl<sub>4</sub> is a covalent compound, therefore, it does not ionize to give Cl<sup>-</sup> ions needed for the formation of ppt. of AgCl.

**Q.42.** Write the state of hybridisation of carbon in the following compounds and shapes of each of the molecules.

(a) H<sub>2</sub>C=O, (b) CH<sub>3</sub>F, (c) HC≡N.

**Ans.** (a) In H<sub>2</sub>C=O, C is sp<sup>2</sup> hybridised, hence formaldehyde is trigonal planar.

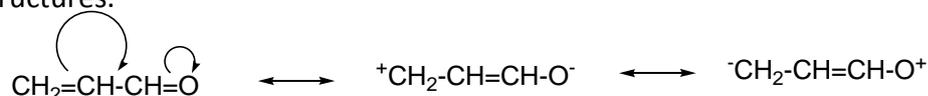
(b) In CH<sub>3</sub>F, C is sp<sup>3</sup> hybridised, hence methyl formaldehyde is tetrahedral.

(c) In HC≡N, C is sp hybridised, hence HCN is a linear molecule.

**Q.43.** In which C-C bond of CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>Br, the inductive effect is expected to be the least?

**Ans.** The magnitude of inductive effect decreases with distance and hence the effect is least in C<sub>2</sub>-C<sub>3</sub> bond.

**Q.44.** Write resonance structures of CH<sub>2</sub>=CH-CHO. Indicate relative stability of the contributing structures.



Structure I is most stable since each C and O atom has an octet of electrons and none of these atoms carries any charge. Structures II and III both involve separation of charge and

hence both are less stable than structure I. However, Structures II is more stable than structure(III) since it carries a negative charge on the more electronegative O atom and positive charge on the less electronegative C atom while in structure (III), the more electronegative O atom carries the positive charge while the less electronegative C atom carries the negative charge.

Thus, the decreasing order of stability:



**Q.45.** What type of hybridization is involved in i) planar and ii) linear molecules?

(i)  $sp^2$

(ii)  $sp$

**Q.46.** Name two compounds which do not contain halogen but give positive Beilstein test.

**Ans.** Urea and thiourea give positive Beilstein test due to the formation of volatile cupric cyanide.

**Q.47.** Suggest a suitable technique of separating naphthalene from kerosene oil present in a mixture.

**Ans.** Simple distillation

**Q.48.** How will you separate a mixture of two organic compounds which have different solubilities in the same solvent.

**Ans.** By Fractional Crystallisation.

**Q.49.** Write the metamer of diethyl ether. What is its IUPAC name?

**Ans.** 1-methoxypropane,  $CH_3OCH_2CH_2CH_3$  or

2-methoxypropane,  $CH_3OCH(CH_3)_2$

**Q.50.** How will you separate a mixture of o-nitrophenol and p-nitrophenol?

**Ans.** Steam distillation.

O-nitrophenol being volatile distils over along with water while p-nitrophenol being non-volatile remains in the flask.

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