NCERT Solutions for 11th Class Chemistry: Chapter 12-Organic Chemistry Some Basic Principles and Techniques

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NCERT Solutions for 11th Class Chemistry: Chapter 12-Organic Chemistry Some Basic Principles and Techniques

Class 11: Chemistry Chapter 12 solutions. Complete Class 11 Chemistry Chapter 12 Notes.

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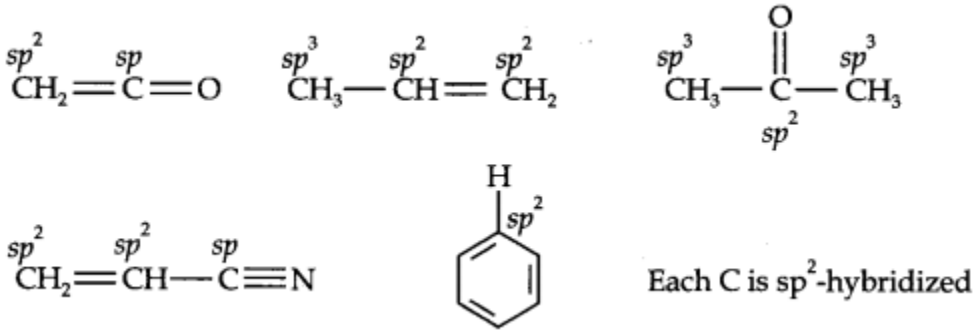
Question 1. What are hybridisation states of each carbon atom in the following compounds? $CH_2=C=O$, $CH_3CH=CH_2$, $(CH_3)_2CO$, $CH_2=CHCN$, C_6H_6.

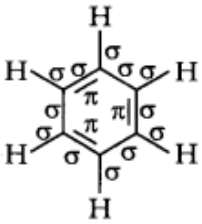
Answer:

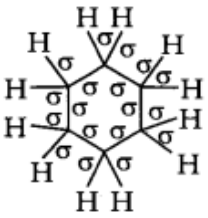


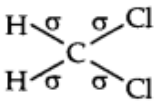
Question 2. Indicate the a- and n-bonds in the following molecules:

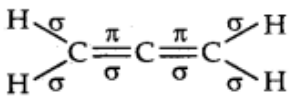
C_6H_6 , C_6H_{12}, CH_2Cl_2, $CH=C=CH_2$, CH_3NO_2, $HCONHCH_3$

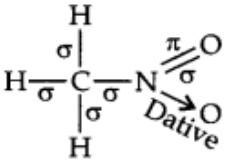
Answer:

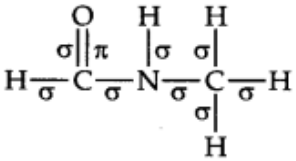






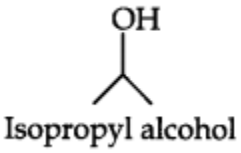




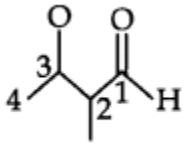


Question 3. Write bond-line formulas for: Isopropyl alcohol, 2,3-Dimethylbutanal, Heptan-4-one.

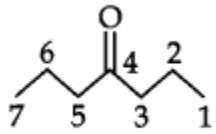
Answer:



Isopropyl alcohol

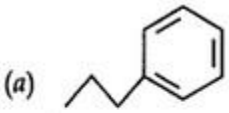


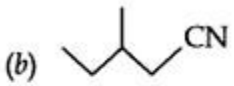
2,3-Dimethylbutanal

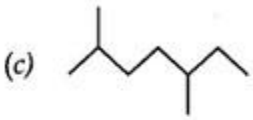


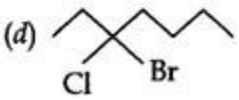
Heptan-4-one

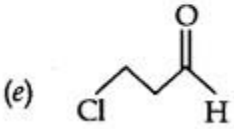
Question 4. Give the TUPAC names of the following compounds:











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Answer: (a) Propylbenzene (b) 3-Methylpentanenitrite (c) 2, 5-Dimethylheptane

(d) 3-Bromo- 3-chloroheptane (e) 3-Chloropropanal (f) 2, 2-Dichloroethanol

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Question 5.Which of the following represents the correct TUPAC 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- l-ol or But-4-ol-yne.

Answer: (a) 2, 2-Demethylpentane (b)2, 4, 7-Trimethyloctane. For two alkyl groups on the same carbon its locant is repeated twice, 2, 4, 7-locant set is lower than 2, 5, 7.

(c) 2- Chloro-4-methylpentane. Alphabetical order of substituents, (d) But-3-yn-l-ol. Lower locant for the principal functional group, i.e., alcohol.

Question 6. Draw formulas for the first five members of each homologous series beginning with the following compounds,

(a) H—COOH (b) CH_3COCH_3 (c) $H—CH=CH_2$

Answer: (a) CH_3—COOH

CH_3CH_2—COOH $CH_3CH_2CH_2$—COOH

$CH_3CH_2CH_2CH_2$—COOH

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(b) CH_3COCH_3

$CH_3COCH_2CH_3$

$CH_3COCH_2CH_2CH_3$

$CH_3COCH_2CH_2CH_2CH_3$

$CH_3CO(CH_3)_4CH_3$

(c) $H—CH=CH_2$

$CH_3CH=CH_2$

$CH_3CH_2CH=CH_2$

$CH_3CH_2CH_2CH=CH_2$

$CH_3CH_2CH_2CH_2CH=CH_2$

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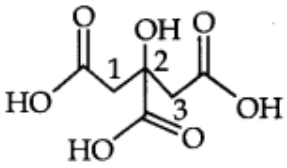
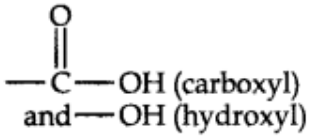
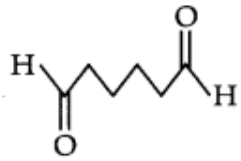
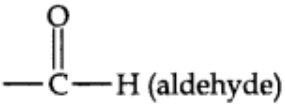
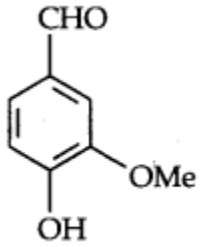
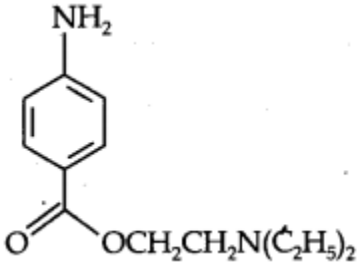
Question 7. Give condensed and bond line structural formulas and identify the functional group(s) present, if any, for: (a) 2, 2, 4-Trimethylpentane (b) 2-Hydroxy-l, 2, 3-propanetricarboxylic acid (c) Hexanedial.

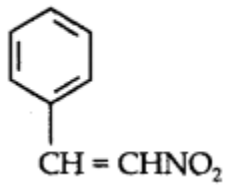
Answer:

Condensed formula	Bond line formula	Functional group/s
(a) $(CH_3)_3CCH_2CH(CH_3)_2$		–
(b) $HOOCCH_2C(OH)(COOH)CH_2COOH$		
(c) $OHC(CH_2)_4CHO$		

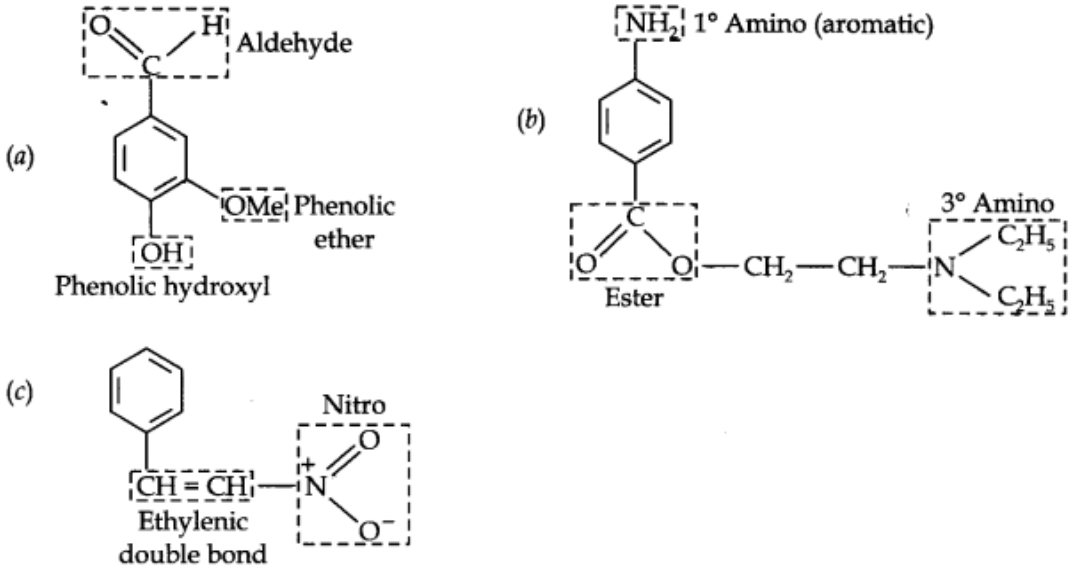
Question 8. Identify the functional groups in the following compounds:

(a) 

(b) 

(c) 

Answer:



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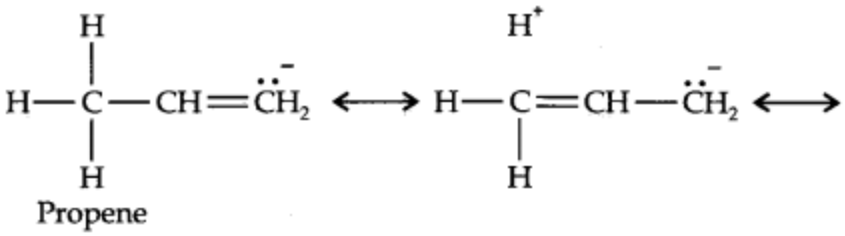
Question 9. Which of the two: $O_2NCH_2CH_2O^-$ or $CH_3CH_2O^-$ is expected to be more stable and why?

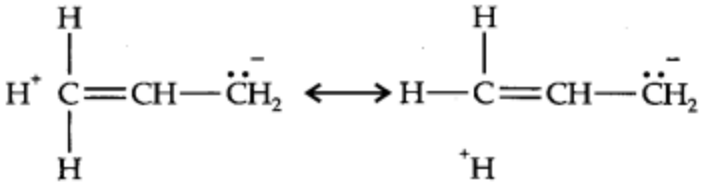
Answer: O_2N——<———- CH_2——<———- CH_2 —<———- O^- is more stable than CH_3——<———-CH_2——<———-O- because NO_2 group has -I-effect and hence it tends to disperse the -ve charge on the O-atom. In contrast, CH_3CH_2 has +I-effect. It, therefore, tends to intensify the -ve charge and hence destabilizes it.

Question 10. Explain why alkyl groups act as electron donors when attached to a π-system.

Answer: Due to hyperconjugation, alkyl groups act as electron donors when attached to a π- system as shown below:

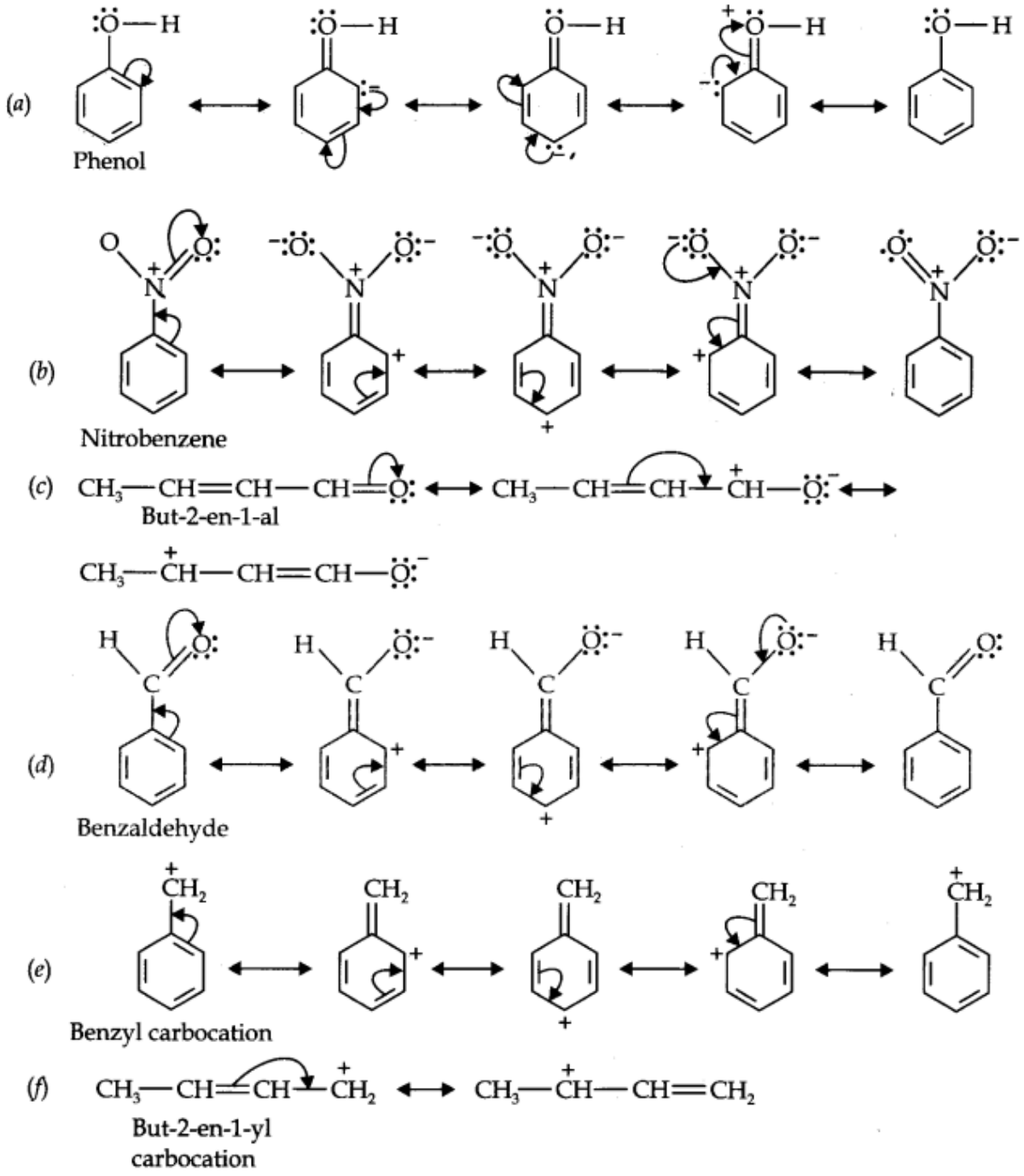


Propene



Question 11. Draw the resonance structures for the following compounds. Show the electron shift using curved-arrow notation. (a) C_6H_5OH (b) $C_6H_5No_2$ (c) $CH_3CH=CHCHO$ (d) $C_6H_5—CHO$ (e) $C_6H_5—CH_2$ (f) $Ch_3Ch=ChCh_2$

Answer:



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Question 12. What are electrophiles and nucleophiles? Explain with examples:

Answer: Electrophiles: The name electrophiles means electron loving. Electrophiles are electron deficient. They may be positive ions or neutral molecules.

Ex: H^+, Cl^+, Br^+, NO_2^+, R_3C^+, RN_2^+, $AlCl_3$, BF_3

Nucleophiles: The name nucleophiles means 'nucleus loving' and indicates that it attacks the region of low electron density (positive centres) in a substrate molecule. They are electron rich they may be negative ions or neutral molecules.

Ex: Cl^- Br^-, CN^-, OH^-, RCR_2^-, NH_3, RNH_2, H_2O, ROH etc.

Question 13. Identify the reagents shown in bold in the following equations as nucleophiles or electrophiles

(a) $CH_3COOH + \mathbf{HO^-} \longrightarrow CH_3COO^- + H_2O$

(b) $CH_3COCH_3 + \mathbf{CN} \longrightarrow (CH_3)_2\, C(CN)(OH)$

(c) $\mathbf{C_6H_5} + CH_3CO \longrightarrow C_6H_5COCH_3$

Answer: Nucleophiles: (a) and (b) and Electrophile : (c)

Question 14. Classify the following reactions in one of the reaction type studied in this unit.

(a) $CH_3CH_2Br + \mathbf{HS^-} \longrightarrow CH_3CH_2SH + Br^-$

(b) $(CH_3)_2C{=}CH_2 + HCl \longrightarrow (CH_3)_2CCl{-}CH_3$

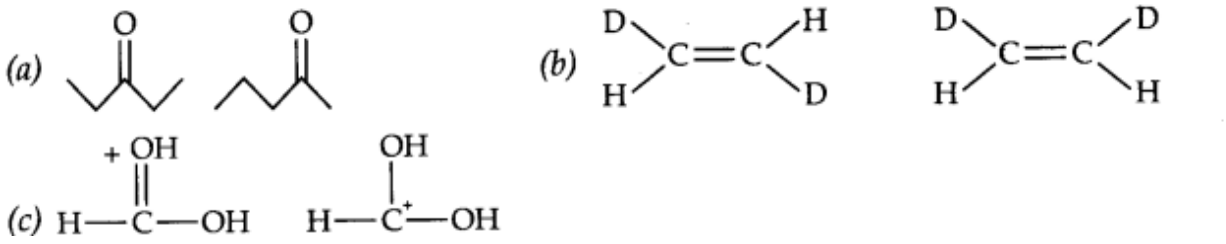
(c) $CH_3CH_2Br + \mathbf{HO^-} \longrightarrow CH_2{=}CH_2 + H_2O + Br^-$

(d) $(CH_3)_3C—CH2OH + HBr ————> (CH_3)_2$ C Br $CH_2CH_2CH_3 + H_2O$

Answer: (a) Nucleophilic substitution (b) Electrophilic addition

(c)Bimolecular elimination (d) Nucleophilic substitution with rearrangement.

Question 15. What is the relationship between the members of following pairs of structures? Are they structural or geometrical isomers or resonance contributors?

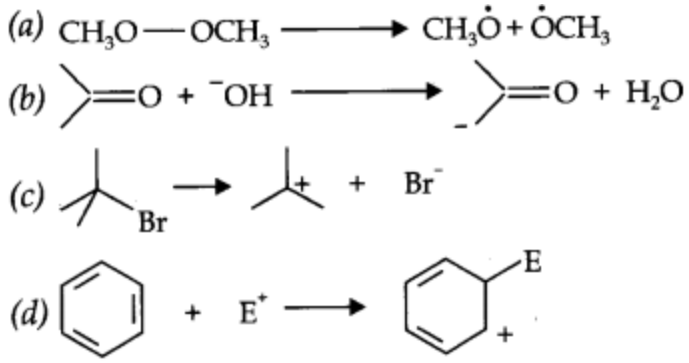


Answer: (a) Structural isomers (actually position isomers as well as metamers)

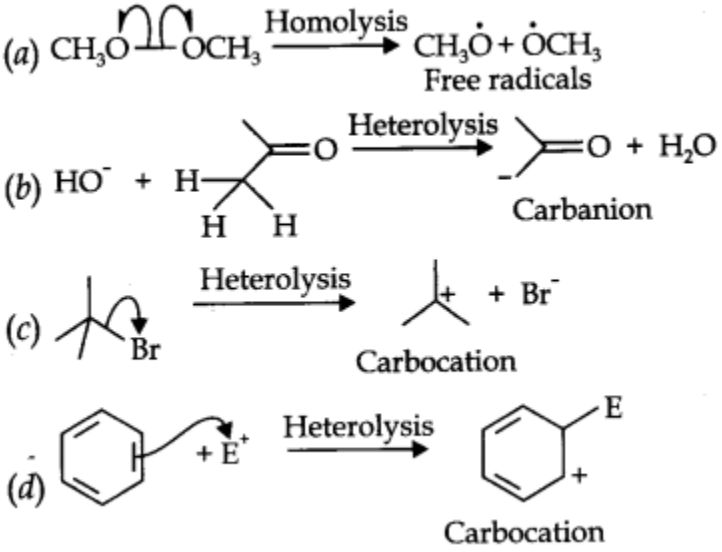
(b) geometrical isomers

(c) resonance contributors because they differ in the position of electrons but not atoms

Question 16. For the following bond cleavages, use curved-arrows to show the electron flow and classify each as homolysis or heterolysis. Identify reactive intermediate produced as free radical, carbocation and carbanion.



Answer:



Question 17. Explain the terms inductive and electromeric effects. Which electron displacement effect explain the following correct orders of acidity of the carboxylic acids?

(a) $Cl_3CCOOH > Cl_2CHCOOH > ClCH_2COOH$

(b) $CH_3CH_2COOH > (CH_3)_2CHCOOH > (CH_3)_3CCOOH$

Answer: Inductive Effect: The inductive effect refers to the polarity produced in a molecule as a result of higher electronegativity of one atom compared to another.Atoms or groups which lose electron towards a carbon atom are said to have +1 Effect.

Those atoms or groups which draw electron away from a carbon atom are said to have -I Effect.

Commomexamples of -I effect are:

NO_2, F, Cl, Br, I, OH etc.

Examples of +1 effect are (Electron releasing)

$(CH_3)_2C-$, $(CH_3)_2CH-$, CH_3CH_2- CH_3- etc.

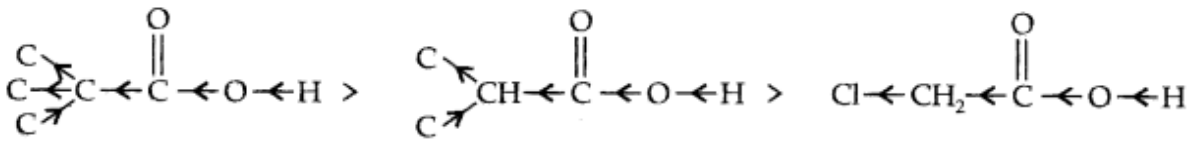
Electromeric effect: The electromeric effect refers to the polarity produced in a multiple bonded compound as it is approached by a reagent.

The atom A has lost its share in the electron pair and B has gained this share.

As a result A acquires a positive charge and B a negative charge. It is a temporary effect and takes place only in the presence of a reagent.

(a) -I-effect as shown below:

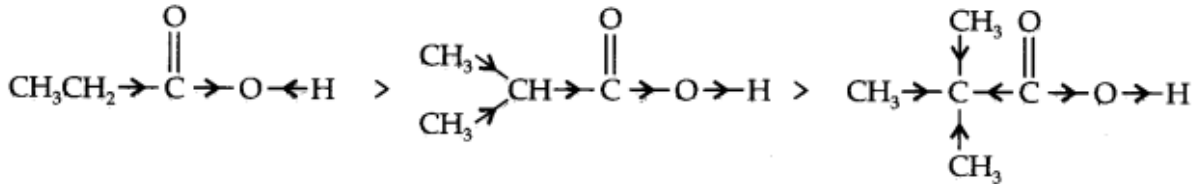
As the number of halogen atoms decreases, the overall -I- effect decreases and the acid strength decreases accordingly.



(b) +I-effect as shown below:

As the number of alkyl groups increases, the +I-effect increases and the acid strength

decreases accordingly.



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Question 18. Give a brief description of the principles of the following techniques taking an example in each case: (a) Crystallisation (b) Distillation (c) Chromatography

Answer: (a) Crystallisation: In this process the impure solid is dissolved in the minimum volume of a suitable solvent. The soluble impurities pass into the solution while the insoluble ones left behind. The hot solution is then filtered and allowed to cool undisturbed till crystallisation is complete. The crystals are then separated from the mother liquor by filtraration and dried.

Example: crystallisation of sugar.

(b) Distillation: The operation of distillation is employed for the purification of liquids from non-volatile impurities. The impure liquid is boiled in a flask and the vapours so formed are collected and condensed to give back pure liquid in another vessel. Simple organic liquids such as benzene toluene, xylene etc. can be purified.

(c) Chromatography: Chromatography is based on the principle of selective distribution of the components of a mixture between two phases, a stationary phase and a moving phase. The stationary phase can be a solid or liquid, while the moving phase is a liquid or a gas. When the stationary phase is solid the basis is adsorption and when it is a liquid the basis is partition. Chromatography is generally used for the Reparation of coloured substances such as plant pigments or dyestuffs.

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

Answer: Fractional crystallisation is used for this purpose. A hot saturated solution of these two compounds is allowed to cool, the less soluble compound crystallises out 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 again allowed to cool when the crystals of the second compound are obtained. These are again filtered and dried.

Question 20. What is the difference between distillation, distillation under reduced pressure and steam distillation?

Answer: Distillation is used in case of volatile liquid mixed with non-volatile impurities.

Distillation under reduced pressure: This method is used to purify such liquids which have very high boiling points and which decompose at or below their boiling points.

Steam distillation is used to purify steam volatile liquids associated with water immiscible impuritites.

Question 21. Discuss the chemistry of Lassaigne's test.

Answer: Lassaigne's test: Nitrogen, sulphur, halogens and phosphorous present in an organic compound are detected by Lassaigne's test.

First of all compounds are converted to ionic form by fusing the compound with sodium metal.

$$Na + C + N \xrightarrow{\Delta} NaCN$$
$$2Na + S \xrightarrow{\Delta} Na_2S$$
$$Na + X \xrightarrow{\Delta} NaX$$
[X = Cl, Br, I]

Cyanide, sulphide or halide of sodium are extracted from the fused mass by boiling it with distilled water. This extract is known as sodium fusion extract.

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Question 22. Differentiate between the principle of estimation of nitrogen in an organic compound by (i) Dumas method (ii) Kjeldahl's method.

Answer: (i) Dumas method: The organic compound is heated strongly with excess of CuO ' (Cupric Oxide) in an atmosphere of CO_2 when free nitrogen, CO_2 and H_2O are obtained.

(ii)Kjeldahl's method: A known mass of the organic compound is heated strongly with cone. H_2SO_4, a little potassium sulphate and a little mercury (a catalyst). As a result of reaction the nitrogen present in the organic compound is converted to ammonium sulphate.

Question 23. Discuss the principle of estimation of halogens, sulphur and phosphorus present in an organic compound.

Answer: Estimation of halogens: It involves oxidising the organic substance with fuming nitric acid in the presence of silver nitrate. The halogen of the substance is thus converted to silver halide which is separated and weighed:

1Weight of organic compound = W gm

weight of silver halide = x g.

$$\% \text{ of halogen} = \frac{\text{At. wt. of halogen} \times 100x}{\text{Mol. wt of silver halide} \times w}$$

Estimation of sulphur: The organic substance is heated with fuming nitric acid but no silver nitrate is added. The sulphur of the substance is oxidised to sulphuric acid which is then precipitated as barium sulphate by adding excess of barium chloride solution. From the weight of $BaSO_4$ so obtained the percentage of sulphur can be calculated.

$$\% \text{ of sulphur} = \frac{32 \text{ (At. weight of S)}}{233 \text{ (mol weight of } BaSO_4)} \times \frac{\text{weight of} \times 100\ BaSO_4}{\text{weight of organic compound}}$$

Estimation of phosphorous: The organic substance is heated with fuming nitric acid whereupon phosphorous is oxidised to phosphoric acid. The phosphoric acid is precipitated as ammonium phosphomolybdate, $(NH_4)_3\ PO_4\ .12MOO_3$, by the addition of ammonia and ammonium molybdate solution which is then separated, dried and weighed.

$$\% \text{ of P} = \frac{31 \times w_1 \times 100}{1877 \times w}$$

where Molar mass of $(NH_4)_3\ PO_4.12MoO_3$ = 1877 g

If phosphorous is estimated as $Mg_2P_2O_7$

$$\% \text{ of P} = \frac{62 \times w_1 \times 100}{222 \times w}\%$$

Question 24. Explain the principle of paper chromatography.

Answer: This is the simplest form of chromatography. Here a strip of paper acts as an adsorbent. It is based on the principle which is partly adsorption. The paper is made of cellulose fibres with molecules of water adsorbed on them. This acts as stationary phase. The mobile phase is the mixture of the components to be identified prepared in a suitable solvent.

Question 25. Why is nitric acid added to sodium extract before adding silver nitrate for testing halogens ?

Answer: Nitric acid is added to sodium extract so as to decompose

$NaCN + HNO_3 \longrightarrow NaNO_3 + HCN$

$Na_2S + 2HNO_3 \longrightarrow 2NaNO_3 + H_2S$

Question 26. Explain the reason for the fusion of an organic compound with metallic sodium for testing nitrogen, sulphur and halogens.

Answer: Organic compound is fused with sodium metal so as to convert organic compounds into NaCN, Na_2S, NaX and Na_3PO_4. Since these are ionic compounds and become more reactive and thus can be easily tested by suitable reagents.

Question 27. Name a suitable technique of separation of the components from a mixture of calcium sulphate and camphor.

Answer: Sublimation.Because camphor can sublime whereas $CaSO_4$ does not.

Question 28. Explain, why an organic liquid vaporises at a temperature below its boiling point in its steam distillation ?

Answer: It is because in steam distillation the sum of vapour pressure of organic compound and steam should be equal to atmospheric pressure.

Question 29.Will CCl_4 give white precipitate of AgCl on heating it with silver nitrate? Give reason for your answer.

Answer: No. CCl_4 is a completely non-polar covalent compound whereas $AgNO_3$ is ionic in nature. Therefore they are not expected to react and thus a white ppt. of silver chloride will not be formed.

Question 30. Why is a solution of potassium hydroxide used to absorb carbon dioxide evolved during the estimation of carbon present in an organic compound?

Answer: CO_2 is acidic in nature and therefore, it reacts with the strong base KOH to form K_2CO_3.

$2KOH + CO_2 ---> K_2CO_3 + H_2O$.

Question 31. Why is it necessary to use acetic acid and not sulphric acid for acidification of sodium extract for testing sulphur by lead acetate test?

Answer: For testing sulphur sodium extract is acidified with acetic acid because lead acetate is soluble and does not interfere with the test.

$$\underset{\text{lead acetate}}{Pb(OCOCH_3)_2} + H_2SO_4 \longrightarrow PbSO_4 \downarrow + 2CH_3COOH$$

Question 32. 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 compound is subjected to complete combustion.

Answer:

Step I. Calculation of mass of CO_2 produced

Mass of compound = 0.20 g

Percentage of carbon = 69%

$$\text{Percentage of carbon} = \frac{12}{44} \times \frac{\text{Mass of carbon dioxide formed}}{\text{Mass of compound}} \times 100$$

$$69 = \frac{12}{44} \times \frac{\text{Mass of carbon dioxide formed}}{(0.20\ \text{g})} \times 100$$

$$\therefore \text{ Mass of } CO_2 \text{ formed} = \frac{69 \times 44 \times (0.20\ g)}{12 \times 100} = \mathbf{0.506\ g}$$

Step II. Calculation of mass of H_2O produced

Mass of compound = 0.20 g

Percentage of hydrogen = 4.8%

$$\text{Percentage of hydrogen} = \frac{2}{18} \times \frac{\text{Mass of water formed}}{\text{Mass of compound}} \times 100$$

$$4.8 = \frac{2}{18} \times \frac{\text{Mass of water formed}}{(0.20\ \text{g})} \times 100$$

$$\therefore \text{ Mass of } H_2O \text{ formed} = \frac{4.8 \times 18 \times (0.20\ g)}{2 \times 100} = \mathbf{0.0864\ g}$$

Question 33. 0.50 g of an organic compound was Kjeldahlished. The ammonia evolved was passed in 50 cm^3 of IN H_2SO_4. The residual acid required 60 cm^3 of N/2 NaOH solution. Calculate the percentage of nitrogen in the compound.

Answer:

Step I. *Calculation of volume of unused acid*
Volume of NaOH solution required = 60 cm^3
Normality of NaOH solution = 1/2 N
Normality of H_2SO_4 solution = 1/N
Volume of unused acid can be calculated by applying normality equation

$$\underbrace{N_1V_1}_{\text{Acid}} = \underbrace{N_1V_1}_{\text{Base}}$$

$$1 \times V = \frac{1}{2} \times 60 = 30 \text{ cm}^3$$

Step II. *Calculation of volume of acid used*
Volume of acid added = 50 cm^3
Volume of unused acid = 30 cm^3
Volume of acid used = (50 – 30) = 20 cm^3

Step III. *Calculation of percentage of nitrogen*
Mass of compound = 0.50 g
Volume of acid used = 20 cm^3
Normality of acid used = 1 N

$$\text{Percentage of N} = \frac{1.4 \times \text{Volume of acid used} \times \text{Normality of acid used}}{\text{Mass of the compound}}$$

$$= \frac{1.4 \times 20 \times 1}{0.50} = \mathbf{56\%}$$

Question 34. 0.3780 g of an organic compound gave 0.5740 g of silver chloride in Carius estimation. Calculate the percentage of chlorine in the compound.

Answer: Mass of the compound = 0.3780 g

Mass of silver chloride = 0.5740 g

$$\text{Percentage of chlorine} = \frac{35.5}{143.5} \times \frac{\text{Mass of siliver chloride}}{\text{Mass of compound}} \times 100$$

$$= \frac{35.5}{143.5} \times \frac{(0.5740 \text{ g})}{(0.3780 \text{ g})} \times 100 = \mathbf{37.57 \text{ g}}$$

Question 35. In an estimation of sulphur by Carius method, 0.468 of an organic sulphur compound gave 0.668 g of barium sulphate. Find the percentage of sulphur in the compound.

Answer: Mass of the compound = 0.468 g

Mass of barium sulphate= 0.668 g

$$\text{Percentage of sulphur} = \frac{32}{233} \times \frac{\text{Mass of barium sulphate}}{\text{Mass of compound}} \times 100$$

$$= \frac{32}{233} \times \frac{(0.668\ g)}{(0.468\ g)} \times 100 = \mathbf{19.60\%}$$

Question 36.

In the organic compound $CH_2{=}CH{-}CH_2{-}CH_2{-}C{\equiv}CH$, the $CH{-}CH_2$ bond is formed by the interaction of a pair of hybridised orbitals:

(a) $sp - sp^2$ *(b)* $sp - sp^3$

(c) $sp^2 - sp^3$ *(d)* $sp^3 - sp^3$

Answer:

(c) is the correct answer. $(CH_2{=}\overset{(sp^2)}{C}H - \overset{(sp^3)}{C}H_2 - CH_2{-}C{\equiv}CH)$

Question 37. In Lassaigne's test for ntrogen in an organic compound, the Prussian blue colour is obtaine d due to the formation of:

(a) $Na_4[Fe(CN)_6]$ (b)$Fe_4[Fe(CN)_6]_3$

(c) $Fe_2[Fe(CN)_6]$ (d)$Fe_3[Fe(CN)_6]_4$.

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Answer: (b) is the correct answer.

Question 38. Which of the following carbocation is most stable?

(a) $(CH_3)_3C\overset{\oplus}{C}H_2$ (b) $(CH_3)_3\overset{\oplus}{C}$

(c) $CH_3CH_2\overset{\oplus}{C}H_2$ (d) $CH_3\overset{\oplus}{C}HCH_2CH_3$.

Answer: (b) is the most stable since it is a tertiary carbocation.

Question 39. The best and latest technique for isolation, purification and separation of organic compounds is: (a) Crystallisation (b) Distillation

(c) Sublimation (d) Chromatography.

Answer: (d) is the correct answer.

Question 40. The following reaction is classified as:

CH_3CH_2I + KOH (aq) ———-> CH_3CH_2OH + KI

(a) electrophilic substitution (b) nucleophilic substitution

(c) elimination (d) addition

Answer: (b) It is a nucleophilic substitution reaction. KOH (aq) provides OH- ion for the nucleophile attack.

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