

## I. Multiple Choice Questions (Type-I)

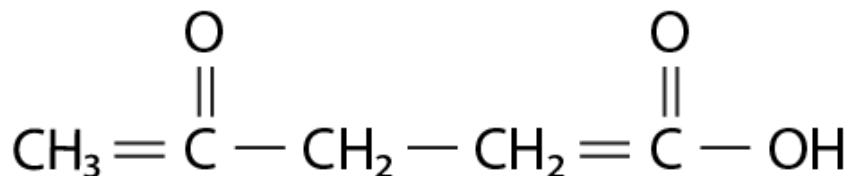
1. Which of the following is the correct IUPAC name?

- (i) 3-Ethyl-4, 4-dimethylheptane
- (ii) 4,4-Dimethyl-3-ethylheptane
- (iii) 5-Ethyl-4, 4-dimethylheptane
- (iv) 4,4-Bis(methyl)-3-ethylheptane

**Solution:**

Option (i) the answer.

2. The IUPAC name for is \_\_\_\_\_.

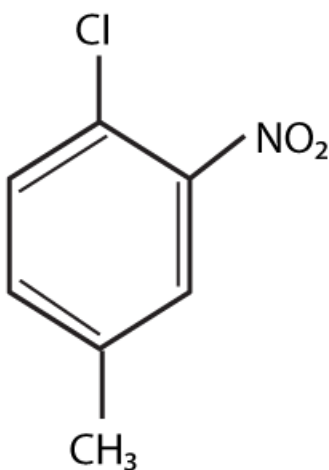


- (i) 1-hydroxypentane-1,4-dione
- (ii) 1,4-dioxopentanol
- (iii) 1-carboxybutan-3-one
- (iv) 4-oxopentanoic acid

**Solution:**

Option (iv) is the answer.

3. The IUPAC name for



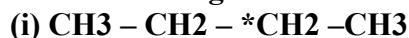
- (i) 1-Chloro-2-nitro-4-methylbenzene
- (ii) 1-Chloro-4-methyl-2-nitrobenzene
- (iii) 2-Chloro-1-nitro-5-methylbenzene
- (iv) m-Nitro-p-chlorotoluene

**Solution:**

Option (ii) is the answer.

**4. Electronegativity of carbon atoms depends upon their state of hybridisation.**

**In which of the following compounds, the carbon marked with an asterisk is most electronegative?**



**Solution:**

Option (iii) is the answer.

**5. In which of the following, functional group isomerism is not possible?**

(i) Alcohols

(ii) Aldehydes

(iii) Alkyl halides

(iv) Cyanides

**Solution:**

Option (iii) is the answer.

**6. The fragrance of flowers is due to the presence of some steam volatile organic compounds called essential oils. These are generally insoluble in water at room temperature but are miscible with water vapour in the vapour phase. A suitable method for the extraction of these oils from the flowers is:**

(i) Distillation

(ii) Crystallisation

(iii) Distillation under reduced pressure

(iv) Steam distillation

**Solution:**

Option (iv) is the answer.

**7. During the hearing of a court case, the judge suspected that some changes in the documents had been carried out. He asked the forensic department to check the ink used at two different places. According to you which technique can give the best results?**

(i) Column chromatography

(ii) Solvent extraction

(iii) Distillation

(iv) Thin-layer chromatography

**Solution:**

Option (iv) is the answer.

**8. The principle involved in paper chromatography is**

(i) Adsorption

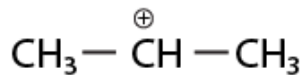
(ii) Partition

(iii) Solubility

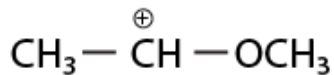
(iv) Volatility

**Solution:**

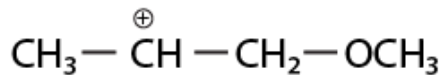
Option (ii) is the answer.

**9. What is the correct order of decreasing stability of the following cations?**


I.



II.



III.

(i) II &gt; I &gt; III

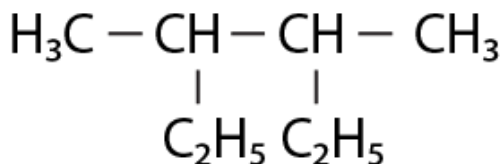
(ii) II &gt; III &gt; I

(iii) III &gt; I &gt; II

(iv) I &gt; II &gt; III

**Solution:**

Option (i) is the answer.

**10. Correct IUPAC name for is \_\_\_\_\_.**


(i) 2-ethyl-3-methylpentane

(ii) 3,4-dimethylhexane

(iii) 2-sec-butylbutane

(iv) 2,3-dimethylbutane

**Solution:**

Option (ii) is the answer.

**11. In which of the following compounds the carbon marked with an asterisk is expected to have the greatest positive charge?**

 (i) \*CH<sub>3</sub>—CH<sub>2</sub>—Cl

 (ii) \*CH<sub>3</sub>—CH<sub>2</sub>—Mg+Cl−

 (iii) \*CH<sub>3</sub>—CH<sub>2</sub>—Br

 (iv) \*CH<sub>3</sub>—CH<sub>2</sub>—CH<sub>3</sub>
**Solution:**

Option (i) is the answer.

**12. Ionic species are stabilised by the dispersal of charge. Which of the following carboxylate ion is the most stable?**

- (i)  $\text{CH}_3 - \overset{\text{O}}{\parallel} \text{C} - \bar{\text{O}}$
- (ii)  $\text{Cl} - \text{CH}_2 - \overset{\text{O}}{\parallel} \text{C} - \bar{\text{O}}$
- (iii)  $\text{F} - \text{CH}_2 - \overset{\text{O}}{\parallel} \text{C} - \bar{\text{O}}$
- (iv)  $\begin{array}{c} \text{F} \\ \diagdown \\ \text{CH} - \overset{\text{O}}{\parallel} \text{C} - \bar{\text{O}} \\ \diagup \\ \text{F} \end{array}$

**Solution:**

Option (iv) is the answer.

**13. Electrophilic addition reactions proceed in two steps. The first step involves the addition of an electrophile. Name the type of intermediate formed in the first step of the following addition reaction.**

**H<sub>3</sub>**



- (i) 2° Carbanion  
 (ii) 1° Carbocation  
 (iii) 2° Carbocation  
 (iv) 1° Carbanion

**Solution:**

Option (iii) is the answer.

**14. A covalent bond can undergo fission in two different ways. The correct representation involving heterolytic fission of  $\text{CH}_3 - \text{Br}$  is**

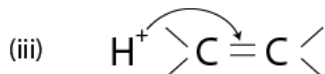
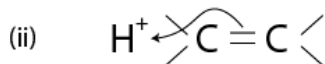
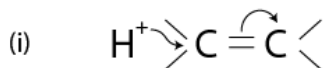
- (i)  $\text{CH}_3 - \text{Br} \longrightarrow \overset{+}{\text{C}}\text{H}_3 + \overset{-}{\text{Br}}$
- (ii)  $\text{CH}_3 - \text{Br} \longrightarrow \overset{+}{\text{C}}\text{H}_3 + \overset{-}{\text{Br}}$
- (iii)  $\text{CH}_3 - \text{Br} \longrightarrow \overset{-}{\text{C}}\text{H}_3 + \overset{+}{\text{Br}}$
- (iv)  $\text{CH}_3 - \text{Br} \longrightarrow \dot{\text{C}}\text{H}_3 + \dot{\text{Br}}$

**Solution:**

Option (ii) is the answer.

**15. The addition of HCl to alkene proceeds in two steps. The first step is the**

attack of  $H^+$  ion  $C=C$  to a portion which can be shown as



(iv) All of these are possible

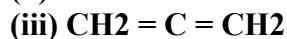
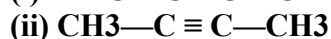
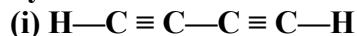
**Solution:**

Option (ii) is the answer.

## II. Multiple Choice Questions (Type-II)

In the following questions, two or more options may be correct.

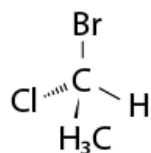
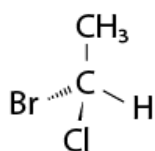
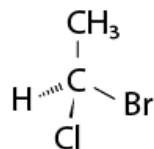
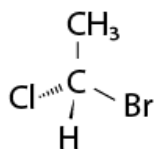
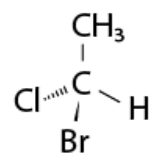
16. Which of the following compounds contain all the carbon atoms in the same hybridisation state?



**Solution:**

Option (i) and (iv) are the answers.

17. In which of the following representations given below spatial arrangement of group/ atom different from that given in structure 'A'?



**Solution:**

Option (i), (iii) and (iv) are the answers.

**18. Electrophiles are electron seeking species. Which of the following groups contain only electrophiles?**

(i)  $\text{BF}_3$ ,  $\text{NH}_3$ ,  $\text{H}_2\text{O}$

(ii)  $\text{AlCl}_3$ ,  $\text{SO}_3$ , +  $\text{NO}_2$

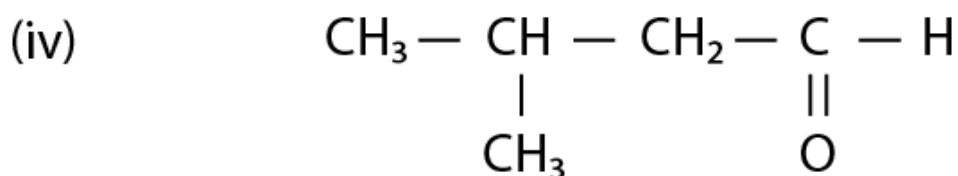
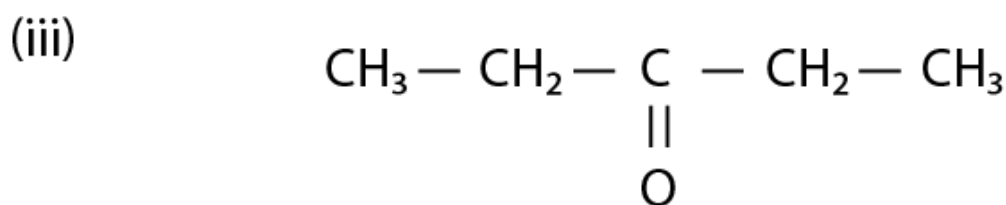
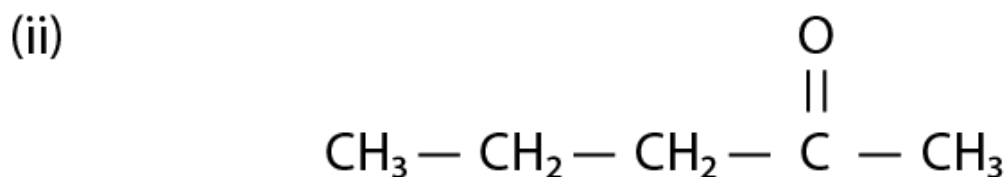
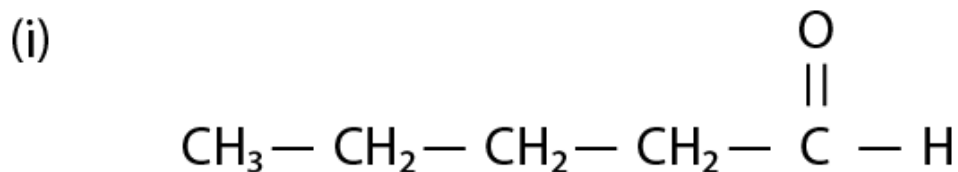
(iii)  $\text{NO}_2^+$ ,  $\text{CH}_3^+$ ,  $\text{CH}_3-\text{C}^+=\text{O}$

(iv)  $\text{C}_2\text{H}_5^-$ ,  $\text{C}_2\text{H}_5$ ,  $\text{CH}_5^+$

**Solution:**

Option (ii) and (iii) are the answers.

**Note:** Consider the following four compounds for answering questions 19 and 20.



19. Which of the following pairs are position isomers?

- (i) I and II
- (ii) II and III
- (iii) II and IV
- (iv) III and IV

**Solution:**

Option (ii) is the answer.

20. Which of the following pairs are not functional group isomers?

- (i) II and III
- (ii) II and IV
- (iii) I and IV
- (iv) I and II

**Solution:**

Option (i) and (iii) are the answers.

21. A nucleophile is a species that should have

- (i) a pair of electrons to donate
- (ii) positive charge

- (iii) negative charge  
 (iv) electron-deficient species

**Solution:**

Option (i) and (iii) are the answers.

**22. Hyperconjugation involves delocalisation of \_\_\_\_\_.**

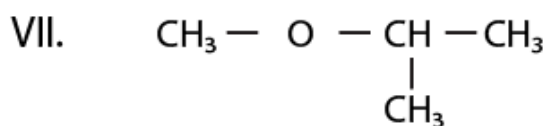
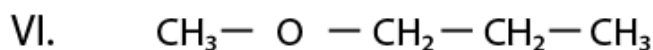
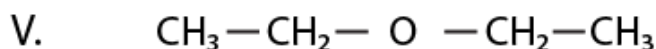
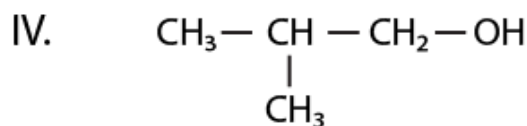
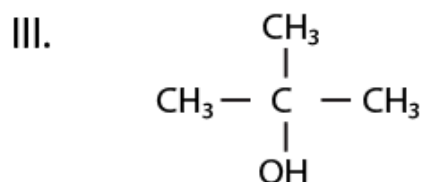
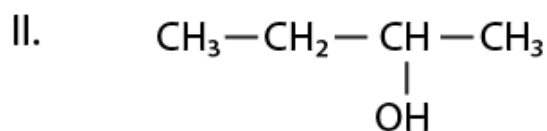
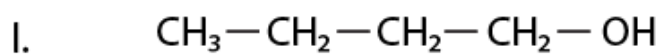
- (i) electrons of carbon-hydrogen  $\sigma$  bond of an alkyl group directly attached to an atom of the unsaturated system.  
 (ii) electrons of carbon-hydrogen  $\sigma$  bond of alkyl group directly attached to the positively charged carbon atom.  
 (iii)  $\pi$ -electrons of carbon-carbon bond  
 (iv) lone pair of electrons

**Solution:**

Option (i) and (ii) are the answers.

### III. Short Answer Type

**Note: Consider structures I to VII and answer the questions 23–26.**





**23. Which of the above compounds form pairs of metamers?****Solution:**

V and VI form pairs of metamers. (metamers of ethers). Here in compounds V and VI, the chain length is the same but the distribution of carbons is different around oxygen atom.

**24. Identify the pairs of compounds which are functional group isomers.****Solution:**

I and V, I and VI, I and VII, II and V, II and VI, II and VII, III and V, III and VI, III and VII, IV and V, IV and VI, IV and VII. Alcohol is the function group of each ether in the given seven compounds.

**25. Identify the pairs of compounds that represent position isomerism.****Solution:**

I and II, III and IV, V and VI are the compounds which represent the position isomerism. Position isomerism means, where the length of the parent chain and functional group is the same but the position of the functional group is different, then it is called position isomer.

**26. Identify the pairs of compounds that represent chain isomerism.****Solution:**

I and III, I and IV, II and III, II and IV, II and IV, V and VII, VI and VII are the compounds which represent chain isomerism. Compounds having same molecular formula but vary in the length of the parent chain(as they are branched) is called chain isomerism.

**27. For testing halogens in an organic compound with  $\text{AgNO}_3$  solution, sodium extract (Lassaigne's test) is acidified with dilute  $\text{HNO}_3$ . What will happen if a student acidifies the extract with dilute  $\text{H}_2\text{SO}_4$  in place of dilute  $\text{HNO}_3$ ?****Solution:**

If dilute  $\text{H}_2\text{SO}_4$  is added then sodium sulphide and sodium cyanide are not decomposed thereby we will not get the correct result if halides are also present.

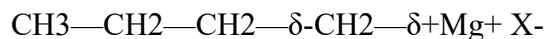
**28. What is the hybridisation of each carbon in  $\text{H}_2\text{C}=\text{C}=\text{CH}_2$ ?****Solution:**

The terminal carbons are  $\text{sp}^2$  hybridised as they form 3 (2 with H and 1 with C) sigma bonds and 1 pi bond(between carbons) while the centre carbon is  $\text{sp}$  hybridised (as it forms 2 sigma bonds, 1 with each carbon and 2 pi bonds, one with each carbon).

**29. Explain, how is the electronegativity of carbon atoms related to their state of hybridisation in an organic compound?****Solution:**

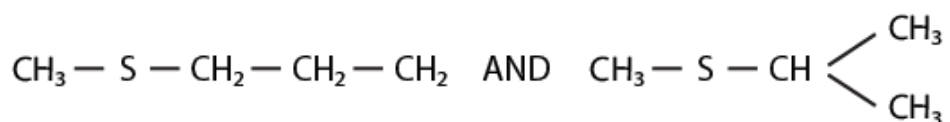
Hybridization for carbon in organic compounds is of three types,  $\text{sp}$ ,  $\text{sp}^2$  and  $\text{sp}^3$ . More the 's' character more is the electronegativity of the carbon as 's' orbitals are closer to the nucleus, hence electrons held more closely.

**30. Show the polarisation of carbon-magnesium bond in the following structure.****Solution:**



Carbon is more electronegative than Mg because of the electronegativity difference in the bond between C-Mg is highly polarised. C being more electronegative the electron density is towards C hence Mg readily loses its electron to form C<sup>-</sup> (carbanion).

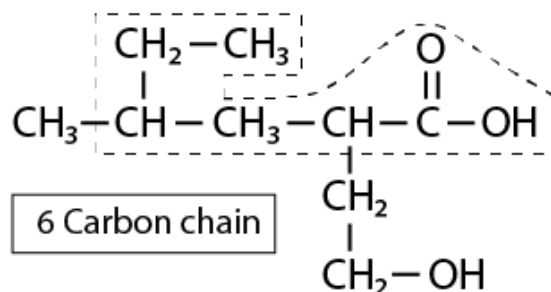
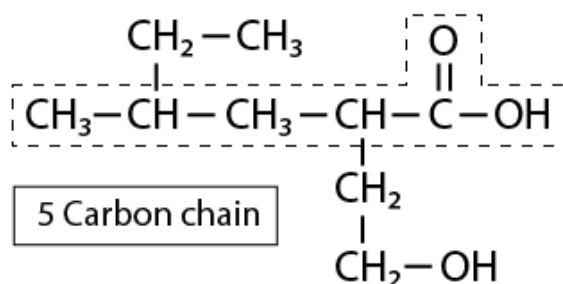
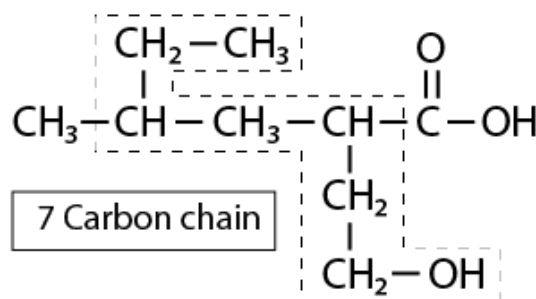
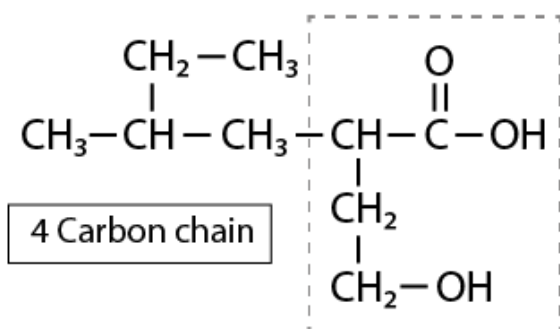
**31. Compounds with same molecular formula but differing in their structures are said to be structural isomers. What type of structural isomerism is shown by**



**Solution:**

In the above structures, both have the same functional group (thioether/sulphide), but there is a difference in the arrangement of atoms in the main chain. So they can exhibit chain isomerism.

**32. Which of the following selected chains is correct to name the given compound according to the IUPAC system.**



- The main(parent) chain should be the longest possible carbon chain with all the carbons with the functional groups included in them. The above selection is the only possible one with both the functional groups in the main chain.
- Out of carboxylic acid and alcohol acid gets the priority hence the numbering starts from carboxylic carbon.
- There is a branched alkyl group substitution at second carbon
- There is a hydroxyl group at 4th carbon therefore it can be named as 2-(2-methyl butyl)-4-hydroxybutanoic acid.

**33. In DNA and RNA, the nitrogen atom is present in the ring system. Can the Kjeldahl method be used for the estimation of nitrogen present in these? Give reasons.**

**Solution:**

The Kjeldahl method cannot be used for the estimation of nitrogen present in DNA and RNA because nitrogen cannot be converted into ammonium sulphate in the conditions provided in this method. The difficulty in decomposing ring structures limits this test for DNA and RNA.

**34. If a liquid compound decomposes at its boiling point, which method(s) can you choose for its purification. It is known that the compound is stable at low pressure, steam volatile and insoluble in water.**

**Solution:**

As the liquid compound decomposes at its boiling point which means that the compound is heat-sensitive, hence we use "Steam distillation" for its purification. It is done for temperature-sensitive material.

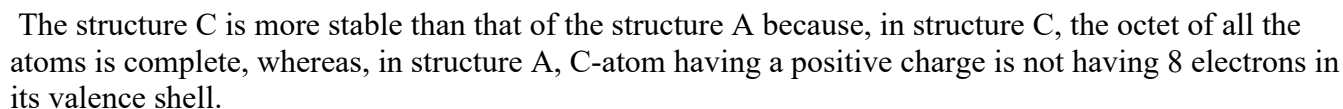
**Note: Answer the questions 35 to 38 based on the information given below:**  
**"Stability of carbocations depends upon the electron releasing inductive effect of groups adjacent to positively charged carbon atom involvement of neighbouring groups in hyperconjugation and resonance."**

**35. Draw the possible resonance structures for**



**and predict which of the structures is more stable. Give the reason for your answer.**

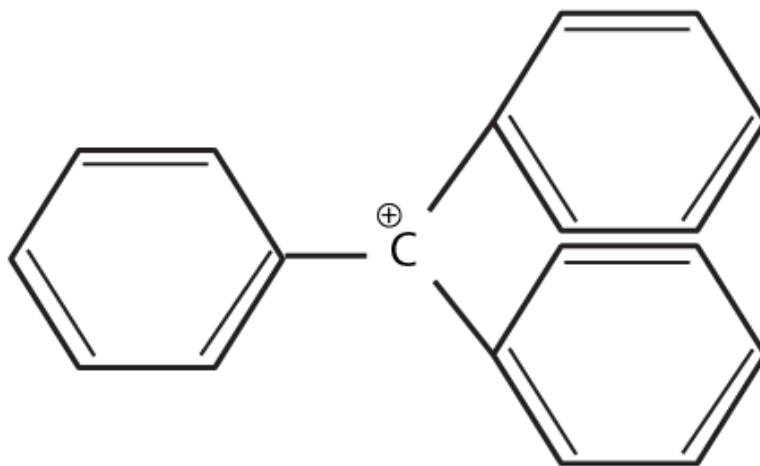
**Solution:**



(A)  $\longleftrightarrow$  (B)

allylic > 3° > 2° > 1° > methyl

**37. The structure of triphenylmethylcation is given below. This is very stable and some of its salts can be stored for months. Explain the cause of the high stability of this cation.**

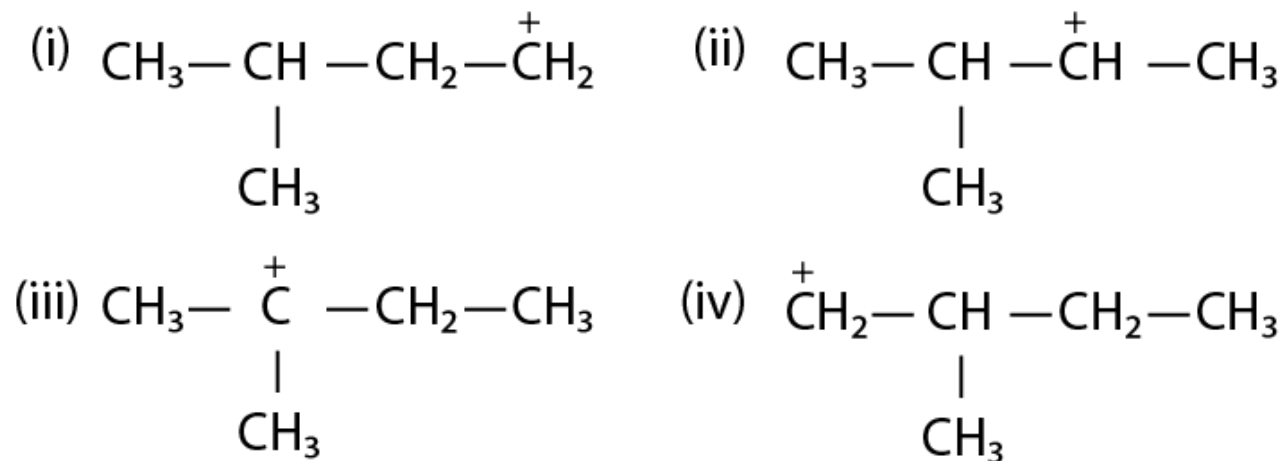


**Solution:**

Triphenylcarbocation is tertiary carbocation and the positive charge is on the carbon atom which is stabilized by the three phenyl group by resonance. Due to the resonance the stability increases.

**38. Write structures of various carbocation that can be obtained from 2-methyl butane. Arrange these carbocations in order of increasing stability.**

**Solution:**



the stability order is found to be:

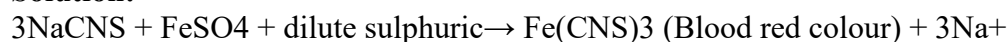
(III) > (II) > (I) > (IV)

This is because (III) is tertiary carbocation, (II) is secondary carbocation, (I) and (IV) are primary,

**39. Three students, Manish, Ramesh and Rajni were determining the extra elements present in an organic compound given by their teacher. They prepared the Lassaigne's extract (L.E.) independently by the fusion of the compound with sodium metal. Then they added solid FeSO<sub>4</sub> and dilute**

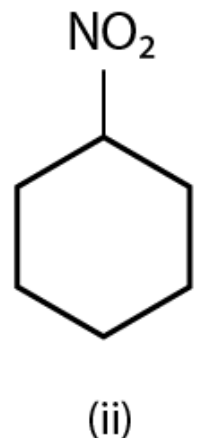
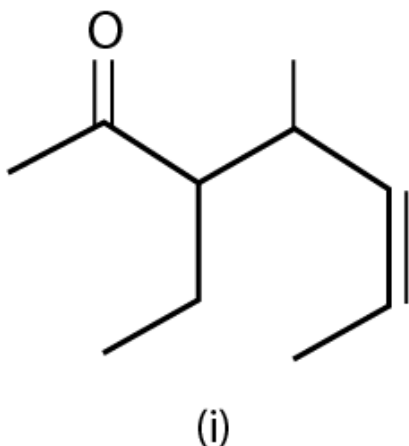
sulphuric acid to a part of Lassaigne's extract. Manish and Rajni obtained Prussian blue colour but Ramesh got a red colour. Ramesh repeated the test with the same Lassaigne's extract but again got red colour only. They were surprised and went to their teacher and told him about their observation. A teacher asked them to think over the reason for this. Can you help them by giving the reason for this observation? Also, write the chemical equations to explain the formation of compounds of different colours

**Solution:**



Ramesh has Nitrogen as well as Sulphur present in his organic compound so, he was observed the Blood-red colour of  $\text{Fe(CNS)}_3$  and Manish and Rajni were having only Nitrogen in their compound, hence they got Prussian blue colour.

**40. Name the compounds whose line formulae are given below:**



**Solution:**

(i) The name of the compound is 3-ethyl-4-methyl-5-heptane-2-one.

(ii) The name of the compound is; 1-nitro-cyclohexane-2-ene.

**41. Write structural formulae for compounds named as-**

(a) 1-Bromoheptane

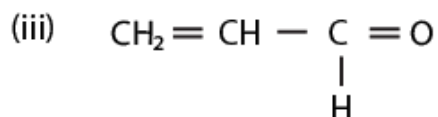
(b) 5-Bromoheptanoic acid

**Solution:**

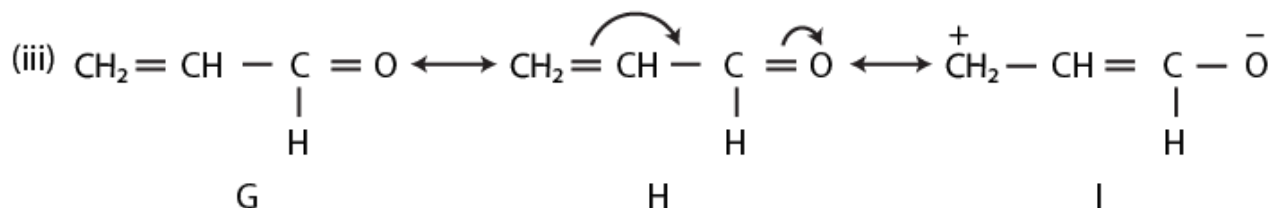
(a)



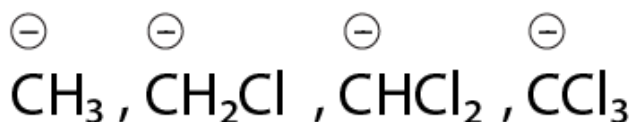
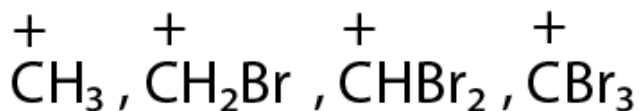
(b)



**Solution:**



**43. Identify the most stable species in the following set of ions giving reasons:**


**Solution:**

- (i)  $\text{C}^+\text{H}_3$  will be more stable as the bromine atom destabilizes the positive charge on a carbon atom. Bromine atom is an electron-withdrawing group and has a lone pair of electrons.
- (ii)  $\text{CCl}_3$  will be most stable because chlorine is more electron-withdrawing atom and the negative charge on carbon will be stabilized by the chlorine atom. As the number of chlorine atom attached to carbocation increases the stability also increases.

**44. Give three points of differences between the inductive effect and resonance effect.**
**Solution:**

1. In the inductive effect, the transmission of the electron is only from sigma bond whereas in resonance effect the transmission occurs from both sigma and pi bond.
2. It is possible when the polarization of bond takes place whereas the resonance effect is possible only if the system is conjugated.
3. Electronegativity plays role in inductive effect whereas in resonance effect more number of an alternative double bond will lead to more resonating structure and hence more stability.

**45. Which of the following compounds will not exist as a resonance hybrid. Give the reason for your answer:**
**Solution:**

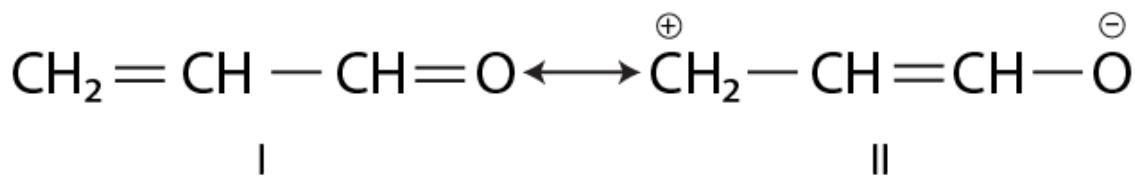
Conjugation is only possible when an atom has any of the charge or alternative position of the double bond. Here  $\text{CH}_3\text{OH}$  will not exist as resonance hybrid because of the reason.

**46. Why does  $\text{SO}_3$  act as an electrophile?**
**Solution:**

Oxygen is more electronegative than sulphur and the electron density at S in  $\text{SO}_3$  is reduced and they need more electrons to suppress the partial positive charge and hence they act as an electrophile.

**47. Resonance structures of propenal are given below. Which of these resonating structures is more stable? Give a reason for your answer.**




**Solution:**

The structure I will be more stable than structure II because all the atoms are having complete octet in structure I and the carbon atom having positive charge don't have a complete octet in structure II.

**48. By mistake, an alcohol (boiling point 97°C) was mixed with a hydrocarbon (boiling point 68°C). Suggest a suitable method to separate the two compounds. Explain the reason for your choice.**

**Solution:**

We can separate the mixture by steam distillation. Both alcohol and hydrocarbon don't have much difference in the boiling point. Steam distillation is particularly used for the purification of temperature-sensitive material.

**49. Which of the two structures (A) and (B) given below is more stabilised by resonance? Explain. (A) CH<sub>3</sub>COOH (B) CH<sub>3</sub>COO<sup>-</sup>**

**Solution:**

The two resonating structure in compound A, are not equivalent, whereas compound B, having a negative charge on the oxygen atom is having the two equivalent structures, hence the compound B is more stable.

**IV. Matching Type**

In the following questions, more than one correlation is possible between options of Column I and Column II. Make as many correlations as you can.

**50. Match the type of mixture of compounds in Column I with the technique of separation/purification given in Column II.**

Column I	Column II
(i) Two solids which have different solubilities in a solvent and which do not undergo a reaction when dissolved in it.	(a) Steam distillation
(ii) The liquid that decomposes at its boiling point	(b) Fractional distillation
(iii) Steam volatile liquid	(c) Simple distillation
(iv) Two liquids which have boiling points close to each other	(d) Distillation under reduced pressure
(v) Two liquids with the large difference in boiling points.	(e) Crystallisation

**Solution:**

- (i) is c  
 (ii) is d  
 (iii) is a  
 (iv) is b  
 (v) is c

**51. Match the terms mentioned in Column I with the terms in Column II.**

Column I	Column II
(i) Carbocation (ii) Nucleophile (iii) Hyperconjugation (iv) Isomers (v) $sp$ hybridisation (vi) Electrophile	(a) Cyclohexane and 1-hexene (b) Conjugation of electrons of C-H $\sigma$ bond with empty p-orbital present at adjacent positively charged carbon. (c) $sp^2$ hybridised carbon with empty p-orbital (d) Ethyne (e) Species that can receive a pair of electrons (f) Species that can supply a pair of electrons.

**Solution:**

- (i) is c  
 (ii) is f  
 (iii) is b  
 (iv) is a  
 (v) is d  
 (vi) is e

**52. Match Column I with Column II.**

Column I	Column II
(i) Dumas method (ii) Kjeldahl's method (iii) Carius method (iv) Chromatography	(a) $AgNO_3$ (b) Silica gel (c) Nitrogen gas (d) Free radicals (e) Ammonium sulphate

**Solution:**

- (i) is c  
 (ii) is e  
 (iii) is a  
 (iv) is b  
 (v) is d

**53. Match the intermediates given in Column I with their probable structure in Column II.**

Column I	Column II
(i) Free radical	(a) Trigonal planar

<b>(ii) Carbocation</b> <b>(iii) Carbanion</b>	<b>(b) Pyramidal</b> <b>(c) Linear</b>
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**Solution:**

- (i) is a  
 (ii) is a  
 (iii) is b

**54. Match the ions given in Column I with their nature-given in Column II.**

- (i)  $\text{CH}_3 - \ddot{\text{O}} - \overset{\oplus}{\text{CH}} - \text{CH}_3$  (a) Stable due to resonance
- (ii)  $\text{F}_3 - \overset{\oplus}{\text{C}}$  (b) Destabilised due to inductive effect
- (iii)  $\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3 - \text{C}^\ominus \\ | \\ \text{CH}_3 \end{array}$  (c) Stabilised by hyperconjugation
- (iv)  $\text{CH}_3 - \overset{\oplus}{\text{CH}} - \text{CH}_3$  (d) A secondary carbocation

**Solution:**

- (i) is a, b and d  
 (ii) is b  
 (iii) is c  
 (iv) is a and d