Tips & Tricks

✍ Wohler synthesised the first organic compound urea in the laboratory.

✍ The number of optical isomers of a compound depends on its structure and number of asymmetric carbon atoms present in its molecule.

✍ Stereoisomers that are not mirror images of each other are called diastereomers.

✍ Order of priority for both asymmetric carbon atoms using sequence rules is

$$-OH > -COOH > -CH(OH)COOH > -H$$

✍ The nitration and sulphonation of alkanes involve free radicals.

✍ Carbenes undergo insertion reactions.

✍ Alkanes usually undergo free radical substitution when hydrogen is replaced by a halogen. It is catalysed by benzoyl peroxide $(C_6H_5COO)_2$.

✍ The polymerisation of alkenes is free radical addition reaction.

✍ Allyl free radical $(CH_2 = CH - CH_2)$ is more stable than *n*-propyl free radical $(CH_3CH_2CH_2)$.

✍ The stability of free radicals is explained on the basis of hyperconjugation or conjugation.

✍ Propene is more reactive than ethene towards electrophilic addition reaction due to the formation of more stable 2° carbocation.

✍ The reactivity of alkyl halides in SN^1 is 3°> 2°>1°>methyl while SN^2 is methyl > 1°> 2°> 3°.

✍ Polar solvents favour SN^1 while non polar solvents favour SN^2 reactions.

✍ Dipole moment of $CHCl_3$ is less than that of CH_2Cl_2. This is because in CH_2Cl_2 all bond moments reinforce each other while in $CHCl_3$ the bond moment of one of the Cl opposes the net moment of the other two.

✍ Low concentration of nucleophiles favour SN^1 while high concentration favour SN^2.

✍ In SN^1 the attack of the nucleophile may be from either side and so recimization takes place. However, in SN^2 the attack of the nucleophile takes place from back side. So it leads to inversion of configuration.

✍ Hunsdieker reaction proceeds via free radical mechanism.

✍ Propene reacts with chlorine at 673 K to form allyl chloride and the intermediate is allyl free radical.

Ordinary Thinking

Objective Questions

Bonding and hybridisation in organic compounds

1. In methane molecule, the hydrogen atoms around carbon are arranged as **[DPMT 1980; MNR 1981; MP PET 1997**

(a) Square planar (b) Tetrahedral

(c) Triangular (d) Octahedral

2. In carbon tetrachloride, four valence of carbon are directed to four corners of **[CPMT 1973, 77]**

(a) Rectangle (b) Square

(c) Tetrahedron (d) None of these

3. In alkene (ethene) number of sp^2 hybrid carbon atoms are

(a) 1 (b) 2

(c) 3 (d) 0

4. Each carbon atom in benzene is in the state of hybridization

[CPMT 1973, 83, 89; MP PMT 1993; KCET (Med.) 1999; DCE 2001]

(a) sp^3 (b) sp^2

(c) sp (d) s^3p

5. Which of the following hybridisation has highest percentage of *s*-character **[BHU 1986]**

(a) sp^3 (b) sp^2

(c) sp (d) None of these

6. The hybridisation present in C_2H_2 is **[EAMCET 1993]**

(a) sp (b) sp^2

(c) sp^3 (d) dsp^2

7. What hybrid orbitals will form the following compound $H_3C-CH=CH-CH_2-CH_3$ **[AFMC 1991]**

(a) sp and sp^3 (b) sp^2 and sp^3

(c) sp and sp^2 (d) Only sp^3

8. The compound in which carbon uses only its sp^3 hybrid orbitals for bond formation is **[IIT-JEE 1989]**

(a) $HCOOH$ (b) $(NH_2)_2CO$

(c) $(CH_3)_3COH$ (d) $(CH_3)_3CHO$

9. A straight chain hydrocarbon has the molecular formula C_8H_{10}. The hybridisation for the carbon atoms from one end of the chain to the other are respectively $sp^3, sp^2, sp^2, sp^3, sp^2, sp^2, sp$ and sp. The structural formula of the hydrocarbon would be **[CBSE PMT 1992]**

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

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

(c) $CH_3-CH=CH-CH_2-C\equiv C-CH=CH_2$

(d) $CH_3-CH=CH-CH_2-CH=CH-C\equiv CH$

10. Which of the following has a bond formed by overlap of $sp-sp^3$ hybrid orbitals**[MNR 1993; UPSEAT 2001, 02]**

(a) $CH_3-C\equiv C-H$

(b) $CH_3-CH=CH-CH_3$

(c) $CH_2=CH-CH=CH_2$

(d) $HC\equiv CH$

11. The bond between carbon atom (1) and carbon atom (2) in compound $N\equiv C-CH=CH_2$ involves the hybridised carbon as **[IIT-JEE 1987; DCE 2000]**

(a) sp^2 and sp^2 (b) sp^3 and sp

(c) sp and sp^2 (d) sp and sp

12. Number of π bonds in $CH_2=CH-CH=CH-C\equiv CH$ is **[Kurukshetra CEE 1991; KCET 2000]**

(a) 2 (b) 3

(c) 4 (d) 5

13. Number of π electrons present in naphthalene is **[AFMC 1991]**

(a) 4 (b) 6

(c) 10 (d) 14

14. Number of π electrons in cyclobutadienyl anion $(C_4H_4)^{-2}$ is **[IIT-JEE 1991]**

(a) 2 (b) 4

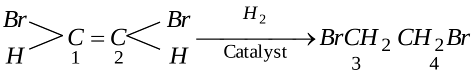
(c) 6 (d) 8

15. Homolytic fission of C - C bond in ethane gives an intermediate in which carbon is **[IIT-JEE 1992]**

(a) sp^3 hybridised (b) sp^2 hybridised

(c) sp hybridised (d) sp^2d hybridised

16. In the reaction



$$\underset{H}{\overset{Br}{}}\!>\underset{1}{C}=\underset{2}{C}<\!\underset{H}{\overset{Br}{}}\xrightarrow[\text{Catalyst}]{H_2}Br\underset{3}{CH_2}\underset{4}{CH_2}Br$$

The hybridisation states of carbon atoms 1, 2, 3, 4 are **[MP PET 1994]**

(a) 1 and 2 sp^2; 3 and 4 sp^3

(b) 1 and 2 sp^2; 3 and 4 sp

(c) 1, 2, 3 and 4 sp

(d) 1, 2 sp^3; 3, 4 sp^2

17. In which of the compounds given below is there more than one kind of hybridisation (sp, sp^2, sp^3) for carbon

(i) $CH_3CH_2CH_2CH_3$

(ii) $CH_3-CH=CH-CH_3$

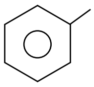
(iii) $CH_2=CH-CH=CH_2$

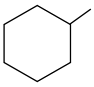
(iv) $H-C\equiv C-H$ **[CBSE PMT 1995]**

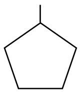
(a) (*ii*) and (*iv*) (b) (*i*) and (*iv*)

(c) (*ii*) and (*iii*) (d) (*ii*)

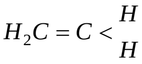
18. Examine the following common chemical structures to which simple functional groups are often attached

(i) 

(ii) 

(iii) 

(iv) $CH_3CH_2CH_2CH_2-$

(v) 

$H_2C=C<\begin{matrix}H\\H\end{matrix}$

Which of these systems have essentially planar geometry **[CBSE PMT 1995]**

(a) (*i*) and (*v*) (b) (*ii*) and (*iii*)

(c) (*ii*), (*iii*) and (*iv*) (d) (*iv*)

19. The structure of di-chloromethane is**[MP PMT 1995]**

(a) Tetrahedral (b) Trigonal

(c) Linear (d) Hexagonal

20. The numbers of sigma (σ) bonds in 1-butene is **[MP PMT 1995]**

(a) 8 (b) 10

(c) 11 (d) 12

21. Which of the following statements is false for isopentane **[MP PET 1996]**

(a) It has three CH_3 groups

(b) It has one CH_2 group

(c) It has one CH group

(d) It has a carbon which is not bonded to hydrogen

22. The number of σ bonds in *o*-xylene is**[MP PET 1996]**

(a) 6 (b) 9

(c) 12 (d) 18

23. In benzene the total number of σ bonds is**[MP PMT 1997]**

(a) 3 (b) 6

(c) 9 (d) 12

24. The number of sp^3 hybridized carbon atoms in cyclohexene are **[MP PMT 1997]**

(a) 2 (b) 3
(c) 4 (d) 6

25. The number of π bonds in 3-hexyne-1-ene is **[MP PMT 1999]**

(a) 1 (b) 2
(c) 3 (d) 4

26. Example of sp^2 hybridization is **[CPMT 1997]**

(a) CH_3^+ (b) CH_3
(c) $C_2H_5^+$ (d) C_2H_5

27. Select the molecule which has only one $\pi -$ bond **[Pb. PMT 1998]**

(a) $CH \equiv CH$ (b) $CH_2 = CHCHO$
(c) $CH_3CH = CH_2$ (d) $CH_3CH = CHCOOH$

28. Carbon atoms in the compound $(CN)_4C_2$ are **[Roorkee 1999]**

(a) *sp* hybridized
(b) sp^2 hybridized
(c) *sp* and sp^2 hybridized
(d) *sp*, sp^2 and sp^3 hybridized

29. Acetylene molecules contain **[DCE 1999]**

(a) 5σ bond
(b) 4σ bond and 1π bond
(c) 3σ and 2π
(d) 3σ and 3π

30. Number of unhybridised orbitals in vinyl acetylene are **[RPMT 1999]**

(a) 2 (b) 3
(c) 4 (d) 6

31. Maximum bond energy of $C-H$ bonds is found in the compound **[RPMT 1999]**

(a) Ethane (b) Ethene
(c) Ethyne (d) Equal in all the three

32. Ethylene possess **[RPET 1999]**

(a) Two sigma and two pi bonds
(b) Two pi bonds
(c) Five sigma and one pi bond
(d) Four sigma and one pi bond

33. The hybridization involved in the six carbon atoms of benzene is **[BHU 1999]**

(a) $3sp^3$, $3sp^2$ (b) $3sp^3$, $3sp$
(c) All $6sp$ (d) All $6sp^2$

34. 1, 3-butadiene has **[JIPMER 2000]**

(a) *sp* and sp^2 hybridised *C*-atoms
(b) *sp*, sp^2 and sp^3 hybridized *C*-atoms
(c) Only sp^2 hybridised *C*-atoms
(d) Only *sp* hybridised *C*-atoms

35. Which of the following $C-H$ bond has the lowest bond dissociation energy **[CBSE PMT 2000]**

(a) Primary (1°) $C-H$ bond
(b) Secondary (2°) $C-H$ bond
(c) Tertiary (3°) $C-H$ bond
(d) All of these

36. Number of σ and π bonds present in 1- butene-3-yne respectively are **[RPMT 1999; MP PET 2000; DCE 2000]**

(a) $7\sigma, 3\pi$ (b) $5\sigma, 2\pi$
(c) $8\sigma, 3\pi$ (d) $6\sigma, 2\pi$

37. Which is an acidic hydrocarbon **[AMU 2000]**

(a) $CH_3CH_2CH_2CH_3$ (b) $CH_3C \equiv CCH_3$
(c) $CH_3C \equiv CH$ (d) $CH_2 = CH - CH = CH_2$

38. A carbon-carbon triple bond in ethyne $(-C \equiv C-)$ consists of **[AMU 2000]**

(a) All σ bonds
(b) Two σ bonds and one π -bond
(c) One σ bond and two π bonds
(d) All π bonds

39. Toluene has **[MP PMT 2000; Kerala CET 2005]**

(a) 6σ and 3 π bond (b) 9 σ and 3π bond
(c) 9 σ and 6π bond (d) 15σ and 3π bond

40. In compound *X*, all the bond angles are exactly $109^{\circ}28'$, *X* is **[DPMT 2000]**

(a) Chloroform (b) Carbon tetrachloride
(c) Chloromethane (d) Iodoform

41. Which of the following hybridization is known as trigonal hybridization **[MH CET 2000]**

(a) sp^3 (b) *sp*
(c) sp^2 (d) dsp^2

42. The types of hybridization present in 1, 2-butadiene are **[MH CET 2000]**

(a) sp, sp^2 and sp^3 (b) sp^2 and sp^3
(c) sp^2 and sp (d) sp and sp^3

43. The *C–H* bond distance is longest in **[BHU 2001]**

(a) C_2H_2 (b) C_2H_4
(c) C_2H_6 (d) C_6H_6

44. Conjugated double bond is present in **[RPMT 1999; JIPMER 2001]**

(a) 1, 2-butadiene (b) 1, 3-butadiene
(c) 1, 3-pentadiene (d) β-butylene

45. In which of the following species is the underlined carbon having sp^3 hybridisation **[AIEEE 2002]**
(a) $CH_3\underline{C}OOH$ (b) $CH_3\,\underline{C}H_2OH$
(c) $CH_3\underline{C}OCH_3$ (d) $CH_2=\underline{C}H-CH_3$

46. The $H-C-H$ bond angle in CH_4 is **[MP PET 2002]**
(a) $109^o28'$ (b) $107^o28'$
(c) 90^o (d) 180^o

47. The hybridisation of carbons of $C-C$ single bond of $HC\equiv C-CH=CH_2$ is **[RPMT 2002]**
(a) sp^3-sp^3 (b) $sp-sp^2$
(c) sp^3-sp (d) sp^2-sp^3

48. The shape of ethylene molecule is **[AFMC 2002]**
(a) Square planar (b) Furan
(c) Trigonal planar (d) Tetrahedral

49. Acetylene molecule has carbon in **[Kerala (Engg.) 2002]**
(a) sp - hybridisation (b) sp^2 - hybridisation
(c) sp^3 - hybridisation (d) sp^3d - hybridisation

50. In the formation of methane molecule, carbon makes use of **[DPMT 2001; MP PMT 2002]**
(a) sp-hybridised orbitals (b) sp^2-hybridised orbitals
(c) sp^3-hybridised orbitals (d) Unhybridised orbitals

51. In graphite C-atom is in ....state **[CPMT 2002]**
(a) sp^3 (b) sp
(c) sp^2 (d) None of these

52. How many π-bonds are present in naphthalene molecule **[RPMT 2002]**
(a) 3 (b) 4
(c) 5 (d) 6

53. Hybridisation state of C in diamond is **[RPMT 2002]**
(a) sp (b) sp^2
(c) sp^3 (d) sp^3d

54. The number of σ and π bonds present in pent-4-ene, 1-yne is **[AIIMS 2002; CPMT 2002]**
(a) 10, 3 (b) 3, 10
(c) 4, 9 (d) 9, 4

55. Which one of the following is more acidic **[DPMT 2002]**
(a) Butane (b) 1-butene
(c) 1-butyne (d) 2-butyne

56. Graphite is soft while diamond is hard because **[BHU 2003]**
(a) Graphite is in powder form
(b) Diamond has sp^2 hybridization but graphite has sp^3 hybridization
(c) Graphite is in planar form while diamond is in tetrahedral form
(d) Graphite is covalent and diamond is ionic

57. Hybridization of 1 and 2 carbon atoms in
$\overset{1}{C}H_2=\overset{2}{C}=CH_2$ **[BHU 2003]**
(a) sp, sp (b) sp^2, sp^2
(c) sp^2, sp (d) sp^3, sp^2

58. Hydrogen bonding is maximum in **[UPSEAT 2003]**
(a) C_2H_5OH (b) CH_3-O-CH_3
(c) $(CH_3)_2C=O$ (d) CH_3CHO

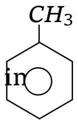
59. How many methyl group are present in 2, 5-dimethyl-4-ethylheptane **[EAMCET 2003]**
(a) 2 (b) 3
(c) 4 (d) 5

60. Which one of the following does not have sp^2 hybridised carbon **[AIEEE 2004]**
(a) Acetonitrile (b) Acetic acid
(c) Acetone (d) Acetamide

61. Allyl cyanide contain σ- and π-bonds **[MP PET 2004]**
(a) $9\sigma, 3\pi$ (b) $9\sigma, 9\pi$
(c) $3\sigma, 4\pi$ (d) $5\sigma, 7\pi$

62. Strongest acid is **[MP PMT 2004]**
(a) $HC\equiv CH$ (b) C_2H_6
(c) C_6H_6 (d) CH_3OH

63. $-C\equiv C-$ bond is found in **[BHU 1982; MP PMT 1994]**
(a) Ethene (b) Butene
(c) Ethyne (d) Glycerine

64. Number of σ bonds in  **[CPMT 1994]**

(a) 6 (b) 15
(c) 10 (d) 12

65. Number of bonds in benzene **[DPMT 2005]**
(a) 6σ and 3π (b) 12σ and 3π
(c) 3π and 12π (d) 6σ and 6π

66. Which is most acidic of the following **[J & K 2005]**
(a) Methane (b) Acetylene
(c) 1-butene (d) Neo-pentane

67. The enolic form of acetone contains **[Pb. PMT 2002]**
(a) 8 σ bonds, 2π-bonds and 1 lone pairs
(b) 9σ-bonds, 1π-bond and 2 lone pairs
(c) 9σ-bonds, 2π-bonds and 1 lone pairs
(d) 10 σ-bonds, 1 π-bonds and 1 lone pairs

Dipole moment, resonance and reaction intermediates

1. Which has zero dipole moment **[NCERT 1990; BHU 2001]**

(a) *cis*-2-butene (b) *trans*-2-butene
(c) 1-butene (d) 2-methyl-1-propene

2. Dipole moment is shown by **[DCE 1999]**
(a) 1, 4-dichloro benzene
(b) Cis-1, 2-dichloro ethane
(c) Trans-1, 2-dichloro, 2-pentene
(d) Trans-1, 2-dichloro ether

3. Which compound shows dipole moment **[RPMT 2002]**
(a) 1,4-di-chloro benzene
(b) 1, 2-di-chloro benzene
(c) Trans-1, 2-di-chloro ethene
(d) Trans-2-butene

4. Which of the following is a polar compound **[MH CET 2003]**
(a) C_2H_6 (b) CCl_4
(c) HCl (d) CH_4

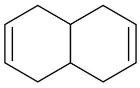
5. The dipole moment is the highest for **[AIIMS 2004]**
(a) *Trans*-2-butene (b) 1, 3-Dimethylbenzene
(c) Acetophenone (d) Ethanol

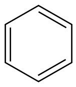
6. Resonance structure of molecule does not have **[IIT-JEE 1984]**
(a) Identical arrangement of atoms
(b) Nearly the same energy content
(c) The same number of paired electrons
(d) Identical bonding

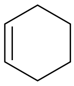
7. All bonds in benzene are equal due to **[Roorkee 1990; KCET 1998]**
(a) Tautomerism (b) Inductive effect
(c) Resonance (d) Isomerism

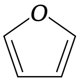
8. Aromatic properties of benzene are proved by **[MP PMT 1994]**
(a) Aromatic sextet theory (b) Resonance theory
(c) Molecular orbital theory (d) All of these

9. Which of the following will show aromatic behaviour **[KCET 1996]**

(a) 

(b) 

(c) 

(d) 

10. Which one of the following orders is correct regarding the inductive effect of the substituents **[CBSE PMT 1998]**
(a) $-NR_2 < -OR > -F$ (b) $-NR_2 > -OR > -F$
(c) $-NR_2 < -OR < -F$ (d) $-NR_2 > -OR < -F$

11. Benzene is unreactive because **[KCET 1998]**
(a) It has double bonds
(b) It has carbon-carbon single bond
(c) Carbon are sp^2 hybridised
(d) π electrons are delocalised

12. Carboxylic acids are easily ionised. The main reason of this statement **[UPSEAT 1999]**
(a) Absence of α-hydrogen
(b) Resonance stabilisation of carboxylate ion
(c) Reactivity of α-hydrogen
(d) Hydrogen bond

13. '$C-C$' bond length in benzene lies between single and double bond. The reason is **[RPET 1999]**
(a) Resonance (b) Isomerism
(c) Metamerism (d) Inductive effect

14. Credit for the ring structure of benzene goes to **[RPET 1999]**
(a) Wholer (b) Faraday
(c) Kekule (d) Baeyer

15. Polarisation of electrons in acroline may be written as **[DCE 2000]**
(a) $CH_2^{\delta-} = CH - CH^{\delta+} = O$
(b) $CH_2^{\delta-} = CH - CH = O^{\delta+}$
(c) $CH_2^{\delta-} = CH^{\delta+} - CH = O$
(d) $CH_2^{\delta+} = CH - CH = O^{\delta-}$

16. In the mixture of conc. H_2SO_4 and HNO_3 the nitrating species is **[MP PMT 2000]**
(a) N_2O_4 (b) NO_2^+
(c) NO_2 (d) NO_2^-

17. Which of the following are not aromatic **[DCE 2001]**
(a) Benzene
(b) Cyclo-octatetrarenyl dianion
(c) Tropyllium cation
(d) Cyclopentadienyl cation

18. Arrangement of $(CH_3)_3-C-(CH_2)_3-CH-CH_3-CH_2-CH_3$ when attached to benzyl or an unsaturated group in increasing order of inductive effect is
(a) $(CH_3)_3-C- < (CH_3)_2-CH- < CH_3-CH_2-$
(b) $CH_3-CH_2- < (CH_3)_2-CH- < (CH_3)_3-C-$
(c) $(CH_3)_2-CH- < (CH_3)_3-C- < CH_3-CH_2-$
(d) $(CH_2)_3-C- < CH_3-CH_2- < (CH_3)_2-CH-$

19. Which of the following is observed in ethylene molecule **[MH CET 2002]**
(a) Electromeric effect (b) Inductive effect
(c) Homolytic fission (d) None of these

20. Cyclopentadienyl anion is **[Orissa JEE 2003]**
(a) Aromatic (b) Non-aromatic
(c) Non-planar (d) Aliphatic

21. Orbital interaction between the sigma bonds of a substituent group and a neighbouring *pi* orbital is known as

[Kerala PMT 2004]

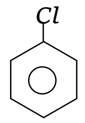
(a) Hyperconjugation
(b) Inductive effect
(c) Steric effect
(d) Dipole-dipole interactions
(e) Electric quadruple interactions

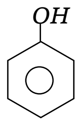
22. Which of the following is the most stable compound

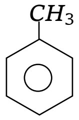
[BHU 2004]

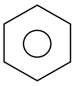
(a) $Ph_3\overset{+}{C}$ (b) $Ph_2\overset{+}{C}H$
(c) $Ph_3\overset{+}{C}H_2$ (d) $Ph\overset{+}{C}H_2$

23. Which of the following will be most easily attacked by an electrophile [MP PET 2004]

(a) 

(b) 

(c) 

(d) 

24. Reactivity towards nucleophilic addition reaction of (I) $HCHO$, (II) CH_3CHO, (III) CH_3COCH_3 is

[Orissa JEE 2004]

(a) II > III > I (b) III > II > I
(c) I > II > III (d) I > II < III

25. Which of the following resonating structures of 1-methoxy-1, 3-butadiene is least stable[IIT Screening 2005]

(a) $\overset{\ominus}{C}H_2 - CH = CH - CH = \overset{\oplus}{O} - CH_3$

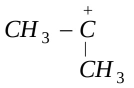
(b) $CH_2 = CH_2 - \overset{\ominus}{C}H - CH = \overset{\oplus}{O} - CH_3$

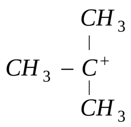
(c) $\overset{\ominus}{C}H_2 - \overset{\oplus}{C}H - CH = CH - O - CH_3$

(d) $CH_2 = CH - \overset{\ominus}{C}H - \overset{\oplus}{C}H - O - CH_3$

26. Which amongst the following is the most stable carbocation

[CBSE PMT 2005]

(a) 
$CH_3 - \overset{+}{C}(CH_3)$

(b) 
$CH_3 - C^{+}(CH_3)_2$

(c) $\overset{+}{C}H_3$ (d) $CH_3\overset{+}{C}H_3$

27. Which is the decreasing order of stability

[IIT-JEE (Screening) 1993]

(i) $CH_3 - \overset{+}{C}H - CH_3$

(ii) $CH_3 - \overset{+}{C}H - O - CH_3$

(iii) $CH_3 - \overset{+}{C}H - CO - CH_3$

(a) $(i) < (ii) < (iii)$ (b) $(i) > (ii) > (iii)$
(c) $(iii) > (ii) > (i)$ (d) $(ii) > (iii) > (i)$

28. The order of decreasing stability of the carbanions

(1) $(CH_3)_3\overset{-}{\ddot{C}}$ (2) $(CH_3)_2\overset{-}{\ddot{C}}H$
(3) $CH_3\overset{-}{\ddot{C}}H_2$ (4) $C_6H_5\overset{-}{\ddot{C}}H_2$ is

(a) 1 > 2 > 3 > 4 (b) 4 > 3 > 2 > 1
(c) 4 > 1 > 2 > 3 (d) 1 > 2 > 4 > 3

29. Choose the chain terminating step

(1) $H_2 \to H^\bullet + H^\bullet$

(2) $Br_2 \to Br^\bullet + Br^\bullet$

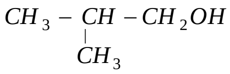
(3) $Br^\bullet + HBr \to H^\bullet + Br_2$

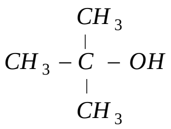
(4) $H^\bullet + Br_2 \to HBr + Br^\bullet$

(5) $Br^\bullet + Br^\bullet \to Br_2$ [RPET 2000]

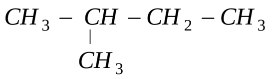
(a) 1 (b) 3
(c) 4 (d) 5

30. The compound, which gives the most stable carbonium on dehydrogenation [UPSEAT 2001]

(a) 
$CH_3 - CH(CH_3) - CH_2OH$

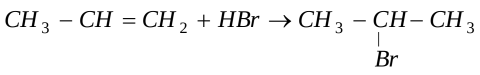
(b) 
$CH_3 - C(CH_3)_2 - OH$

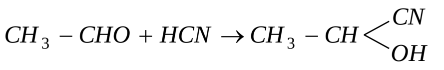
(c) $CH_3 - CH_2 - CH_2 - CH_2OH$

(d) 
$CH_3 - CH(CH_3) - CH_2 - CH_3$

31. Which of the following requires radical intermediate

[Orissa JEE 2004]

(a) 
$CH_3 - CH = CH_2 + HBr \to CH_3 - CH(Br) - CH_3$

(b) 
$CH_3 - CHO + HCN \to CH_3 - CH(CN)(OH)$

(c) $CH_3 - CH = CH_2 + HBr \to CH_3 - CH_2 - CH_2 - Br$

(d) $CH_3CHO + NH_2OH \xrightarrow{H^+} CH_3 - CH = N - OH$

32. Which of the following species is paramagnetic in nature

[NCERT 1984]

(a) Free radical (b) Carbonium ion
(c) Carbanion (d) All the above

33. In which of the following species the central C-atom is negatively charged [NCERT 1985]

(a) Carbanion (b) Carbonium ion
(c) Carbocation (d) Free radical

34. Which of the following free radicals is most stable

[NCERT 1982]

(a) Primary (b) Methyl
(c) Secondary (d) Tertiary

35. Which of the following contains three pairs of electrons

[BHU 1985]

(a) Carbocation (b) Carbanion

(c) Free radical (d) None of these

36. Which of the following carbanion is most stable **[NCERT 1983]**

(a) Methyl (b) Primary

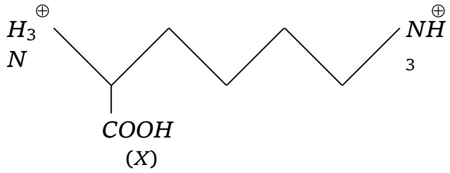
(c) Secondary (d) Tertiary

37. Among the given cations, the most stable carbonium ion is **[IIT-JEE 1981]**

(a) *sec*-butyl (b) *ter*-butyl

(c) *n*-butyl (d) None of these

38. In the compound given below



The correct order of the acidity of the positions (X), (Y) and (Z) is **[IIT-JEE Screening 2004]**

(a) $(Z) > (X) > (Y)$ (b) $(X) > (Y) > (Z)$

(c) $(X) > (Z) > (Y)$ (d) $(Y) > (X) > (Z)$

39. C-C bond length in benzene is **[MP PMT 1987; MP PMT 2001; AIIMS 2001]**

(a) 1.39 $\mathring{A}$

(b) 1.54 $\mathring{A}$

(c) 1.34 $\mathring{A}$

(d) Different in different bonds

40. Heterolysis of carbon-chlorine bond produces **[MNR 1986; MP PET/PMT 1998]**

(a) Two free radicals

(b) Two carbonium ions

(c) Two carbanions

(d) One cation and one anion

41. In CH_3CH_2OH, the bond that undergoes heterolytic cleavage most readily is **[IIT-JEE 1988]**

(a) $C-C$ (b) $C-O$

(c) $C-H$ (d) $O-H$

42. Which of the following intermediate have the complete octet around the carbon atom **[Orissa JEE 2003]**

(a) Carbonium ion (b) Carbanion ion

(c) Free radical (d) Carbene

43. A solution of D (+) - 2-chloro-2-phenylethane in toluene racemises slowly in the presence of small amount of $SbCl_5$, due to the formation of **[IIT-JEE 1999]**

(a) Carbanion (b) Carbene

(c) Free radical (d) Carbocation

44. The reagent in Friedel Craft's reaction is **[DPMT 2005]**

(a) Pyridine (b) $RCOCl$

(c) $RCOOH$ (d) HCl

45. Which gives monosubstituted product **[DPMT 2005]**

(a) o-dinitrobenzene (b) m-dinitrobenzene

(c) p-dinitrobenzene (d) Nitrobenzene

46. An aromatic compounds among other things should have a π-electron cloud containing electrons where n can't be **[J & K 2005]**

(a) 1/2 (b) 3

(c) 2 (d) 1

47. Which of the following is an electrophile **[J & K 2005]**

(a) H_2O (b) SO_3

(c) NH_3 (d) ROR

48. The presence of the chlorine atom on benzene ring makes the second substituent enter at a position **[J & K 2005]**

(a) *ortho* (b) *meta*

(c) *para* (d) *ortho/para*

49. Which is the most stable carbocation **[J & K 2005]**

(a) iso-propyl (b) Triphenylmethyl cation

(c) Ethyl cation (d) π-propyl cation

Organic reactions and their mechanism

1. To which of the following four types does this reaction belong $B^- + R-A \rightarrow B-R+A^-$ **[Manipal MEE 1995]**

(a) Unimolecular electrophilic substitution

(b) Bimolecular electrophilic substitution

(c) Unimolecular nucleophilic substitution

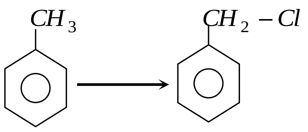
(d) Bimolecular nucleophilic substitution

2. An alkyl halide may be converted into an alcohol by **[Pb. PMT 2000]**

(a) Elimination (b) Addition

(c) Substitution (d) Dehydrohalogenation

3.



The above reaction proceeds through **[AMU 2000]**

(a) Nucleophilic substitution

(b) Electrophilic substitution

(c) Free radical substitution

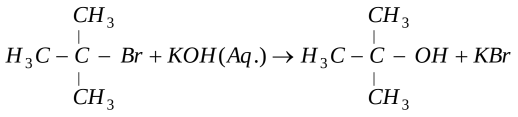
(d) More than one of the above processes

4. Geometry of reaction intermediate in SN^1 reaction is **[MH CET 2001]**

(a) Tetrahedral (b) Planar

(c) Triangular bipyramidal (d) None of these

5.



$$H_3C-\overset{\overset{CH_3}{|}}{\underset{\underset{CH_3}{|}}{C}}-Br+KOH(Aq.)\rightarrow H_3C-\overset{\overset{CH_3}{|}}{\underset{\underset{CH_3}{|}}{C}}-OH+KBr$$

above reaction is **[RPMT 2003]**

(a) SN^1 (b) SN^2

(c) E_1 (d) Both (a) and (b)

6. In electrophilic substitution reaction nitrobenzene is **[Kerala (Med.) 2003]**

(a) Meta-directing

(b) Ortho-directing

(c) Para-directing

(d) Not reactive and does not undergo any substitution

(e) Non-selective

7. The most common type of reaction in aromatic compounds is **[Orissa JEE 2003]**

(a) Elimination reaction

(b) Addition reaction

(c) Electrophilic substitution reaction

(d) Rearrangement reaction

8. The function of $AlCl_3$ in Friedel-Craft's reaction is **[KCET 2003]**

(a) To absorb HCl (b) To absorb water

(c) To produce nucleophile (d)To produce electrophile

9. Which of the following can't be used in Friedal Craft's reactions **[AFMC 2004]**

(a) $FeCl_3$ (b) $FeBr_2$

(c) $AlCl_3$ (d) $NaCl$

10. The nitration of a compound is due to the**[Pb. PMT 2004]**

(a) NO_2 (b) NO_3

(c) NO (d) NO_2^+

11. Dehydrohalogenation of an alkyl halide is a/an **[MH CET 2004]**

(a) Nucleophilic substitution reaction

(b) Elimination reaction

(c) Both nucleophilic substitution and elimination reaction

(d) Rearrangement

12. Addition of HCl to vinyl chloride gives 1, 1-dichloroethane because of **[MP PET 2004]**

(a) Mesomeric effect of Cl

(b) Inductive effect of Cl

(c) Restricted rotation around double bond

(d) None of these

13. Formation of ethylene from acetylene is an example of

(a) Elimination reaction (b) Substitution reaction

(c) Addition reaction (d) Condensation reaction

14. Conversion of CH_4 to CH_3Cl is an example of which of the following reaction **[Pb. CET 2001]**

(a) Electrophilic substitution

(b) Free radical addition

(c) Nucleophilic substitution

(d) Free radical substituion

15. Following reaction, $(CH_3)_3CBr + H_2O \rightarrow (CH_3)_3COH + HBr$ is an example of **[DCE 2002]**

(a) Elimination reaction (b) Free radical substitution

(c) Nucleophilic substitution(d)Electrophilic substitution

16. Which is an electrophile **[DCE 2002]**

(a) BCl_3 (b) CH_3OH

(c) NH_3 (d) $AlCl_4^-$

17. The electrophile in the nitration of benzene is **[Orissa JEE 2004]**

(a) NO_2^+ (b) NO_2

(c) NO^+ (d) NO_2^-

18. The following compound will undergo electrophilic substitution more readily than benzene **[UPSEAT 2004]**

(a) Nitrobenzene (b) Benzoic acid

(c) Benzaldehyde (d) Phenol

19. Which represents nucleophilic aromatic substitution reaction **[Orissa JEE 2004]**

(a) Reaction of benzene with Cl_2 in sunlight

(b) Benzyl bromide hydrolysis

(c) Reaction of $NaOH$ with dinitrofluorobenzene

(d) Sulphonation of benzene

20. Which is an electrophile **[DCE 2000]**

(a) $AlCl_3$ (b) CN^-

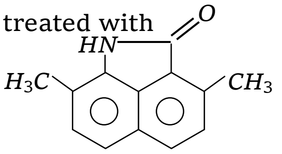
(c) NH_3 (d) CH_3OH

21. Strongest nucleophile is **[BHU 2003]**

(a) RNH_2 (b) ROH

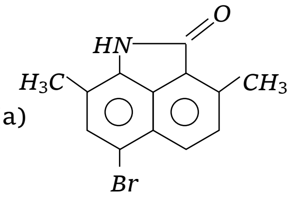
(c) $C_6H_5O^-$ (d) CH_3O^-

22. The major product obtained when Br_2/Fe is treated with

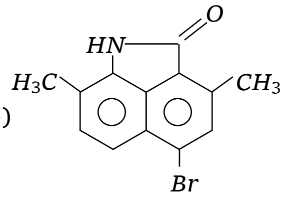


is **[IIT-JEE Screening 2004]**

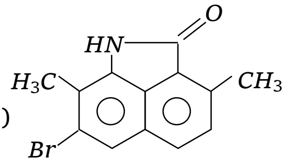
(a)



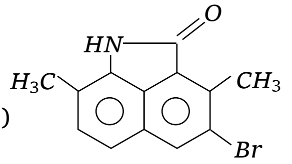
(b)



(c)



(d)



23. Which one of the following is least reactive in a nucleophilic substitution reaction **[CBSE PMT 2004]**

(a) CH_3CH_2Cl (b) $CH_2 = CHCH_2Cl$

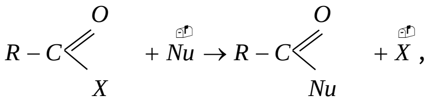
(c) $(CH_3)_3C-Cl$ (d) $CH_2=CHCl$

24. Among the following the strongest nucleophile is **[AIIMS 2005]**

(a) C_2H_5SH (b) CH_3COO^-

(c) CH_3NH_2 (d) $NCCH_2^-$

25. The reaction **[AIEEE 2005]**



$R-\overset{O}{\overset{\|}{C}}-X + \overset{\ominus}{Nu} \rightarrow R-\overset{O}{\overset{\|}{C}}-Nu + \overset{\ominus}{X}$, is fastest when X is

(a) Cl (b) NH_2

(c) OC_2H_5 (d) $OCOR$

26. Elimination of bromine from 2-bromobutane results in the formation of **[AIEEE 2004, 05]**

(a) Equimolar mixture of 1 and 2-butene
(b) Predominantly 2-butene
(c) Predominantly 1-butene
(d) Predominantly 2-butyne

27. Examine the following statements pertaining to an SN^2 reaction

(1) The rate of reaction is independent of the concentration of the nucleophile
(2) The nucleophile attacks the C^- atom on the side of the molecule opposite to the group being displaced
(3) The reaction proceeds with simultaneous bond formation and bond rupture/cleavage

Amongst the following which of the above were true **[NCERT 1982]**

(a) 1, 2 (b) 1, 3
(c) 1, 2, 3 (d) 2, 3

28. What is the decreasing order of reactivity amongst the following compounds towards aromatic electrophilic substitution **[IIT-JEE 1995]**

I. Chlorobenzene II. Benzene
III. Anilinium chloride IV. Toluene

(a) $I > II > III > IV$ (b) $IV > II > I > III$
(c) $II > I > III > IV$ (d) $III > I > II > IV$

29. Which of the following applies in the reaction,

$CH_3CHBrCH_2CH_3 \xrightarrow{alc.KOH}$

(i) $CH_3CH=CHCH_3$ (major product)

(ii) $CH_2=CHCH_2CH_3$ (minor product) **[Orissa JEE 2005]**

(a) Markovnikov's rule (b) Saytzeff's rule
(c) Kharasch effect (d) Hofmann's rule

30. Bromination of alkanes involves **[J & K 2005]**

(a) Carbanions (b) Carbocations
(c) Carbenes (d) Free radicals

31. Which of the following cannot undergo nucleophilic substitution under ordinary conditions **[J & K 2005]**

(a) Chlorobenzene (b) *tert*-butylchloride
(c) Isopropyl chloride (d) None of these

32. Which of the following alkyl groups has the maximum + I effect **[KCET 2002]**

(a) CH_3- (b) $(CH_3)_2CH-$
(c) $(CH_3)_3C-$ (d) CH_3CH_2-

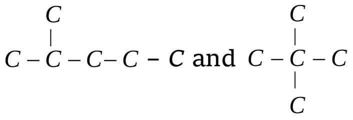
Structural and stereo isomerism

1. Only two isomers of monochloro product is possible of **[IIT-JEE 1986]**

(a) *n*-butane (b) 2,4-dimethyl pentane
(c) Benzene (d) 1-methyl propane

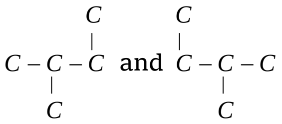
2. Which is the example of branch isomerization **[NCERT 1976]**

(a)



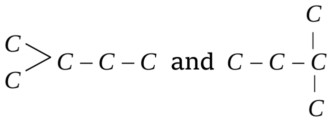
$C-\overset{\overset{C}{|}}{C}-C-C-C$ and $C-\underset{\underset{C}{|}}{\overset{\overset{C}{|}}{C}}-C$

(b)



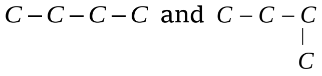
$C-\underset{\underset{C}{|}}{C}-\overset{\overset{C}{|}}{C}$ and $\overset{\overset{C}{|}}{C}-\underset{\underset{C}{|}}{C}-C$

(c)



$\begin{matrix}C\\C\end{matrix}\!\!>C-C-C$ and $C-C-\underset{\underset{C}{|}}{\overset{\overset{C}{|}}{C}}$

(d)



$C-C-C-C$ and $C-C-\underset{\underset{C}{|}}{C}$

3. The isomer of diethyl ether is **[CPMT 1975]**

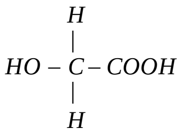
(a) $(CH_3)_2CHOH$ (b) $(CH_3)_3C-OH$
(c) C_3H_7OH (d) $(C_2H_5)_2CHOH$

4. Isomers have essentially identical **[CBSE PMT 1988; MP PMT 1983, 86]**

(a) Structural formula (b) Chemical properties
(c) Molecular formula (d) Physical properties

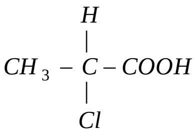
5. Which one of the following shows optical activity **[NCERT 1984, 90]**

(a)



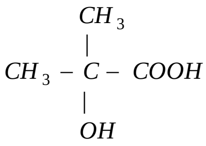
$HO-\underset{\underset{H}{|}}{\overset{\overset{H}{|}}{C}}-COOH$

(b)



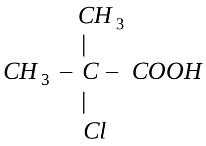
$CH_3-\underset{\underset{Cl}{|}}{\overset{\overset{H}{|}}{C}}-COOH$

(c)



$CH_3-\underset{\underset{OH}{|}}{\overset{\overset{CH_3}{|}}{C}}-COOH$

(d)



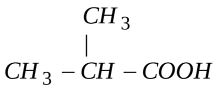
$CH_3-\underset{\underset{Cl}{|}}{\overset{\overset{CH_3}{|}}{C}}-COOH$

6. In ethane and cyclohexane which one of the following pairs of conformations are more stable

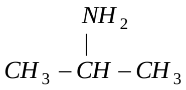
(a) Eclipsed and chair conformations
(b) Staggered and chair conformations
(c) Staggered and boat conformations
(d) Eclipsed and boat conformations

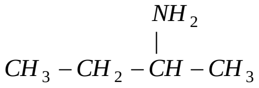
7. Which of the following may exist in enantiomorphs

[CBSE PMT 1988]

(a) 
$CH_3-\overset{CH_3}{\overset{|}{CH}}-COOH$

(b) $CH_2=CHCH_2CH_2CH_3$

(c) 
$CH_3-\overset{NH_2}{\overset{|}{CH}}-CH_3$

(d) 
$CH_3-CH_2-\overset{NH_2}{\overset{|}{CH}}-CH_3$

8. Which of the following compounds may not exist as enantiomers **[CPMT 1987]**

(a) $CH_3CH(OH)CO_2H$

(b) $CH_3CH_2CH(CH_3)CH_2OH$

(c) $C_6H_5CH_2CH_3$

(d) $C_6H_5CHClCH_3$

9. Number of isomers of molecular formula $C_2H_2Br_2$ are

[CPMT 1987]

(a) 1 (b) 2

(c) 3 (d) 0

10. Lactic acid shows which type of isomerism **[CPMT 1987; MP PMT 1987; BHU 2003]**

(a) Geometrical isomerism (b) Tautomerism

(c) Optical isomerism (d) Metamerism

11. Which one of the following is an optically active compound

[CBSE PMT 1988; DPMT 1983]

(a) *n*-propanol (b) 2-chlorobutane

(c) *n*-butanol (d) 4-hydroxyheptane

12. Compounds with same molecular formula but different structural formulae are called **[BHU 1979; AFMC 1989]**

(a) Isomers (b) Isotopes

(c) Isobars (d) Isoelectronic

13. Which one of the following compounds shows optical isomerism **[MP PET 1990]**

(a) $CH_3CHCl-CH_2-CH_3$

(b) $CH_3-CH_2-CHCl-CH_2-CH_3$

(c) $ClCH_2-CH_2-CH_2-CH_3$

(d) $ClCH_2-CH_2-CH_3$

14. Which one of the following objects is 'achiral'

(a) Letter P (b) Letter F

(c) Ball (d) A pair of hand

15. Total number of isomers of a disubstituted benzene compound is

(a) 1 (b) 2

(c) 3 (d) 4

16. Separating of *d* and *l* enantiomorphs from a racemic mixture is called **[CBSE PMT 1988; DPMT 1983; KCET 2002]**

(a) Resolution (b) Dehydration

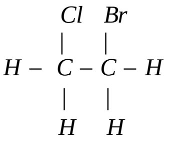
(c) Rotation (d) Dehydrohalogenation

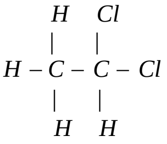
17. Number of optical isomers of lactic acid are

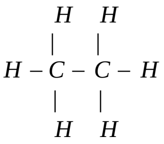
(a) 1 (b) 2

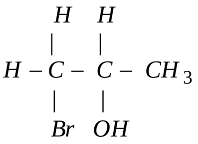
(c) 3 (d) 4

18. Which one of the following contains asymmetric carbon atom **[IIT-JEE 1989; Roorkee 2000]**

(a) 
$H-\underset{H}{\overset{Cl}{C}}-\underset{H}{\overset{Br}{C}}-H$

(b) 
$H-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{Cl}{C}}-Cl$

(c) 
$H-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-H$

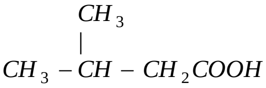
(d) 
$H-\underset{Br}{\overset{H}{C}}-\underset{OH}{\overset{H}{C}}-CH_3$

19. *n*-butane and isobutane are examples of

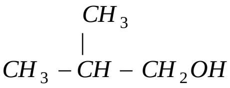
(a) Chain isomers (b) Geometrical isomers

(c) Position isomers (d) Tautomers

20. Which of the following has chiral structure

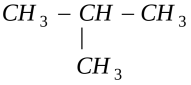
(a) 
$CH_3-\overset{CH_3}{\overset{|}{CH}}-CH_2COOH$

(b) $CH_3-CH=CH-CH_3$

(c) 
$CH_3-\overset{CH_3}{\overset{|}{CH}}-CH_2OH$

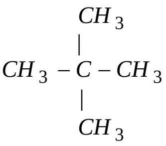
(d) $CH_3-CHOH-CH_2CH_3$

21. Which of the following pairs is an example of position isomerism

(a) $CH_3-CH_2-CH_2-CH_3$ and 
$CH_3-\underset{CH_3}{\underset{|}{CH}}-CH_3$

(b) $CH_3-CH_2-CH=CH_2$ and $CH_3-CH=CH-CH_3$

(c) CH_3-CH_2OH and CH_3-O-CH_3

(d) 
$CH_3-\underset{CH_3}{\underset{|}{\overset{CH_3}{\overset{|}{C}}}}-CH_3$ and $CH_3-CH_2-CH_2-CH_2-CH_3$

22. Geometrical isomerism is shown by **[IIT-JEE 1983; CPMT 1990, 94; CBSE PMT 1992; MP PET 1997; AMU (Engg.) 1999]**

(a) 2-butene (b) 2-butyne

(c) 2-butanol (d) Butanal

23. An organic compound exhibits optical isomerism when

[CPMT 1971, 78, 81; MP PET 1999]

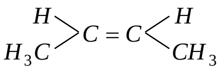
(a) Four groups linked to carbon atom are different

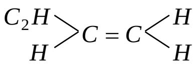
(b) Three groups linked to carbon atom are different

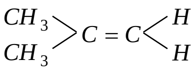
(c) Two groups linked to carbon atom are different

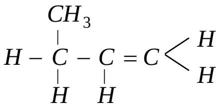
(d) All the groups linked to carbon atom are same

24. Which one of the following exhibits geometrical isomerism **[NCERT 1979; DPMT 1984; CBSE PMT 1990]**

(a) 

(b) 

(c) 

(d) 

25. Maximum number of isomers of alkene C_4H_8 are **[IIT-JEE 1982; MP PMT 1985; MADT Bihar 1995; Kerala (Engg.) 2002]**

(a) 2 (b) 3

(c) 4 (d) 6

26. Rotation of plane polarised light is measured by **[CPMT 1985; DCE 2001]**

(a) Manometer (b) Polarimeter

(c) Viscometer (d) Refractometer

27. An alkane forms isomers if the number of least carbon atom is **[CPMT 1976; BHU 1985, 89]**

(a) 1 (b) 2

(c) 3 (d) 4

28. Which is not found in alkenes**[AIIMS 1982; RPMT 1999]**

(a) Chain isomerism (b) Geometrical isomerism

(c) Metamerism (d) Position isomerism

29. How many isomers of $C_5H_{11}OH$ will be primary alcohols **[CBSE PMT 1992]**

(a) 2 (b) 3

(c) 4 (d) 5

30. The compound $C_4H_{10}O$ can show **[IIT-JEE 1981; MP PET 2000]**

(a) Metamerism (b) Functional isomerism

(c) Positional isomerism (d) All types

31. The number of possible alcoholic isomers for $C_4H_{10}O$ are **[DPMT 1984; MNR 1986]**

(a) 4 (b) 2

(c) 3 (d) 5

32. How many isomers are possible for C_4H_8O **[MNR 1992; UPSEAT 2001, 02]**

(a) 3 (b) 4

(c) 5 (d) 6

33. Which of the following can exhibit *cis-trans* isomerism **[CBSE PMT 1989]**

(a) $HC \equiv CH$ (b) $ClCH = CHCl$

(c) $CH_3.CHCl.COOH$ (d) $ClCH_2 - CH_2Cl$

34. The number of geometrical isomers in case of a compound with the structure $CH_3 - CH = CH - CH = CH - C_2H_5$ is **[NCERT 1980]**

(a) 4 (b) 3

(c) 2 (d) 5

35. The property by virtue of which a compound can turn the plane polarised light is known as**[BHU 1979]**

(a) Photolysis (b) Phosphorescence

(c) Optical activity (d) Polarization

36. Meso-tartaric acid is optically inactive due to the presence of **[AIIMS 1982; MP PMT 1987]**

(a) Molecular symmetry

(b) Molecular asymmetry

(c) External compensation

(d) Two asymmetric C-atoms

37. Which of the following compounds exhibits optical isomerism**[BHU 1983; AFMC 1990; CPMT 1993; MP PMT 1999, 2000]**

(a) CH_3CH_2COOH (b) $CH_3CHOHCOOH$

(c) $CH_3CH_2CH_2OH$ (d) $CH_3CHOHCH_3$

38. The maximum number of stereoisomers possible for 2-hydroxy-2-methyl butanoic acid is**[Roorkee 1992]**

(a) 1 (b) 2

(c) 3 (d) 4

39. Which one of the following pairs represents the stereoisomerism **[AIIMS 1992]**

(a) Geometrical isomerism, position isomerism

(b) Geometrical isomerism, conformational isomerism

(c) Optical isomerism, geometrical isomerism

(d) Optical isomerism, metamerism

40. Diethyl ether is not associated with which one of these isomers **[AFMC 1993]**

(a) Butanoic acid (b) Methyl propionate

(c) Steroisomerism (d) None of these

41. Diethyl ether and methyl *n*-propyl ether are **[MP PET 1994; AFMC 1999; MP PMT 2002]**

(a) Position isomers (b) Functional isomers

(c) Metamers (d) Chain isomers

42. *n*-propyl alcohol and isopropyl alcohol are examples of **[MP PMT 1994]**

(a) Position isomerism (b) Chain isomerism

(c) Tautomerism (d) Geometrical isomerism

43. It is possible to distinguish between optical isomers by

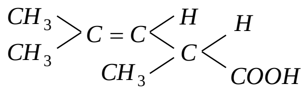
[Manipal MEE 1995; AFMC 1995]

(a) Infrared spectroscopy
(b) Mass spectrometry
(c) Melting point determination
(d) Polarimetry

44. The isomerism exhibited by alkyl cyanide and alkyl isocyanide is **[AFMC 1995, 97]**

(a) Functional (b) Positional
(c) Tautomerism (d) Metamerism

45. The following compound can exhibits



[IIT-JEE 1995; DCE 2000]

(a) Tautomerism
(b) Optical isomerism
(c) Geometrical isomerism
(d) Geometrical and optical isomerisms

46. Name the compound, that is not isomer with diethyl ether

[IIT-JEE 1981; CPMT 1989; MADT Bihar 1995]

(a) *n*-propylmethyl ether
(b) Butane-1-ol
(c) 2-methylpropane-2-ol
(d) Butanone

47. Which statement is true for cyclohexane **[MP PET 1996]**

(a) It has two possible isomers
(b) It has three conformations
(c) Boat conformation is most stable
(d) Chair and boat conformations differ in energy by 44 *kJ/mol*

48. Two compounds have the structural formulae $CH_3-O-CH_2CH_3$ and $CH_3-CH_2-CH_2OH$. The above is an example of

(a) Metamerism (b) Functional isomerism
(c) Positional isomerism (d) Chain isomerism

49. Which of the following pairs are not isomeric compounds

(a) Ethyl ethanoate and methyl propanoate
(b) Butanone and butanal
(c) Ethoxy propane and propoxy ethane
(d) Methoxy methane and ethanol

50. Functional isomerism is exhibited by the following pair of compounds

(a) Acetone, propionaldehyde
(b) Diethyl ether, methyl propyl ether
(c) Butane, isobutane
(d) 1-butene, 2-butene

51. The total number of possible isomeric trimethyl benzene is

[MP PET 1997]

(a) 2 (b) 3
(c) 4 (d) 6

52. Optically active isomers but not mirror images are called

[MP PET 1999]

(a) Enantiomers (b) Mesomers
(c) Tautomers (d) Diastereoisomers

53. C_7H_9N has how many isomeric forms that contain a benzene ring **[CPMT 1997, 99; JIPMER 2002; DCE 2**

(a) 4 (b) 5
(c) 6 (d) 7

54. The total number of isomers formed by C_5H_{10} is

[Bihar MEE 1996]

(a) 2 (b) 3
(c) 4 (d) 5
(e) None of these

55. Which of the following contains asymmetric centre

[CPMT 1996]

(a) 2-butene (b) 2, 2-dimethylpropane
(c) 2-hexyne (d) Lactic acid

56. Which of the following cannot be given to exemplify chiral structure **[JIPMER 1997]**

(a) A shoe (b) A screw
(c) A screw driver (d) All of these

57. Which of the following is expected to be optically active

[JIPMER 1997]

(a) $(CH_3)_4C$ (b) $C_2H_5CH(CH_3)C_3H_7$
(c) $(C_2H_5)_2CHCH_3$ (d) $CH_3CH=CHCH_3$

58. Which compound does not show geometrical isomerism

[RPMT 1997]

(a) 2-butene (b) 2-pentene
(c) 2,3-dibromo-2-butene (d) 2-methyl propene

59. The isomers which can be converted into another forms by rotation of the molecules around single bond are

[AIIMS 1997]

(a) Geometrical isomers (b) Conformers
(c) Enantiomers (d) Diastereomers

60. The number of enantiomers of the compound $CH_3CHBrCHBrCOOH$ is **[AIIMS 1997]**

(a) 0 (b) 1
(c) 3 (d) 4

61. $C_6H_5C\equiv N$ and $C_6H_5N\equiv C$ exhibit which type of isomerism **[CPMT 1997]**

(a) Position (b) Functional
(c) Dextro isomerism (d) Metamerism

62. Which of the following compounds is not chiral

[CBSE PMT 1998; DPMT 2002]

(a) $DCH_2CH_2CH_2Cl$ (b) CH_3CH_2CHDCl
(c) $CH_3CHDCH_2CH_2Cl$ (d) $CH_2CHClCH_2D$

63. *cis* and *trans* 2-butene are **[BHU 1998; DPMT 2002]**

(a) Conformational isomers (b) Optical isomers

(c) Position isomers (d) Geometrical isomers

64. Which one of the following is the chiral molecule **[BHU 1998; 2005]**

(a) CH_3Cl (b) CH_2Cl_2

(c) $CHBr_3$ (d) $CHClBrI$

65. Cyanide and isocyanide are isomers of type **[AFMC 1997]**

(a) Positional (b) Functional

(c) Tautomer (d) Structural

66. Glucose and fructose are **[AMU (Engg.) 1999]**

(a) Optical isomers (b) Functional isomers

(c) Position isomers (d) Chain isomers

67. Which of the following compounds which is an optically active compound **[UPSEAT 1999]**

(a) 1-butanol (b) 2-butanol

(c) 3-butanol (d) 4-heptanol

68. *d*-tartaric acid and *l*-tartaric acid are **[MH CET 1999]**

(a) Enantiomers (b) Tautomers

(c) Diastereoisomers (d) Structural isomers

69. Minimum resistance in bond rotation will be observed in the compound **[RPMT 1999]**

(a) Hexachloroethane (b) Ethylene

(c) Acetylene (d) Ethane

70. Which pair show cis-trans isomerism **[RPET 1999]**

(a) Maleic-fumaric acid (b) Lactic-tartaric acid

(c) Malonic-succinic acid (d)Crotonic-acrylic acid

71. 1, 2-Dichloroethene shows **[RPET 1999]**

(a) Geometrical isomerism (b) Optical isomerism

(c) Ring-chain isomerism (d) Resonance

72. Which compound is optically active **[DCE 1999]**

(a) 4-chloro, 1 hydroxy butane

(b) 3^o -butyl alcohol

(c) Secondary butyl amine

(d) *n*-butyl alcohol

73. Choose the pair of chain isomer **[RPMT 2000]**

(a) CH_3CHBr_2 and CH_2BrCH_2Br

(b) 1-propanol and 2-propanol

(c) Neo-pentane and isopentane

(d) Diethyl ether and methyl-*n*-propyl ether

74. Optical isomerism arises due to the presence of **[RPMT 2000]**

(a) An asymmetric carbon atom

(b) Centre of symmetry

(c) Axis of symmetry

(d) Plane of symmetry

75. Least hindered rotation about carbon-carbon bond is observed in **[RPMT 2000]**

(a) Ethane (b) Ethylene

(c) Ethyne (d) Hexachloroethane

76. Which pair represents chain isomer **[RPMT 2000]**

(a) CH_3CHCl_2 and $ClCH_2CH_2Cl$

(b) *n*-propyl alcohol and isopropyl alcohol

(c) 2-methyl-1 propanol and 2-Methyl-2 propanol

(d) 2-methyl butane and neopentane

77. Which of the following compounds will exhibit geometrical isomerism **[IIT-JEE Screening 2000]**

(a) 1-phenyl-2-butene (b) 3-phenyl-1-butene

(c) 2-phenyl-1-butene (d) 1, 1-Diphenyl-1-propene

78. On bromination, propionic acid yields two isomeric 2-bromopropionic acids. This pair is an important example of **[BHU 2000]**

(a) Chain isomers (b) Optical isomers

(c) Cis-trans isomers (d) Position isomers

79. Geometrical isomerism is not possible in **[CPMT 2000]**

(a) Propene (b) 3-hexane

(c) Butenedioic acid (d) Cyclic compound

80. Only two isomeric monochloro derivatives are possible for **[Pb. PMT 2000]**

(a) 2-methyl propane (b) *n*-pentane

(c) Benzene (d) 2, 4-dimethyl pentane

81. Lactic acid in which a methyl group, a hydroxyl group, a carboxylic acid group and a hydrogen atom are attached to a central carbon atom, shown optical isomerism due to the molecular geometry at the **[Pb. PMT 2000]**

(a) Central carbon atom

(b) Carbon atom of the methyl group

(c) Carbon atom of the carboxylic acid group

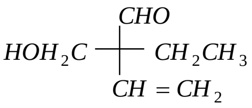
(d) Oxygen of the hydroxyl groups

82. The number of possible alkynes with molecular formula C_5H_8 is **[MP PMT 2000]**

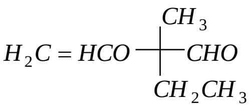
(a) 2 (b) 3

(c) 4 (d) 5

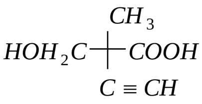
83. Which of the following will not lose asymmetry on reduction with $LiAlH_4$ **[Roorkee 2000]**

(a) 

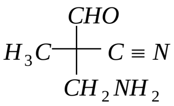
$HOH_2C-\overset{CHO}{\underset{CH=CH_2}{+}}-CH_2CH_3$

(b) 

$H_2C=HCO-\overset{CH_3}{\underset{CH_2CH_3}{+}}-CHO$

(c) 

$HOH_2C-\overset{CH_3}{\underset{C\equiv CH}{+}}-COOH$

(d) 

$H_3C-\overset{CHO}{\underset{CH_2NH_2}{+}}-C\equiv N$

84. Reason for geometrical isomerism by 2-butene is **[CBSE PMT 2000]**

(a) Chiral carbon
(b) Free rotation about single bond
(c) Free rotation about double bond
(d) Restricted rotation about double bond

85. Stereoisomers which are not the mirror images of one another are called **[RPMT 2000]**
(a) Enantiomers (b) Mesomers
(c) Tautomers (d) Diasteroisomers

86. The isomerism shown by *n*-butyl alcohol and isobutyl alcohol is **[RPMT 2000]**
(a) Metamerism (b) Chain
(c) Position (d) Stereo

87. Which is optically active **[MH CET 2001]**
(a) CH_2Cl_2
(b) $CHCl_3$
(c) Meso form of tartaric acid
(d) Glyceraldehyde

88. Which of the following will show geometrical isomerism **[CPMT 2001; BHU 2005]**
(a) $CH_3CH = CHCH_3$ (b) $(CH_3)_2C = C(CH_3)_2$
(c) $(CH_3)_2C = C(CH_3)_2$ (d) $CH_3 - CH = C(CH_3)_2$

89. What is the maximum number of open chain structures possible for C_4H_8 **[MP PET 2001]**
(a) 2 (b) 3
(c) 4 (d) 1

90. Glucose has optical isomers **[DCE 2001]**
(a) 8 (b) 12
(c) 16 (d) Cannot be predicted

91. An organic compound
$^1CH_3 - ^2CH_2 - ^3CH_2 - ^4CH_2 - ^5CH_2 - ^6CH_2 - ^7CH_3$
To make it chiral compound the attack should be on which carbon atom **[DCE 2001]**
(a) 1 (b) 3
(c) 4 (d) 7

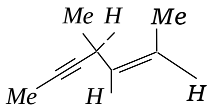
92. Which of the following statements is not true about enantiomers **[DCE 2001]**
(a) They have same physical properties
(b) They have different biological properties
(c) They have same chemical properties towards chiral compounds
(d) None of these

93. Meso-tartaric acid is **[BHU 2001]**
(a) Optically inactive
(b) Optically active because of molecular symmetry
(c) Optically inactive due to external compensation
(d) Optically active because of asymmetric carbon atom

94. The number of possible isomers of the compound with molecular formula C_7H_8O is **[BHU 2001]**
(a) 3 (b) 5
(c) 7 (d) 9

95. The number of isomers for the compound with molecular formula $C_2BrClFI$ is **[IIT-JEE (Screening) 2001]**
(a) 3 (b) 4
(c) 5 (d) 6

96. Hydrogenation of the adjoining compound in the presence of poisoned palladium catalyst gives **[IIT-JEE (Screening) 2001]**



(a) An optically active compound
(b) An optically inactive compound
(c) A racemic mixture
(d) A diastereomeric mixture

97. The number of possible structural isomers for a compound with the molecular formula C_7H_{16} is**[DCE 2001]**
(a) 8 (b) 9
(c) 10 (d) 12

98. Which of the following molecule contains asymmetric carbon atom **[JIPMER 2002]**
(a) $CH_3CHClCOOH$ (b) CH_3CH_2COOH
(c) $ClCH_2CH_2COOH$ (d) $Cl_2CHCOOH$

99. A similarity between optical and geometrical isomerism is that **[AIEEE 2002]**
(a) Each forms equal number of isomers for a given compound
(b) If in a compound one is present then so is the other
(c) Both are included in stereoisomerism
(d) They have no similarity

100. If the light waves pass through a nicol prism then all the oscillations occur only in one plane, such beam of light is called as **[Kerala (Med.) 2002]**
(a) Non-polarised light (b) Plane polarised light
(c) Polarised light (d) Optical light

101. Racemic mixture is formed by mixing two**[AIEEE 2002]**
(a) Isomeric compounds (b) Chiral compounds
(c) Meso compounds (d) Optical isomers

102. Which of the following does not show geometrical isomerism **[AIEEE 2002]**
(a) 1, 2 dichloro-1-pentene
(b) 1, 3-dichloro-2-pentene
(c) 1, 1-dichloro-1-pentene
(d) 1, 4-dichloro-2-pentene

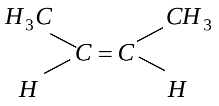
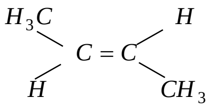
103.  and 

exhibit which isomerism **[MP PET 2002]**

(a) Position isomerism (b) Geometrical isomerism

(c) Optical isomerism (d) Functional isomerism

104. Which compound is chiral **[RPMT 2002]**

(a) butane

(b) 1-chloro-2-methyl butane

(c) 2-methyl butane

(d) 2-methyl propane

105. Methyl acetate and propionic acid are **[RPMT 2002]**

(a) Functional isomer (b) Structural isomer

(c) Stereoisomer (d) Geometrical isomer

106. Which compound shows *cis-trans* isomerism**[CPMT 2002]**

(a) 1-butene (b) 2-propene

(c) 2-butene (d) Benzene

107. Isomers of propionic acid are **[MP PMT 2002]**

(a) $HCOOC_2H_5$ and CH_3COOCH_3

(b) $HCOOC_2H_5$ and $C_3H_7COOCH_3$

(c) CH_3COOCH_3 and C_3H_7OH

(d) C_3H_7OH and CH_3COCH_3

108. The functional isomer of ethyl alcohol is**[MP PMT 2002]**

(a) CH_3OCH_3 (b) CH_3COCH_3

(c) CH_3COOH (d) CH_3CH_2CHO

109. Disymmetric object is one which is **[Kerala (Engg.) 2002]**

(a) Superimposable on its mirror image

(b) Non-superimposible on its mirror image

(c) Optically inactive

(d) Achiral

110. Geometrical isomers differ in **[CBSE PMT 2002]**

(a) Position of atoms

(b) Length of carbon

(c) Spatial arrangement of atoms

(d) Position of functional group

111. Which of the following hydride is capable of showing conformations **[JIPMER 2002]**

(a) $NH_2 - NH_2$ (b) B_2H_6

(c) CH_4 (d) None of these

112. Which of the following is an chiral compound **[AIIMS 2002]**

(a) Hexane (b) Methane

(c) *n*-butane (d) 2,3,4-trimethyl hexane

113. What is the possible number of optical isomers for a compound containing 2-dissimilar asymmetric carbon atom **[CPMT 1999; UPSEAT 1999, 2000, 02]**

(a) 2 (b) 4

(c) 6 (d) 8

114. Which of the following compounds is optically active **[Pb. PMT 2001; AMU 2002; Kerala (Med.) 2003]**

(a) $(CH_3)_2CHCH_2OH$ (b) CH_3CH_2OH

(c) CCl_2F_2 (d) $CH_3CHOHC_2H_5$

115. Optically active compound is **[UPSEAT 2002]**

(a) 3-chloropentane (b) 2-chlorobutane

(c) 2-chloropropane (d) None of these

116. If a carbon atom is attached to $-H,-OH,-COOH$ and $-OCOC_2H_5$ number of chiral C – atoms in compound is **[RPMT 2003]**

(a) 1 (b) 2

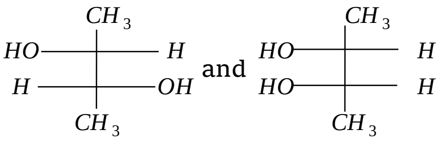
(c) 3 (d) 4

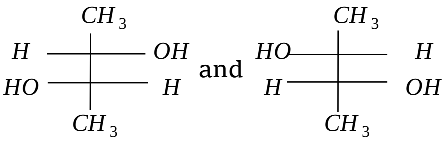
117. Isomerism due to rotation round single bond of carbon-carbon is **[UPSEAT 2003]**

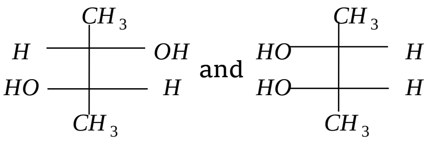
(a) Conformation (b) Enantiomerism

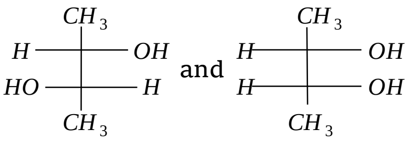
(c) Diasterio isomerism (d) Position isomerism

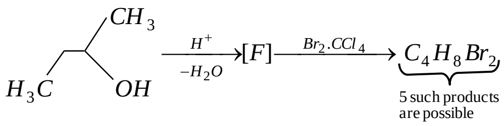
118. Which of the following pairs of compounds are enantiomers **[CBSE PMT 2003]**

(a) 

(b) 

(c) 

(d) 

119. 

How many structures of *F* is possible **[IIT-JEE (Screening) 2003]**

(a) 2 (b) 5

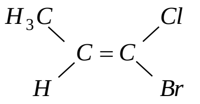
(c) 6 (d) 3

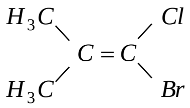
120. An enantiomerically pure acid is treated with racemic mixture of an alcohol having one chiral carbon. The ester formed will be **[IIT-JEE (Screening) 2003]**

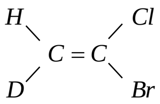
(a) Optically active mixture (b) Pure enantiomer

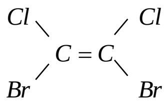
(c) Meso compound (d) Racemic mixture

121. Which one of the following will not show geometrical isomerism **[MP PMT 2003]**

(a) 

(b) 

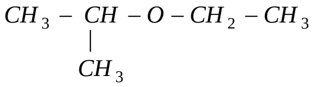
(c) 

(d) 

122. Isomerism shown by

$CH_3 - (CH_2)_3 - O - CH_3$

$CH_3 - CH_2 - O - CH_2 - CH_2 - CH_3$


$CH_3 - \underset{\underset{CH_3}{|}}{CH} - O - CH_2 - CH_3$ is **[RPMT 2003]**

(a) Position isomerism (b) Chain isomerism

(c) Metamerism (d) Optical isomerism

123. A compound whose molecules are superimposable on their mirror images even through they contain an asymmetric carbon atom is called **[Kerala (Med.) 2003]**

(a) A meso compound (b) An erythro isomer

(c) A threo isomer (d) a glycol

124. Of the following, the compound possessing optical isomerism **[Kerala (Med.) 2003]**

(a) CH_3CH_2OH (b) $CH_3CHClBr$

(c) CCl_2BrF (d) CCl_2F_2

125. Which of the following statement is wrong **[EAMCET 2003]**

(a) Diethyl ketone and methyl propyl ketone are position isomers

(b) 2-chloro pentane and 1-chloro pentane are position isomers

(c) *n*-butane and 2-methyl propane are chain isomers

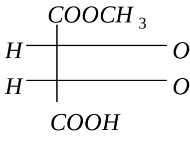
(d) Acetone and propinaldehyde are functional isomers

126. Dimethyl ether and ethyl alcohol are **[MH CET 2004; Pb. CET 2002]**

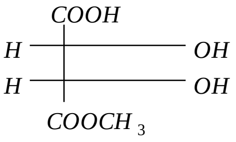
(a) Metamers (b) Homologues

(c) Functional isomers (d) Position isomers

127. The correct statement about the compounds *A* and *B* is **[DCE 2002; UPSEAT 2004; IIT-JEE 1997; DPMT 2005]**



(A)



(B)

(a) *A* and *B* are identical

(b) *A* and *B* are diastereomers

(c) *A* and *B* are enantiomers

(d) None of these

128. Ethyl acetoacetate shows, which type of isomerism **[Pb. CET 2003]**

(a) Chain (b) Optical

(c) Metamerism (d) Tautomerism

129. Which of the following will have a mesoisomer also **[AIEEE 2004]**

(a) 2, 3-Dichloropentane

(b) 2, 3-Dichlorobutane

(c) 2-Chlorobutane

(d) 2-Hydroxypropanoic acid

130. For which of the following parameters the structural isomers C_2H_5OH and CH_3OCH_3 would be expected to have the same values ? (Assume ideal behaviour) **[AIEEE 2004]**

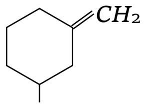
(a) Boiling points

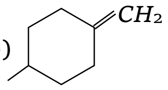
(b) Vapour pressure at the same temperature

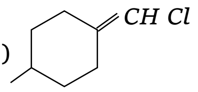
(c) Heat of vaporization

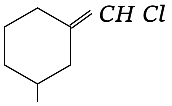
(d) Gaseous densities at the same temperature and pressure

131. The geometrical isomerism is shown by **[AIIMS 2004]**

(a) 

(b) 

(c) 

(d) 

132. Which of the following compounds will exhibit *cis-trans* isomerism **[Kerala PMT 2004]**

(a) 2-butene (b) 2-butyne

(c) 2-butanol (d) Butanone

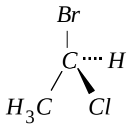
(e) Butanol

133. Which of the following compounds exhibit stereoisomerism **[MP PMT 2004]**

(a) 2-methyl-butane I (b) 3-methyl-butanoic
acid

(c) 3-methyl-butyne I (d) 2-methyl butanoic
acid

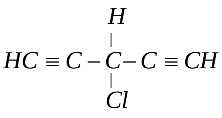
134. The chirality of the compound **[CBSE PMT 2005]**

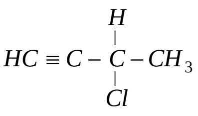


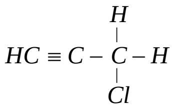
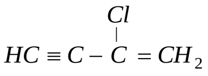
(a) *R* (b) *S*

(c) *Z* (d) *E*

135. Which of the following is most likely to show optical isomerism **[UPSEAT 2004]**

(a) 
$HC \equiv C - \underset{Cl}{\overset{H}{C}} - C \equiv CH$

(b) 
$HC \equiv C - \underset{Cl}{\overset{H}{C}} - CH_3$

(c)  $HC \equiv C-\overset{H}{\underset{Cl}{C}}-H$ (d)  $HC \equiv C-\overset{Cl}{C}=CH_2$

136. Nitroethane can exhibit one of the following kind of isomerism **[DCE 2004]**

(a) Metamerism (b) Optical activity

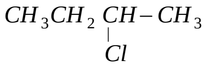
(c) Tautomerism (d) Position isomerism

137. $CH_3CH(OH).COOH$ shows **[BVP 2004]**

(a) Geometrical isomerism (b) Optical isomerism

(c) Both (d) None

138. Which will have enantiomer **[BVP 2004]**

(a)  $CH_3CH_2\underset{Cl}{CH}-CH_3$ (b) $CH_2CH_2CH_2CH_2Cl$

(c) $CH_3CH_2CH_2CHCl_2$ (d) None

139. The total number of acylic isomers including the stereoisomers with the molecular formula C_4H_7Cl **[Pb. CET 2004]**

(a) 11 (b) 12

(c) 9 (d) 10

140. The number of possible enantiomeric pairs that can be produced during mono-chlorination of 2-methylbutane is **[Pb. CET 2004]**

(a) 3 (b) 4

(c) 1 (d) 2

141. Which one of the following pairs represents stereoisomerism **[CBSE PMT 2005]**

(a) Chain isomerism and rotational isomerism

(b) Structural isomerism and geometric isomerism

(c) Linkage isomerism and geometric isomerism

(d) Optical isomerism and geometric isomerism

142. When isomers have the same structural formula but differ in relative arrangement of atoms or groups are called **[CPMT 2000; KCET (Med.) 2000]**

(a) Mesomers (b) Stereoisomers

(c) Optical isomers (d) Geometrical mesomers

143. $CH_3CH_2CH=CH_2$ and $CH_3-CH=CH-CH_3$ show

(a) Chain isomerism (b) Position isomerism

(c) Functional isomerism (d) Metamerism

144. The number of possible isomers of butene are **[Kerala (Engg.) 2002]**

(a) 3 (b) 2

(c) 4 (d) 5

(e) 6

145. Which of the following show geometrical isomerism **[BCECE 2005]**

(a) C_2H_5Br (b) $(CH_2)(COOH)_2$

(c) $(CH)_2(COOH)_2$ (d) C_2H_6

146. Among the following the most stable compound is **[AIIMS 2005]**

(a) $cis-1,2-cyclohexan\ ediol$

(b) $trans-1,2-cyclohexan\ ediol$

(c) $cis-1,3-cyclohexan\ ediol$

(d) $trans-1,3-cyclohexan\ ediol$

147. Chirality of carbon compound is because of its **[Kerala (Med.) 2002]**

(a) Tetrahedral nature of carbon

(b) Monovalent nature of carbon

(c) Divalent nature of carbon

(d) Trivalent nature of carbon

148. Which kind of isomerism is possible for 1-chloro-2-nitroethene **[J & K 2005]**

(a) Functional group isomerism

(b) Position isomerism

(c) E/Z isomerism

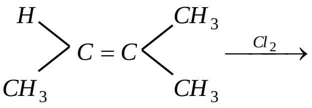
(d) Optical isomerism

149. Which will give chiral molecule **[DPMT 2005]**

(a) $CH_3COCl \xrightarrow{LiAlH_4}$

(b) $C_2H_5CHO \xrightarrow[H^+/H_2O]{CH_3MgBr}$

(c) $(CH_3)_2CHC_2H_5 \xrightarrow{Cu}$

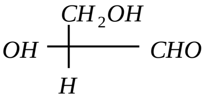
(d) 

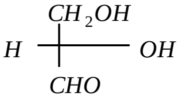
150. Which of the following will be chiral **[J & K 2005]**

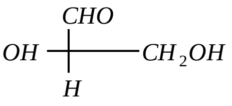
(a) CH_3CHCl_2 (b) $CH_3CHBrCl$

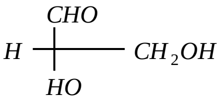
(c) CD_2Cl_2 (d) CH_2ClBr

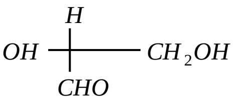
151. Which of the following fischer projection formula is same as D-Glyceraldehyde **[Kerala CET 2005]**

(a) 

(b) 

(c) 

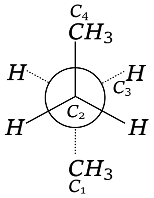
(d) 

(e) 

Critical Thinking

Objective Questions

1. In the given conformation C_2 is rotated about C_2-C_3 bond anticlockwise by an angle of 120° then the conformation obtained is **[AIIMS 2004]**



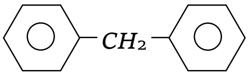
(a) Fully eclipsed conformation

(b) Partially eclipsed conformation

(c) Gauche conformation

(d) Staggered conformation

2. The molecular formula of diphenyl methane,



, is $C_{13}H_{12}$

How many structural isomers are possible when one of the hydrogens is replaced by a chlorine atom **[CBSE PMT 2004]**

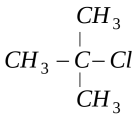
(a) 8 (b) 7

(c) 6 (d) 4

3. SN^1 reaction is faster in **[Orissa JEE 2004]**

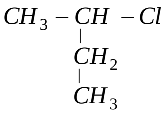
(a) CH_3CH_2Cl (b) $\begin{matrix}CH_3\\CH_3\end{matrix}{>}CH-Cl$

(c)



$CH_3-\underset{CH_3}{\overset{CH_3}{\underset{|}{\overset{|}{C}}}}-Cl$

(d)



$CH_3-\underset{\underset{CH_3}{|}}{\underset{CH_2}{\underset{|}{CH}}}-Cl$

4. How many enantiomer pairs are obtained by monochlorination of 2, 3-dimethylbutane **[Kerala PMT 2004]**

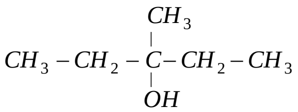
(a) Nil (b) Four

(c) Two (d) Three

(e) One

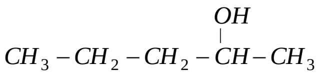
5. Among the following compounds which can be dehydrated very easily is **[AIEEE 2004]**

(a)



$CH_3-CH_2-\underset{OH}{\overset{CH_3}{\underset{|}{\overset{|}{C}}}}-CH_2-CH_3$

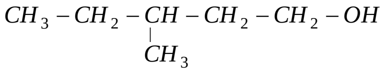
(b)



$CH_3-CH_2-CH_2-\overset{OH}{\overset{|}{C}H}-CH_3$

(c) $CH_3-CH_2-CH_2-CH_2-CH_2-OH$

(d)



$CH_3-CH_2-\underset{CH_3}{\underset{|}{CH}}-CH_2-CH_2-OH$

6. Which of the following statements is not characteristic of free radical chain reaction **[JIPMER 1997]**

(a) It gives major product derived from most stable free radical

(b) It is usually sensitive to change in solvent polarity

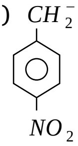
(c) It proceeds in three main steps like initiation, propagation and termination

(d) It may be initiated by U.V. light

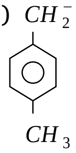
7. Most stable carbanion is **[BHU 2003]**

(a) CH_3^- (b) $CH_3CH_2^-$

(c)



(d)



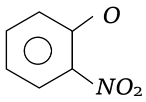
8. Among the following the dissociation constant is highest for **[AIIMS 2004]**

(a) C_6H_5OH (b) $C_6H_5CH_2OH$

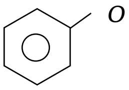
(c) $CH_3C\equiv CH$ (d) $CH_3NH_3^+Cl^-$

9. Which one of the following compounds is most acidic **[CBSE PMT 2005]**

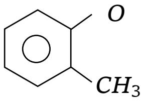
(a) $Cl-CH_2-CH_2-OH$ (b)



(c)



(d)



10. Which one is electrophilic addition **[AMU (Engg.) 1999]**

(a) $CH_3-CH_3+Cl_2\rightarrow C_2H_5Cl+HCl$

(b) $CH_3CH=O+HCN\rightarrow (CH_3)_2C(OH)CN$

(c) $(CH_3)_2C=O+HCN\rightarrow CH_3CH(OH)CN$

(d) $CH_2=CH_2+Br_2\rightarrow CH_2BrCH_2Br$

11. A compound has 3 chiral carbon atoms. The number of possible optical isomers it can have **[DCE 2004]**

(a) 3 (b) 2

(c) 8 (d) 4

12. How many chiral isomers can be drawn from 2-bromo, 3-chloro butane **[DCE 2003]**

(a) 2 (b) 3

(c) 4 (d) 5

13. Number of isomers of C_4H_{10} is

[CBSE PMT 1996; AFMC 1997; RPMT 2002; MP PMT 1997]

(a) 2 (b) 3

(c) 4 (d) Isomerism not exist

14. The number of possible isomers for compound $C_2H_3Cl_2Br$ is **[MP PMT 1999]**

(a) 2 (b) 3

(c) 4 (d) 5

15. The optically active tartaric acid is named as D-(+)- tartaric acid because it has a positive**[IIT-JEE 1999]**

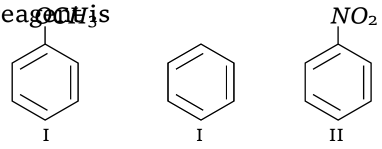
(a) Optical rotation and is derived from D-glucose

(b) pH in organic solvent

(c) Optical rotation and is derived from $D(+)$ glyceraldehyde

(d) Optical rotation only when substituted by deuterium

16. Among the following compounds (I-III) the correct order of reaction with electrophilic reagent is **[CBSE PMT 1997]**



(a) II > III > I (b) III < I < II

(c) I > II > III (d) I = II > III

17. Carbocation which is most stable **[BHU 2003]**

(a) $CH_3CH_2^+$ (b) CH_3^+

(c) $C_6H_5CH_2^+$ (d) $CH_3CH_2CH_2^+$

18. Tautomerism is exhibited by

[CBSE PMT 1997; KCET 2002]

(a) $(CH_3)_3CNO$ (b) $(CH_3)_2NH$

(c) R_3CNO_2 (d) RCH_2NO_2

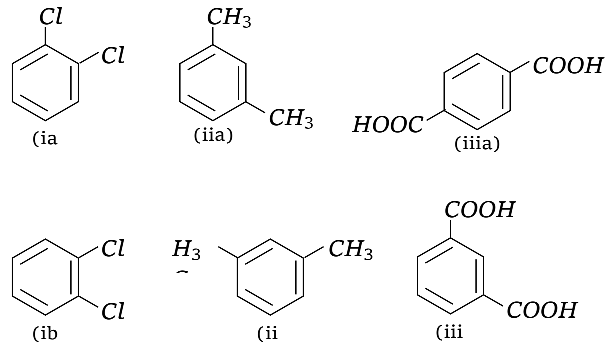
19. Which of the following will have geometrical isomers

[MP PET 1996; MP PMT 1997; AFMC 1997]

(a) 2-methylpropene (b) 2-butene

(c) 1-butene (d) Propene

20. Examine the following three pairs of possible isomers



Now state whether the pairs represent identical compounds or different isomers

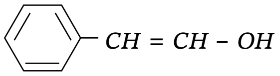
(a) All three pairs represent different compounds

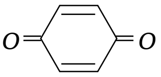
(b) (*ia*) and (*ib*) are identical; (*iia*) and (*iib*) are identical; and (*iiia*) and (*iiib*) are identical

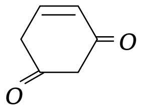
(c) (*ia*) and (*ib*) are isomers; (*iia*) and (*iib*) are identical; and (*iiia*) and (*iiib*) are isomers

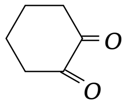
(d) (*ia*) and (*ib*) are identical; (*iia*) and (*iib*) are identical, and (*iiia*) and (*iiib*) are isomers

21. Tautomerism is exhibited by **[IIT-JEE 1998]**

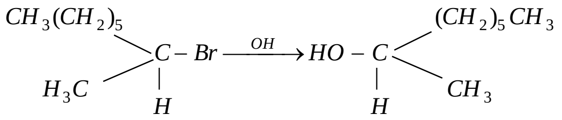
(a) 

(b) 

(c) 

(d) 

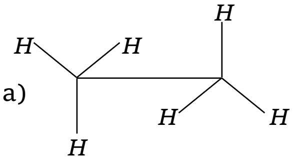
22. The following reaction is described as**[CBSE PMT 1997]**

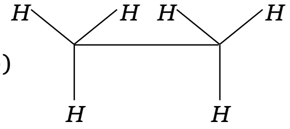


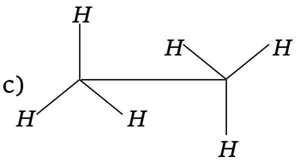
(a) SE^2 (b) SN^1

(c) SN^2 (d) SN^0

23. Which one of the following represents eclipsed form of ethane

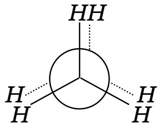
(a) 

(b) 

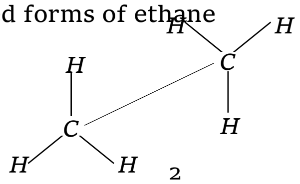
(c) 

(d) None of these

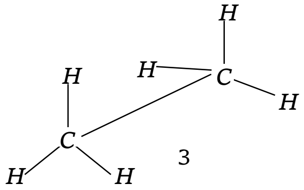
24. Which are the staggered forms of ethane



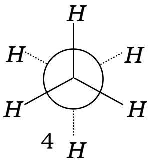
1



2



3



4

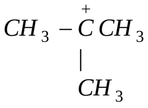
(a) 1 and 4 (b) 3 and 4

(c) 2 and 4 (d) 1 and 3

25. Which of the following is the most stable cation **[CBSE PMT 1988; MNR 1988; AIIMS 1985]**

(a) $CH_3CH_2\overset{+}{C}HCH_3$

(b)



$CH_3-\overset{+}{C}CH_3$ with CH_3 below C

(c) $CH_3CH_2CH_2\overset{+}{C}H_2$ (d) CH_3^+

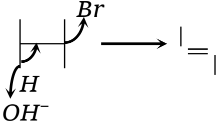
26. In a reaction of C_6H_5Y, the major product (> 60%) is *m*-isomer, so the group *Y* is **[AIIMS 1997; UPSEAT 2003]**

(a) $-COOH$ (b) $-NH_2$

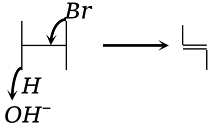
(c) $-OH$ (d) $-Cl$

27. Dehydrohalogenation in presence of OH^- is correctly represented by **[Orissa JEE 2004]**

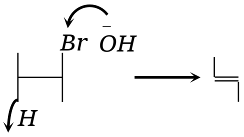
(a)



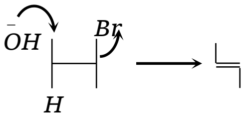
(b)



(c)



(d)



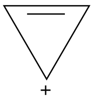
28. Number of structural isomers of $C_4H_{10}O$ are **[CPMT 1983, 84, 89, 91; MADT Bihar 1984; MNR 1984; MP PET 1997; Pb. PMT 1999; MH CET 2003]**

(a) 3 (b) 6

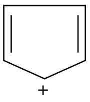
(c) 7 (d) 10

29. Among the following the aromatic compound is **[AIIMS 2004]**

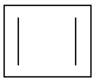
(a)



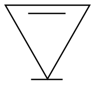
(b)



(c)



(d)



30. Which of the following compounds are not arranged in order of decreasing reactivity towards electrophilic substitution **[DCE 2003]**

(a) Fluoro benzene > chloro benzene > bromo benzene

(b) Phenol > *n*-propyl benzene > benzoic acid

(c) Chloro toluene > para-nitro toluene > 2-chloro-4-nitro toluene

(d) Benzoic acid > phenol > *n*-propyl benzene

31. Most stable carbonium ion is **[Pb. CET 2004]**

(a) $\overset{+}{C}_2H_5$ (b) $(CH_3)_3\overset{+}{C}$

(c) $(C_6H_5)_3\overset{+}{C}$ (d) $C_6H_5\overset{+}{C}H_2$

32. Which one of the following species is most stable **[IIT-JEE 1995]**

(a) $p-O_2N-C_6H_4-\overset{+}{C}H_2$

(b) $p-CH_3O-C_6H_4-\overset{+}{C}H_2$

(c) $p-Cl-C_6H_4-\overset{+}{C}H_2$

(d) $C_6H_5-\overset{+}{C}H_2$

33. Which of the following gives most stable carbocation by dehydration **[RPMT 2002]**

(a) $(CH_3)_2CH-OH$

(b) $(CH_3)_3C-OH$

(c) CH_3-CH_2-OH

(d) $CH_3-CH_2-O-CH_2-CH_3$

34. Which of the following orders regarding relative stability of free radicals is correct **[UPSEAT 2004]**

(a) 3° < 2° < 1° (b) 3° > 2° > 1°

(c) 1° < 2° > 3° (d) 3° > 2° < 1°

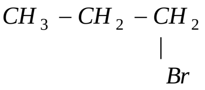
35. The +*I* effect of alkyl groups is in the order **[DCE 2002]**

(a) 2° > 3° > 1° (b) 1° > 2° > 3°

(c) 3° > 2° > 1° (d) None of these

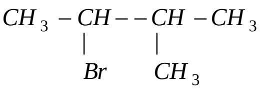
36. Which one has asymmetric *C*-atom **[Roorkee 1995]**

(a)



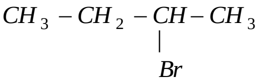
$CH_3-CH_2-CH_2$ with Br below the last C

(b)



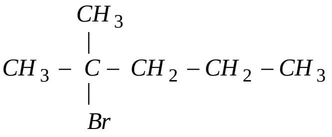
$CH_3-CH--CH-CH_3$ with Br and CH_3 below

(c)



$CH_3-CH_2-CH-CH_3$ with Br below

(d)



$CH_3-C-CH_2-CH_2-CH_3$ with CH_3 above and Br below C

37. Which of the following compounds will show metamerism **[KCET 1996]**

(a) $CH_3COOC_2H_5$ (b) $C_2H_5-S-C_2H_5$

(c) CH_3-O-CH_3 (d) $CH_3-O-C_2H_5$

38. How many carbon atoms in the molecule $HCOO-(CHOH)_2-COOH$ are asymmetric **[MP PET 2001]**

(a) 1 (b) 2

(c) 3 (d) None of these

39. Which of the following act as nucleophiles **[Roorkee 1999]**

(a) CH_3NH_2 (b) RO^-

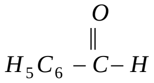
(c) $AlCl_3$ (d) CH_3MgBr

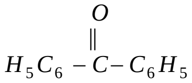
40. Which of the following has the highest nucleophilicity **[IIT-JEE Screening 2000]**

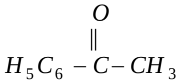
(a) F^- (b) OH^-

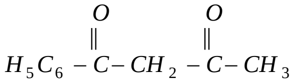
(c) CH_3^- (d) NH_2^-

41. Keto-enol tautomerism is found in **[IIT-JEE 1988; MADT Bihar 1995]**

(a) 
$H_5C_6-\overset{\overset{\displaystyle O}{\|}}{C}-H$

(b) 
$H_5C_6-\overset{\overset{\displaystyle O}{\|}}{C}-C_6H_5$

(c) 
$H_5C_6-\overset{\overset{\displaystyle O}{\|}}{C}-CH_3$

(d) 
$H_5C_6-\overset{\overset{\displaystyle O}{\|}}{C}-CH_2-\overset{\overset{\displaystyle O}{\|}}{C}-CH_3$

42. Which of the following compounds will show geometrical isomerism **[IIT-JEE 1998]**

(a) 2-butene (b) Propene

(c) 1-phenylpropene (d) 2-methyl-2-butene

43. Which behaves both as a nucleophile and electrophile

[IIT-JEE Screening 1991; Pb. CET 1985]

(a) CH_3NH_2 (b) CH_3Cl

(c) CH_3CN (d) CH_3OH

44. The number of optical isomers of an organic compound having *n* asymmetric carbon atoms will be **[MP PET 1994]**

(a) 2^{n+1} (b) n^2

(c) 2^n (d) 2^{n-1}

45. Total number of isomers of C_6H_{14} are

[IIT-JEE 1987; DPMT 1983; CPMT 1991; MNR 1990; MP PET 1995; UPSEAT 2001]

(a) 4 (b) 5

(c) 6 (d) 7

46. With a change in hybridisation of the carbon bearing the charge, the stability of a carbanion increase in the order

[DCE 2003]

(a) $sp < sp^2 < sp^3$ (b) $sp < sp^3 < sp^2$

(c) $sp^3 < sp^2 < sp$ (d) $sp^2 < sp < sp^3$

47. The *C* - *C* bond length of the following molecules is in the order **[IIT-JEE 1991]**

(a) $C_2H_6 > C_2H_4 > C_6H_6 > C_2H_2$

(b) $C_2H_2 < C_2H_4 < C_6H_6 < C_2H_6$

(c) $C_2H_6 > C_2H_2 > C_6H_6 > C_2H_4$

(d) $C_2H_4 > C_2H_6 > C_2H_2 > C_6H_6$

48. In the reaction $CH_3CHO + HCN \rightarrow CH_3CH(OH)CN$ a chiral centre is produced. This product would be

[CBSE PMT 1995]

(a) Laevorotatory (b) Meso compound

(c) Dextrorotatory (d) Racemic mixture

49. Cyclic hydrocarbon molecule '*A*' has all the carbon and hydrogen in a single plane. All the carbon-carbon bonds are of same length less than 1.54Å, but more than 1.34Å. The $C-C$ bond angle will be **[BVP 2003]**

(a) $109^o28'$ (b) 100^o

(c) 180^o (d) 120^o

50. How many structural isomers are possible for a compound with molecular formula C_3H_7Cl **[CBSE PMT 200**

(a) 2 (b) 5

(c) 7 (d) 9

AR Assertion & Reason

For AIIMS Aspirants

Read the assertion and reason carefully to mark the correct option out of the options given below:

(a) If both assertion and reason are true and the reason is the correct explanation of the assertion.

(b) If both assertion and reason are true but reason is not the correct explanation of the assertion.

(c) If assertion is true but reason is false.

(d) If the assertion and reason both are false.

(e) If assertion is false but reason is true.

1. Assertion : Aniline is better nucleophile than anilium ion.

Reason : Anilium ion have +*ve* charge. **[AIIMS 1996]**

2. Assertion : Neopentane forms one mono substituted compound.

Reason : Neopentane is isomer of pentane. **[AIIMS 2001]**

3. Assertion : *Trans*-2-butene on reaction with Br_2 gives *meso*-2, 3-dibromobutane.

Reason : The reaction involves syn-addition of bromine. **[AIIMS 2003]**

4. Assertion : Cis-1, 3-dihydroxy cyclohexane exists in boat conformation.

Reason : In the chair form, there will not be hydrogen bonding between the two hydroxyl groups. **[AIIMS 2003]**

5. Assertion : Hydroxyketones are not directly used in Grignard reaction.

Reason : Grignard reagents react with hydroxyl group. **[AIIMS 2003]**

6. Assertion : Benzyl bromide when kept in acetone water it produces benzyl alcohol.

Reason : The reaction follows SN^2 mechanism. **[AIIMS 2003]**

7. Assertion : Carbon possesses property of catenation.

Reason : Carbon atoms form double as well as triple bonds during catenation.

8. Assertion : Olefins have the general formula C_nH_{2n+1}.

Reason : There is one double bond between two carbon atoms in their molecules.

9. Assertion : Saturated hydrocarbons are chemically less reactive.

Reason : All isomeric paraffins have same parent name.

10. Assertion : A mixture of glucose and *m*-dinitrobenzene can be separated by shaking it with ether.

Reason : Glucose is soluble in water.

11. Assertion : Tertiary carbonium ions are generally formed more easily than primary carbonium ions.

Reason : Hyperconjugative as well as inductive effect due to additional alkyl groups stabilize tertiary carbonium ions.

12. Assertion : Heterolytic fission involves the breaking of a covalent bond in such a way that both the electrons of the shared pair are carried away by one of the atoms.

Reason : Heterolytic fission occurs readily in polar covalent bonds.

13. Assertion : The order of reactivity of carbonium ions is $2° > 3° > 1°$.

Reason : Carbon atom in carbonium ions is in sp^3 state of hybridisation.

14. Assertion : Free radicals are short lived and highly reactive.

Reason : Free radicals are highly unstable.

15. Assertion : Each carbon in ethylene molecule is sp^2 hybridised.

Reason : The $H-C-H$ bond angle in ethylene molecule is 120°.

16. Assertion : Cyclohexanone exhibits keto-enol tautomerism.

Reason : In cyclohexanone, one form contains the keto group ($C = O$) while other contains enolic group $(-C = C - OH)$.

17. Assertion : Staggered form is less stable than the eclipsed form.

Reason : The conformation in which the bond pairs of two central atoms are very far from one another is called staggered form.

18. Assertion : *Trans* isomers are more stable than *cis* isomer.

Reason : The *cis* isomer is the one in which two similar groups are on the same side of double bond.

19. Assertion : Propadiene is optically active.

Reason : Propadiene has a plane of symmetry.

20. Assertion : Lactic acid is optically active.

Reason : A symmetry in the inner structure of the organic compound causes optical activity.

21. Assertion : Same number of electron pairs are present in resonance structures.

Reason : Resonance structures differ in the location of electrons around the constituent atoms.

22. Assertion : Carbon-oxygen bonds are of equal length in carbonate ion.

Reason : Bond length decreases with the multiplicity of bond between two atoms.

Answers

Bonding and hybridisation in organic compounds

1	b	2	c	3	b	4	b	5	c
6	a	7	b	8	c	9	d	10	a
11	c	12	c	13	c	14	d	15	b
16	a	17	d	18	a	19	a	20	c
21	d	22	d	23	d	24	c	25	c
26	ac	27	c	28	c	29	c	30	d
31	c	32	c	33	d	34	c	35	c
36	a	37	c	38	c	39	d	40	b
41	c	42	a	43	c	44	b	45	b
46	a	47	b	48	c	49	a	50	c
51	c	52	c	53	c	54	a	55	d
56	c	57	c	58	a	59	d	60	a
61	a	62	d	63	c	64	b	65	b
66	b	67	b						

Dipole moment, resonance and reaction intermediates

1	b	2	b	3	b	4	c	5	c
6	d	7	c	8	d	9	b	10	c
11	d	12	b	13	a	14	c	15	d
16	b	17	d	18	b	19	a	20	a
21	a	22	a	23	b	24	c	25	c
26	b	27	b	28	b	29	d	30	b
31	c	32	c	33	a	34	d	35	a
36	a	37	b	38	b	39	a	40	d
41	d	42	b	43	d	44	b	45	b
46	a	47	b	48	d	49	b		

Organic reactions and their mechanism

1	d	2	c	3	c	4	b	5	a
6	c	7	c	8	d	9	d	10	d
11	b	12	d	13	c	14	d	15	c
16	a	17	a	18	d	19	b,c	20	a
21	d	22	a	23	d	24	a	25	a
26	b	27	d	28	b	29	b	30	d
31	d	32	c						

Structural and stereo isomerism

1	a	2	a	3	b	4	c	5	b
6	b	7	d	8	c	9	c	10	c
11	b	12	a	13	a	14	c	15	c
16	a	17	b	18	d	19	a	20	d
21	b	22	a	23	a	24	a	25	d
26	b	27	d	28	c	29	c	30	d
31	a	32	d	33	b	34	a	35	c
36	a	37	b	38	b	39	c	40	d
41	c	42	a	43	d	44	a	45	b
46	d	47	d	48	b	49	c	50	a
51	b	52	d	53	b	54	d	55	d
56	d	57	b	58	d	59	b	60	d
61	b	62	a	63	d	64	d	65	b
66	b	67	b	68	a	69	d	70	a
71	a	72	c	73	c	74	a	75	a
76	d	77	a	78	b	79	a	80	a
81	a	82	b	83	b	84	d	85	d
86	b	87	d	88	a	89	b	90	c
91	b	92	a	93	a	94	d	95	d
96	b	97	b	98	a	99	c	100	b
101	b	102	c	103	b	104	b	105	a
106	c	107	a	108	a	109	b	110	c
111	a	112	d	113	b	114	d	115	b
116	a	117	a	118	b	119	a	120	d
121	b	122	c	123	a	124	b	125	a
126	c	127	c	128	d	129	b	130	d
131	d	132	a	133	d	134	a	135	b
136	c	137	b	138	a	139	b	140	d
141	d	142	b	143	b	144	a	145	c
146	d	147	a	148	c	149	b	150	b
151	c								

Critical Thinking Questions

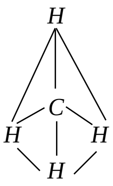
1	c	2	d	3	c	4	e	5	a
6	b	7	c	8	d	9	b	10	d
11	c	12	c	13	a	14	b	15	c
16	c	17	c	18	d	19	b	20	d
21	acd	22	c	23	b	24	c	25	b
26	a	27	a	28	c	29	a	30	d
31	c	32	b	33	b	34	b	35	c
36	bc	37	b	38	b	39	abd	40	c
41	cd	42	ac	43	c	44	c	45	b
46	c	47	b	48	d	49	d	50	a

Assertion & Reason

1	a	2	b	3	c	4	d	5	a
6	a	7	b	8	e	9	b	10	b
11	a	12	b	13	d	14	b	15	b
16	a	17	e	18	b	19	e	20	b
21	e	22	b						

Answers and Solutions

Bonding and hybridisation in organic compounds

1. (b) 

(CH_4)

Tetrahedral

3. (b) $CH_2=CH_2$ both the carbon atoms are sp^2 hybridised.

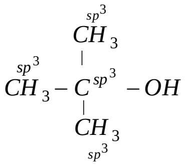
5. (c)

Type	s-character
sp^3	25%
sp^2	33.33%
sp	50%

6. (a) $\overset{sp}{CH}\equiv\overset{sp}{CH}$

7. (b) sp^2 and sp^3

$$\underset{sp^3}{CH_3}-\underset{sp^2}{CH}=\underset{sp^2}{CH}-\underset{sp^3}{CH_2}-\underset{sp^3}{CH_3}$$

8. (c) 

$$\underset{sp^3}{\overset{sp^3}{CH_3}}-\underset{\underset{\underset{sp^3}{CH_3}}{|}}{\overset{\overset{\overset{sp^3}{CH_3}}{|}}{C^{sp^3}}}-OH$$

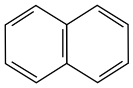
All the carbon atoms are sp^3 hybridized.

9. (d) $\underset{sp^3}{CH_3}-\overset{sp^2}{CH}=\underset{sp^2}{CH}-\overset{sp^3}{CH_2}-\underset{sp^2}{CH}=\overset{sp^2}{CH}-\underset{sp}{C}\equiv\underset{sp}{CH}$

10. (a) $\underset{sp^3}{CH_3}-\underset{sp}{C}\equiv\underset{sp}{C}-H$

11. (c) sp and sp^2

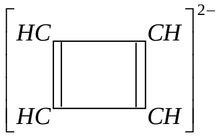
$$N\equiv\underset{1}{\overset{sp}{C}}-\underset{2}{\overset{sp^2}{CH}}=\underset{3}{CH_2}$$

13. (c)  π electrons = 10.

π bonds =5

hence electrons are double

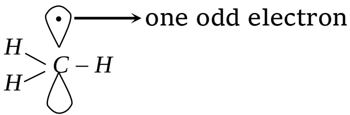
14. (d) Cyclobutadienyl anion $(C_4H_4)^{2-}$



π electrons = 8.

15. (b) $CH_3-CH_3\xrightarrow[\text{bond fission}]{\text{Homolytic}}\underset{\text{Methyl free radicals}}{\overset{\bullet}{C}H_3+\overset{\bullet}{C}H_3}$

free radical is formed which is sp^2-hybridized.



16. (a) $Br-\underset{sp^2}{\overset{1}{CH}}=\underset{sp^2}{\overset{2}{CH}}-Br\xrightarrow[\text{Catalyst}]{H_2}Br-\underset{sp^3}{\overset{3}{CH_2}}-\underset{sp^3}{\overset{4}{CH_2}}-Br$

17. (d) (i) $\overset{sp^3}{CH_3}-\overset{sp^3}{CH_2}-\overset{sp^3}{CH_2}-\overset{sp^3}{CH_3}$

only sp^3 hybridized carbon

(ii) $\overset{sp^3}{CH_3}-\overset{sp^2}{CH}=\overset{sp^2}{CH}-\overset{sp^3}{CH_3}$

Both sp^2 and sp^3 hybridized carbon.

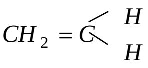
(iii) $\overset{sp^2}{CH_2}=\overset{sp^2}{CH}-\overset{sp^2}{CH}=\overset{sp^2}{CH_2}$

Only sp^2 hybridized carbon.

(iv) $H-\underset{sp}{C}\equiv\underset{sp}{C}-H$

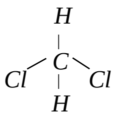
Only sp hybridized carbon.

18. (a) (i) Benzene and its derivatives are always planar because all the carbon in benzene are sp^2 hybridized.

(v) 

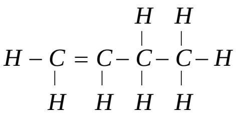
$CH_2=C\begin{smallmatrix}\diagup H\\ \diagdown H\end{smallmatrix}$

Both the carbon are sp^2 hybridized. Therefore planar.

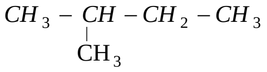
19. (a) 

Tetrahedral structure

sp^3hybridization

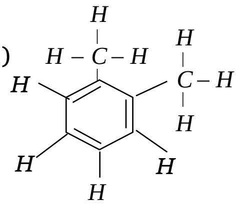
20. (c) 

$H-\underset{\underset{H}{|}}{C}=\underset{\underset{H}{|}}{C}-\underset{\underset{H}{|}}{\overset{\overset{H}{|}}{C}}-\underset{\underset{H}{|}}{\overset{\overset{H}{|}}{C}}-H$; 11σ bonds and 1π bond.

21. (d) 

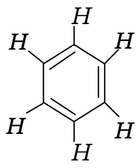
$CH_3-\underset{\substack{|\\ CH_3}}{CH}-CH_2-CH_3$

It has 3 CH_3 groups, one CH_2 group and one CH group.

22. (d) 

O–dimethyl benzene
or
O–xylene

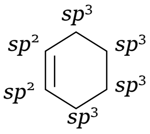
It has 18σ bonds and 3π bonds.

23. (d) 

$C-C=\sigma$ bonds $=6$

$C-H=\sigma$ bonds $\underline{=6}$

$\underline{12}$

24. (c) 

Cyclo hexene

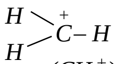
Two carbon atoms are sp^2-hybridized while remaining 4 are sp^3 hybridized.

25. (c) $\overset{1}{CH_2}=\overset{2}{CH}-\overset{3}{C}\equiv\overset{4}{C}-\overset{5}{CH_2}-\overset{6}{CH_3}$

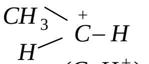
3-hexyne-1-ene

Three π bonds.

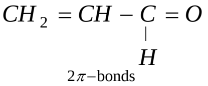
26. (a, c) Carbonium ions an sp^2 hybridized species.



(CH_3^+)

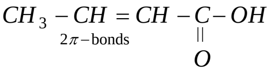


$(C_2H_5^+)$

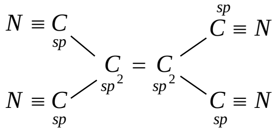
27. (c) (a) $\underset{2\pi\text{–bonds}}{H-C\equiv C-H}$ (b) 

$CH_2=CH-\underset{\substack{|\\ H}}{C}=O$

2π–bonds

(c) $\underset{1\pi\text{ bond}}{CH_3CH=CH_2}$ (d) 

$\underset{2\pi\text{–bonds}}{CH_3-CH=CH}-\underset{\substack{\|\\ O}}{C}-OH$

28. (c) 

29. (c) $\overset{\sigma}{H-}\overset{\sigma}{C}\underset{\pi}{\equiv}\overset{\sigma}{C}-H$ 3σ and 2π bonds are present.

30. (d) Vinyl acetylene there are 6 unhybridised orbitals.

$\underset{\substack{sp^2\\ 1}}{CH_2}=\underset{\substack{sp^2\\ 1}}{CH}-\underset{\substack{sp\\ 2}}{C}\equiv\underset{\substack{sp\\ 2}}{CH}$

(no. of unhybridised orbitals)

31. (c) Bond energy is maximum for triple bond.

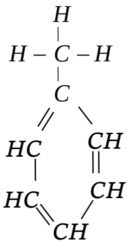
32. (c) $\underset{5\sigma,\,1\pi}{CH_2=CH_2}$

33. (d) In benzene all 6 carbons are sp^2 hybridised.

34. (c) $\underset{sp^2}{CH_2}=\underset{sp^2}{CH}-\underset{sp^2}{CH}=\underset{sp^2}{CH_2}$

36. (a) $\underset{7\sigma,\,3\pi}{CH_2=CH-C\equiv CH}$

37. (c) Propyne has one acidic hydrogen.

39. (d) 

15σ and 3π .

40. (b) In CCl_4 all bond angles are same *i.e.* of $109^{o}28'$ the carbon is sp^3 hybridised.

41. (c) Geometry in sp^2-hybridisation is trigonal.

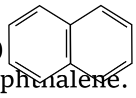
42. (a) $\underset{sp^2}{CH}=\underset{sp}{C}=\underset{sp^2}{CH}-\underset{sp^3}{CH_3}$

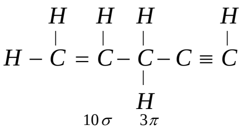
43. (c) Single bond has longest distance of bonds so C_2H_6 ethane is correct answer.

47. (b) $HC\equiv\underset{sp}{C}-\underset{sp^2}{CH}=CH_2$

48. (c) In ethylene molecule carbons are sp^2 hybridised so its structure is trigonal planar

49. (a) $\underset{sp}{CH}\equiv\underset{sp}{CH}$

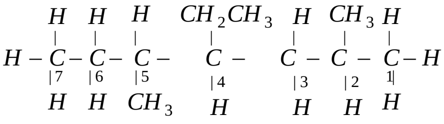
52. (c)  5 π bonds are present in naphthalene.

54. (a) 

$H-\overset{\substack{H\\ |}}{C}=\overset{\substack{H\\ |}}{C}-\overset{\substack{H\\ |}}{\underset{\substack{|\\ H}}{C}}-C\equiv\overset{\substack{H\\ |}}{C}$

10σ 3π

57. (c) $\underset{sp^2}{\overset{1}{CH_2}}=\underset{sp}{\overset{2}{C}}=CH_2$

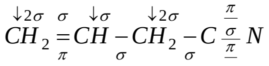
59. (d) 

$H-\overset{\substack{H\\ |}}{\underset{\substack{|7\\ H}}{C}}-\overset{\substack{H\\ |}}{\underset{\substack{|6\\ H}}{C}}-\overset{\substack{H\\ |}}{\underset{\substack{|5\\ CH_3}}{C}}-\overset{\substack{CH_2CH_3\\ |}}{\underset{\substack{|4\\ H}}{C}}-\overset{\substack{H\\ |}}{\underset{\substack{|3\\ H}}{C}}-\overset{\substack{CH_3\\ |}}{\underset{\substack{|2\\ H}}{C}}-\overset{\substack{H\\ |}}{\underset{\substack{|1\\ H}}{C}}-H$

2, 5 d; methyl4-ethylheptane (5 Methylgroup)

60. (a) $\overset{sp^3}{CH_3}-\overset{sp^2}{CO}-\overset{sp^3}{CH_3}$ Acetone $\overset{sp^3}{CH_3}\overset{sp^2}{COOH}$ Acetic acid

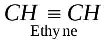
$\overset{sp^3}{CH_3}-\overset{sp}{C}\equiv N$ Acetonitrile $\overset{sp^3}{CH_3}-\overset{sp^2}{CONH_2}$ Acetamide

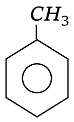
61. (a) 
$\overset{\downarrow 2\sigma}{CH_2} \underset{\pi}{\overset{\sigma}{=}} \overset{\downarrow \sigma}{CH} \underset{\sigma}{-} \overset{\downarrow 2\sigma}{CH_2} \underset{\sigma}{-} C \overset{\pi}{\underset{\pi}{\overset{\sigma}{\equiv}}} N$

Allylcyanide

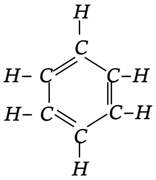
Total 9σ bond and 3π bond.

62. (d) Because hydrogen is attached with high electronegative element.

63. (c) 
$\underset{\text{Ethyne}}{CH \equiv CH}$

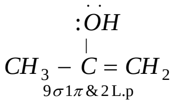
64. (b) 

has 15σ bonds.

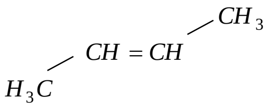
65. (b) 

12π and 3π bonds

66. (b) The s-character of $C-H$ bond of acetylene is higher in comparison to $C-H$ bond of ethene and ethane. The electrons of the $C-H$ bond in acetylene are strongly held by carbon nuclei. This facilitates the removal of hydrogen as proton.

67. (b) 
$\underset{9\sigma 1\pi \& 2\text{L.p}}{CH_3 - \overset{:\ddot{O}H}{\overset{|}{C}} = CH_2}$

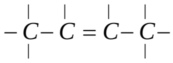
Dipole moment, resonance and reaction intermediates

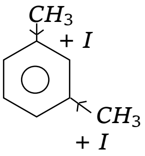
1. (b) 

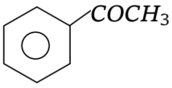
$\mu = 0$ symmetrical structure.

2. (b) Due to presence of two chlorine atom on the same side of carbon atom produces dipole moment in molecule.

4. (c) We know that there is more difference in the electronegativities of hydrogen and chlorine. Therefore HCl is a polar compound.

5. (c) (i) 
Trans-2 butene
(u=0)

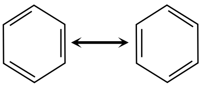
(ii) 

(iii) 

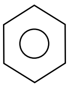
(iv) $\underset{+I}{C_2H_5OH}$

The dipole moment is the highest for Acetophenone.

6. (d) Resonance structure of molecule does not have identical bonding.

7. (c) 

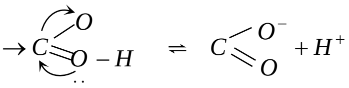
All the bonds $(C-C)$ are equal in benzene. The $C-C$ bond length is $1.39\,\text{Å}$ which is in between $C-C$ bond $(1.54\,\text{Å})$ and $C=C$ $(1.34\,\text{Å})$.

9. (b)  (1) Molecule is planar.

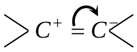
(2) 6π electrons are present.

11. (d) Benzene is unreactive instead of having 3π bonds because of resonance π-electrons are delocalized.

12. (b) Carboxylic acids are easily ionized because there is resonance in carboxylate ion due to π-electron shifting so H^+ get ionised very easily.



13. (a) Due to delocalisation of π electrons benzene has resonance.

19. (a) 

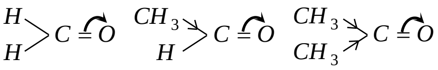
21. (a) It is hyperconjugation process.

22. (a) Triphenyl methyl cation has three benzene resonating ring so it is most stable compound.

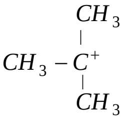
23. (b) Due to mesomeric effect (+) of – OH group the electron density on benzene ring increase. So the electrophile easily attacked on these electron rich center.

24. (c) Carbonyl carbon become more reactive toward nucleophilic addition by increasing the $+I$ effect of alkyl group so the reactivity order is as

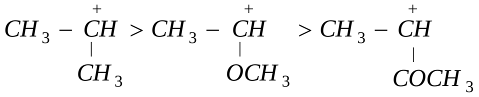

$\underset{\text{I}}{HCHO} > \underset{\text{II}}{CH_3CHO} > \underset{\text{IIII}}{CH_3COCH_3}$



25. (c) The octet of all atoms are complete in structures (a) and (b). In structure (d) electron deficiency of positively charged carbon is duly compensated by lone pair electrons of adjacent oxygen atom while such neighbour group support is not available in structure (c).

26. (b) 
$CH_3 - \overset{CH_3}{\overset{|}{\underset{\underset{CH_3}{|}}{C^+}}}$
Due to $(+I)$ effect of three methyl group 3° carbocation is more stable.

27. (b)



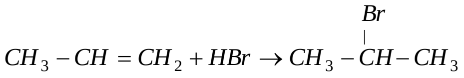
$CH_3-\underset{CH_3}{\overset{+}{CH}} > CH_3-\underset{OCH_3}{\overset{+}{CH}} > CH_3-\underset{COCH_3}{\overset{+}{CH}}$

28. (b) $\underset{\text{Benzyl carbanion}}{C_6H_5-\overline{CH_2^{\cdot\cdot}}} > \underset{\text{Ethyl carbanion}}{CH_3\overline{CH_2^{\cdot\cdot}}}$

$\underset{\text{Isopropyl carbanion}}{(CH_3)_2\overline{CH^{\cdot\cdot}}} > \underset{\text{Tert-butyl Carbanion}}{(CH_3)_3\overline{C^{\cdot\cdot}}}$

30. (b) 3° alcohol on dehydrogenation gives most stable carbonium ion.

32. (c) Without intermediate reaction take place as under



$CH_3-CH=CH_2+HBr \to CH_3-\overset{Br}{CH}-CH_3$

(According to markownikoff rule)

But the halogen bonded with terminal carbon so it take place in presence of peroxide by free radical mechanism.

$\underset{\text{peroxide}}{R-O-OR} \to 2R\dot{O}\ ;\ HBr+R\dot{O} \to ROH+Br^{\cdot}$

$CH_3-CH=CH_2+Br^{\cdot} \to CH_3-C\dot{H}-CH_2-Br$

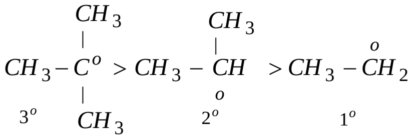
$CH_3-\dot{C}H-CH_2Br+HBr \to$

$CH_3-CH_2-CH_2Br+Br^{\cdot}$

33. (a)

	Species	Valence electrons	Magnetic behaviour
1.	Free radical	7	Paramagnetic
2.	Carbonium ion	6	Diamagnetic
3.	Carbanion	8	Diamagnetic
4.	Carbene	6	Diamagnetic
5.	Nitrene	6	Diamagnetic

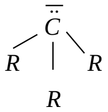
34. (d)



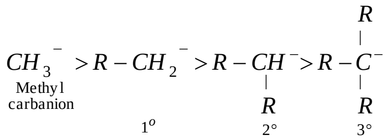
$\underset{3^o}{CH_3-\underset{CH_3}{\overset{CH_3}{C^o}}} > \underset{2^o}{CH_3-\underset{o}{\overset{CH_3}{CH}}} > \underset{1^o}{CH_3-\overset{o}{CH_2}}$

Greater the no. of alkyl groups attached to the carbon atom carrying the odd electrons, greater is the delocalization of odd electron and hence more stable is the free radical.

35. (a)

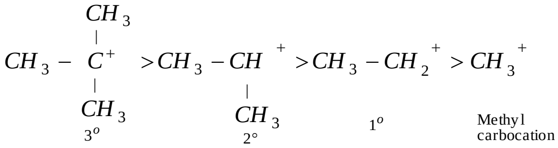


36. (a)



$\underset{\text{Methyl carbanion}}{CH_3^-} > \underset{1^o}{R-CH_2^-} > \underset{2^\circ}{R-\underset{R}{CH^-}} > \underset{3^\circ}{R-\underset{R}{\overset{R}{C^-}}}$

37. (b)



$\underset{3^o}{CH_3-\underset{CH_3}{\overset{CH_3}{C^+}}} > \underset{2^\circ}{CH_3-\underset{CH_3}{CH^+}} > \underset{1^o}{CH_3-CH_2^+} > \underset{\text{Methyl carbocation}}{CH_3^+}$

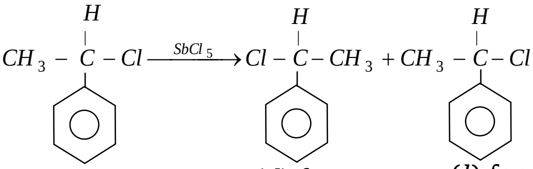
Greater the no. of alkyl groups, greater would be the dispersal of the charge and hence more stable will be the carbonium ion.

39. (a) $C-C$ bond length in benzene is 1.39Å which is in between $C-C$ (1.54 Å) and $C=C$ (1.34 Å) because of resonance.

40. (d) $C-Cl \xrightarrow[\text{bond fission}]{\text{Heterolytic}} \underset{\text{Cation}}{C^+} + \underset{\text{Anion}}{Cl^-}$

41. (d) $CH_3CH_2OH \xrightarrow{\text{Heterolytic cleavage}} CH_3CH_2^+ + OH^-$

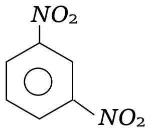
43. (d)



(*d*) form (*l*) form

44. (b) The reaction of an alkyl halide or aryl halide with benzene in the presence of a Lewis acid, generally $AlCl_3$ is known as Friedel Craft's reaction.

45. (b)



gives only monosubstitution product as $-NO_2$ group is meta directing and only one m-position is possible in m-dinitrobenzene.

46. (a) According to Huckel ruel, all aromatic compounds must have $(4n+2)\pi$ electrons where n is an integer, *i.e.*, $n=0,1,2,3,...$ and possesses unusual stability due to the complete delocalisation of π-electrons.

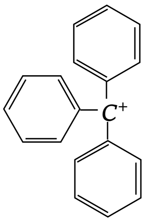
47. (b) $H-\ddot{\underset{\cdot\cdot}{O}}-H,\ :NH_3,\ R-\ddot{\underset{\cdot\cdot}{O}}-R$ - nucleophiles SO_3 has electron deficient centre (a reagent which can accept an electron pair in a reaction, is called an electrophile)

48. (d) Chlorine atom is *orth-para* directing group.

49. (b) Stability of carbonium ions.

tertiary alkyl > secondary alkyl > primary alkyl > methyl.

More the number of alkyl groups, the greater the dispersal of positive charge and therefore, more the stability of carbonium ion is observed.



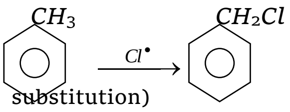
triphenylmethyl cation

Dispersal of positive charge increases with the increase in the number of benzene ring.

Organic reactions and their mechanism

1. (d) It is SN^2 type of reaction.

3. (c) $Cl_2 \xrightarrow{\text{Light}} 2Cl^\bullet$



$+H^+$ (Freeradical substitution)

5. (a) It is nucleophilic substitution reaction which is in first order.

9. (d) All cations are expected to act as Lewis acid since they are electron deficient in nature. However cation such as Na^+, K^+ etc. (Inert gas configuration) have a very little tendency to accept electrons. Therefore they do not acts as lewis acids in friedel Craft's reaction.

10. (d) The process of nitration takes place as below

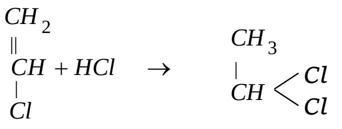
$$HONO_2 + 2H_2SO_4 \rightleftharpoons H_3O^+ + 2HSO_4^- + \underset{\text{(nitronium ion)}}{NO_2^+}$$

The electrophile responsible for nitration is NO_2^+ ion.

11. (b) Dehydrohalogenation of an alkyl halide on presence of alcoholic potash is an example of elimination reaction.

$$R - CH_2CH_2 - Cl + \underset{\text{alc.}}{KOH} \xrightarrow{\Delta} RCH = CH_2 + KCl + H_2O$$

12. (d)



$$\overset{CH_2}{\underset{Cl}{CH}} + HCl \rightarrow \overset{CH_3}{CH} \!<\! \begin{matrix} Cl \\ Cl \end{matrix}$$

(1, 1 dichloroethane)

It is addition reaction.

Which is according to Markownikoff rule.

13. (c) $CH \equiv CH + H_2 \rightarrow CH_2 = CH_2$

That is called addition reaction.

14. (d) When methane gas is treated with chlorine in the presence of sunlight, one hydrogen of methane replaced by the chlorine atom and forms methyl chloride. The mechanism involved in this reaction is free radical mechanism. So it is an example of free radical substitution reaction.

15. (c) Due to OH^- attack it is nucleophilic substitution.

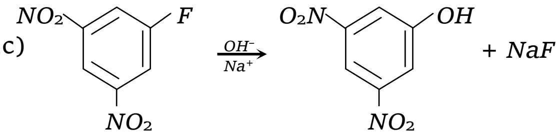
16. (a) Electron deficient species (in complete octet) acts as an electrophile *i.e.* BCl_3.

17. (a) $NO_2^\oplus$ is produced when conc. HNO_3 reacts with conc. H_2SO_4.

$$HNO_3 + H_2SO_4 \rightarrow HSO_4^- + NO_2^\oplus + H_2O$$

18. (d) Phenol will undergo electrophilic substitution more readily than benzene.

19. (b,c)



Di nitro fluoro　　Di nitro phenol

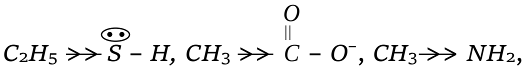
20. (a) $AlCl_3$ is lewis acid *i.e.*, electron deficient compound. So it is electrophile.

21. (d) $CH_3 - O^-$ is the strongest nucleophile which is capable of acting as donar of electon pair.

22. (a) The phenyl ring having $H - N<$ group is activated while another one is deactivated due to $-\underset{\underset{O}{\|}}{C}-$, so electrophilic aromatic bromination will occur at para position with respect to $H - N<$ group inactivated ring.

23. (d) The non reactivity of the chlorine atom in vinyl chloride may be explained from the molecular orbital point of view as follows. If the chlorine atom has sp^2 hybridization the $C - Cl$ bond will be a σ-bond and the two lone pairs of electron would occupy the other two sp^2 orbitals. This would leave a p-orbital containing a lone pair and this orbital could not conjugate with the π bond of the ethylenic link. Thus two M.O.S. will be required to accommodate these four π electrons. Further more since chlorine is more electronegative than carbon, the electron will tend to be found in the chlorine atom has now lost full control of the one pair and so, is less negative than it would have been had there been no conjugation. Since two carbon atoms have acquired a share in the lone pair, each atom acquires a small negative charge. Hence, owing to delocalisation of bonds (through conjugation), the vinyl chloride molecule has an increased stability. Before the chlorine atom can be displaced by some other group the lone pair must be localised again on the chlorine atom. This requires energy and so the chlorine is more firmly bound than has no conjugation occurred.

24. (a) Nucleophiles are those substances which can donate a pair of electrons. These can be neutral or negative. The nucleophilic power depends on the tendency of species to donate electrons. This is more, when an electron pushing group (+*I* group) is present. Among the alkyl groups, those having higher number of *C*-atoms will push more, hence ethyl > methyl.



$C_2H_5 \gg \ddot{S} - H,\ CH_3 \gg \overset{\overset{O}{\|}}{C} - O^-,\ CH_3 \gg NH_2,$

(+I) (+I) (+I)

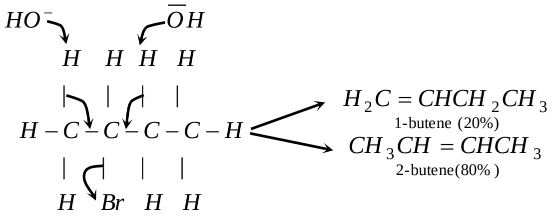
$CH_5 + CH_2$

(–I)

25. (a) Conjugated acid of Cl^- is a stronger acid i.e., HCl.

26. (b) Saytzeffs product.

29. (b) If the dehydrohalogenation of an alkyl halide can yield more than one alkene, then according to the saytzeff rule, the main product is the most highly substituted alkene.



30. (d) Halogenation of alkanes takes place in presence of light (sunlight or UV) or at elevated temperature via free radical.

31. (d) All the given species undergo nucleophilic substitution reaction. This reactivity can be explained in terms of the nature of $C-X$ bond which is highly polarised covalent bond due to large difference in the electronegativities of carbon and halogen atoms.

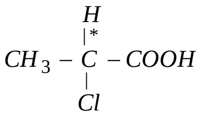
$$-\overset{\delta^+}{C}-\overset{\delta^-}{X}$$

32. (c) Increasing + I effect

$(CH_3)_3C > (CH_3)_2CH > CH_3CH_2 > CH_3$

Structural and stereo isomerism

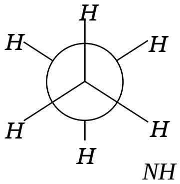
5. (b)

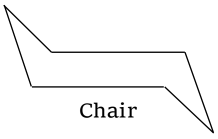


$$CH_3-\overset{\overset{H}{|^*}}{\underset{\underset{Cl}{|}}{C}}-COOH$$

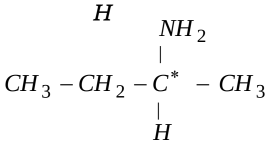
In this structure chiral carbon atom is present since it is optical active.

6. (b) In ethane staggard form and in cyclohexane chair form is more stable.





7. (d)

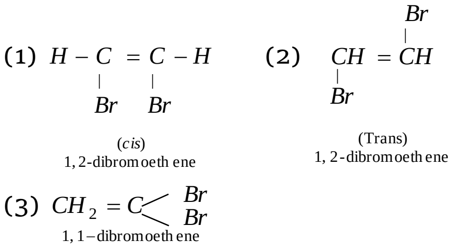


$$CH_3-CH_2-\overset{\overset{NH_2}{|}}{\underset{\underset{H}{|}}{C^*}}-CH_3$$

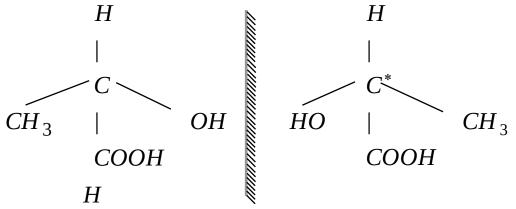
Chiral centre is present. Hence, it exists as optical isomers or enantiomorphs.

8. (c) In $C_6H_5CH_2CH_3$ chiral centre is absent.

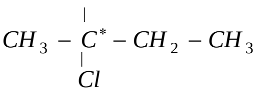
9. (c) $C_2H_2Br_2$ has three isomers.



10. (c) Lactic acid shows optical isomerism



11. (b)



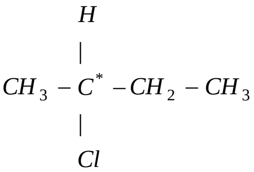
$$CH_3-\overset{\overset{H}{|}}{\underset{\underset{Cl}{|}}{C^*}}-CH_2-CH_3$$

2-Chlorobutane

because they contain chiral carbon atom.

12. (a)

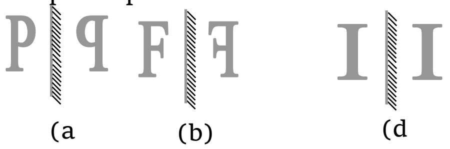
13. (a)



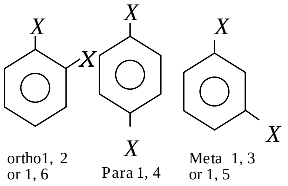
$$CH_3-\overset{\overset{H}{|}}{\underset{\underset{Cl}{|}}{C^*}}-CH_2-CH_3$$

In other compounds chiral carbon is absent.

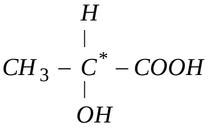
14. (c) Ball is achiral where other objects are chiral because objects and their mirror images are non-super imposable



15. (c)

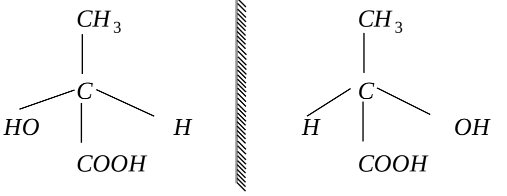


17. (b)



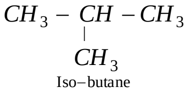
$$CH_3-\overset{\overset{H}{|}}{\underset{\underset{OH}{|}}{C^*}}-COOH$$

Only one chiral centre. Hence two optical isomers are possible.



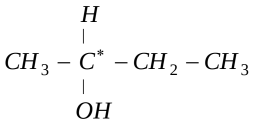
No. of optical isomer = 2^n (where n = no. of chiral carbon) = 2^1 = 2.

19. (a) $\underset{n-\text{butane}}{CH_3-CH_2-CH_2-CH_3}$ and



$\underset{\text{Iso-butane}}{CH_3-\underset{\substack{|\\CH_3}}{CH}-CH_3}$

20. (d)

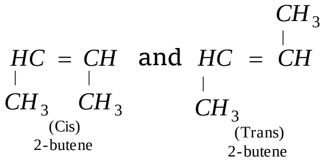


$CH_3-\overset{\substack{H\\|}}{\underset{\substack{|\\OH}}{C^*}}-CH_2-CH_3$

Chiral structure is that in which one carbon atom is attached to 4 different atoms or groups.

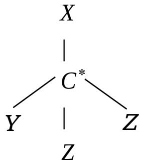
21. (b) $\underset{1-\text{butane}}{CH_3-CH_2-CH=CH_2}$ & $\underset{2-\text{butane}}{CH_3-CH=CH-CH_3}$

22. (a)

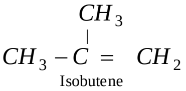


$\underset{\substack{\text{(Cis)}\\ \text{2-butene}}}{\underset{\substack{|\\CH_3}}{HC}=\underset{\substack{|\\CH_3}}{CH}}$ and $\underset{\substack{\text{(Trans)}\\ \text{2-butene}}}{\underset{\substack{|\\CH_3}}{HC}=\overset{\substack{CH_3\\|}}{CH}}$

23. (a) Four groups linked to carbon atom are different

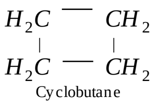


25. (d) Five isomers of C_4H_8

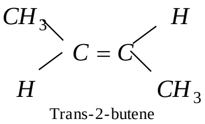
1. 

$\underset{\text{Isobutene}}{CH_3-\overset{\substack{CH_3\\|}}{C}=CH_2}$

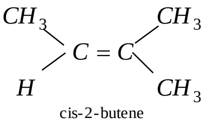
2. $\underset{1-\text{butene}}{CH_3CH_2-CH=CH_2}$

3. 

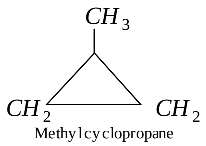
Cyclobutane

4. 

Trans-2-butene

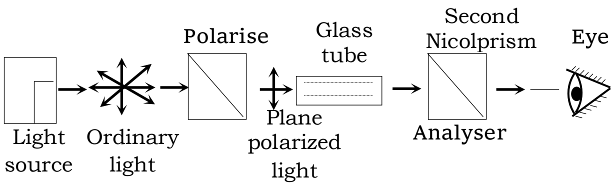
5. 

cis-2-butene

6. 

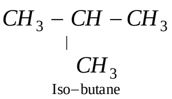
Methylcyclopropane

26. (b) Polarimeter is an instrument used for measuring the optical rotation. It consists of two Nicol prisms, one called the polarizer (near the light source) and the other called the analyser (near the eye). In between the polarizer and analyser, a glass tube containing the solution of an optically active compound is placed.



Ray diagram of

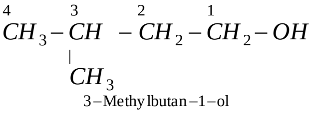
27. (d) $\underset{n-\text{butane}}{CH_3-CH_2-CH_2-CH_3}$ and



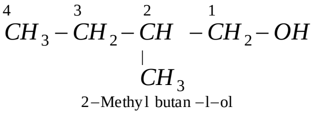
$\underset{\text{Iso-butane}}{CH_3-\underset{\substack{|\\CH_3}}{CH}-CH_3}$

28. (c) Metamerism is a special types of isomerism shown by secondary amines, ethers and ketones.

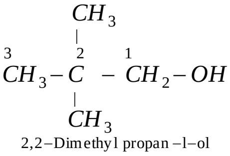
29. (c) $\underset{\text{Pentan-1-ol}}{CH_3-CH_2-CH_2-CH_2-CH_2-OH}$



$\underset{\text{3-Methylbutan-1-ol}}{\overset{4}{C}H_3-\overset{3}{\underset{\substack{|\\CH_3}}{CH}}-\overset{2}{C}H_2-\overset{1}{C}H_2-OH}$



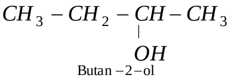
$\underset{\text{2-Methyl butan-1-ol}}{\overset{4}{C}H_3-\overset{3}{C}H_2-\overset{2}{\underset{\substack{|\\CH_3}}{CH}}-\overset{1}{C}H_2-OH}$



$\underset{\text{2,2-Dimethyl propan-1-ol}}{\overset{3}{C}H_3-\overset{\substack{CH_3\\|\\2}}{\underset{\substack{|\\CH_3}}{C}}-\overset{1}{C}H_2-OH}$

30. (d) Position isomers :

$\underset{\text{Butan-1-ol}}{CH_3-CH_2-CH_2-CH_2-OH}$ and



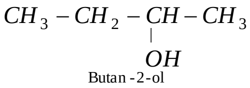
$\underset{\text{Butan-2-ol}}{CH_3-CH_2-\underset{\substack{|\\OH}}{CH}-CH_3}$

Functional isomers:

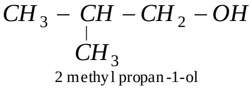
$\underset{\text{Butanol}}{CH_3CH_2CH_2-CH_2-OH}$ and $\underset{\text{Diethylether}}{C_2H_5-O-C_2H_5}$

Metamers: $\underset{\text{Diethylether}}{C_2H_5-O-C_2H_5}$ and $\underset{\text{Methyl propylether}}{CH_3-O-C_3H_7}$

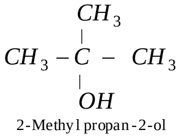
31. (a) 1. $\underset{\text{Butan-1-ol}}{CH_3-CH_2-CH_2-CH_2-OH}$

2. 

$\underset{\text{Butan-2-ol}}{CH_3-CH_2-\underset{\substack{|\\OH}}{CH}-CH_3}$

3. 

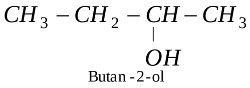
$\underset{\text{2 methyl propan-1-ol}}{CH_3-\underset{\substack{|\\CH_3}}{CH}-CH_2-OH}$

4. 

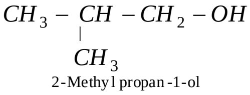
$\underset{\text{2-Methyl propan-2-ol}}{CH_3-\overset{\substack{CH_3\\|}}{\underset{\substack{|\\OH}}{C}}-CH_3}$

32. (d) $C_4H_{10}O$ have six isomers are possible

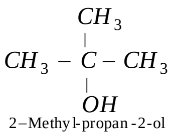
1. $\underset{\text{Butan-1-ol}}{CH_3CH_2CH_2CH_2-OH}$

2. 

$\underset{\text{Butan-2-ol}}{CH_3-CH_2-\underset{\substack{|\\OH}}{CH}-CH_3}$

3. 

$\underset{\text{2-Methyl propan-1-ol}}{CH_3-\underset{\substack{|\\CH_3}}{CH}-CH_2-OH}$

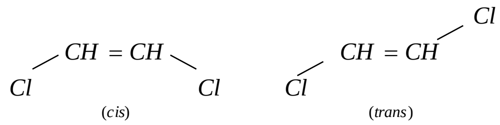
4. 

$\underset{\text{2-Methyl-propan-2-ol}}{CH_3-\overset{\substack{CH_3\\|}}{\underset{\substack{|\\OH}}{C}}-CH_3}$

5. $\underset{\text{Methyl propyl ether}}{CH_3-O-C_3H_7}$

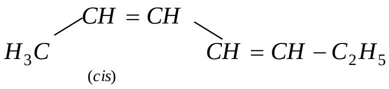
6. $\underset{\text{Diethyl ether}}{C_2H_5-O-C_2H_5}$

33. (b)

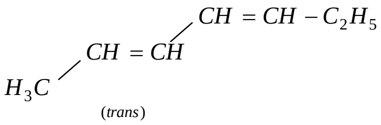


34. (a) $\overset{1}{C}H_3-\overset{2}{C}H=\overset{3}{C}H-\overset{4}{C}H=\overset{5}{C}H-\overset{6,7}{C_2H_5}$

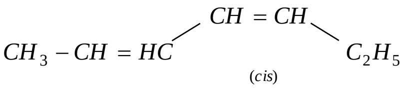
1.



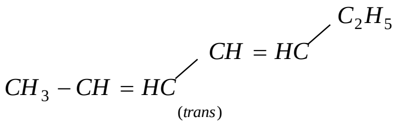
2.



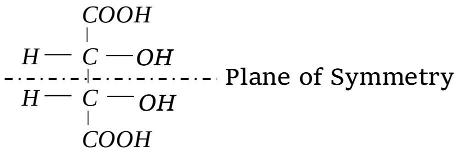
3.



4.

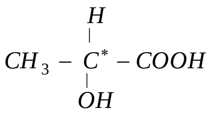


36. (a) Molecular symmetry



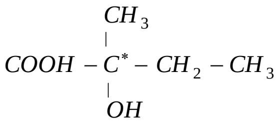
Mesotartaric acid is optically inactive due to internal compensation *i.e.* the effect one half of the molecule is neutralized by other.

37. (b)



$CH_3-\underset{OH}{\overset{H}{C^*}}-COOH$ * chiral centre is present.

38. (b)



$COOH-\underset{OH}{\overset{CH_3}{C^*}}-CH_2-CH_3$

One chiral centre. Therefore two forms are possible.

39. (c) Optical isomerism and geometrical isomerism.

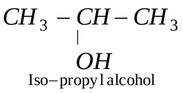
40. (d) (a) $CH_3CH_2CH_2COOH\,(C_4H_8O_2)$

(b) $CH_3CH_2-COOCH_3\,(C_4H_8O_2)$

Diethyl ether $C_2H_5-O-C_2H_5$ is position isomer and not stereoisomer.

41. (c) $C_2H_5-O-C_2H_5$ and $CH_3-O-C_3H_7$ are metamers.

42. (a) $\underset{\text{n-propyl alcohol}}{CH_3-CH_2-CH_2-OH}$ and

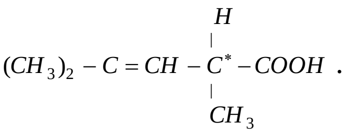


$\underset{\text{Iso-propyl alcohol}}{CH_3-\underset{OH}{CH}-CH_3}$

are position isomers of each other.

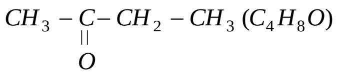
44. (a) $R-N\overset{\rightarrow}{\equiv}C$ and $R-C\equiv N$ are functional isomers.

45. (b) Optical isomerism because chiral centre is present



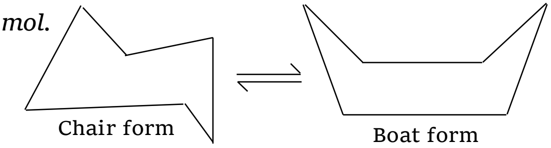
$(CH_3)_2-C=CH-\underset{CH_3}{\overset{H}{C^*}}-COOH$.

46. (d) Butanone



$CH_3-\underset{O}{\underset{\|}{C}}-CH_2-CH_3\,(C_4H_8O)$ is not an isomer of $C_2H_5-O-C_2H_5\,(C_4H_{10}O)$

47. (d) Chair and boat form differ in energy by 44 *kJ/mol.*



48. (b) $CH_3-O-CH_2-CH_3$ and $CH_3CH_2CH_2-OH$

ethylmethyl ether and propylalcohol are functional isomers.

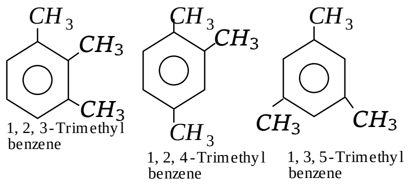
49. (c) $\underset{\text{Ethoxy propane}}{CH_3-CH_2-CH_2-O-C_2H_5}$

$\underset{\text{Propoxy ethane}}{CH_3-CH_2-CH_2-O-C_2H_5}$

Both are same compounds.

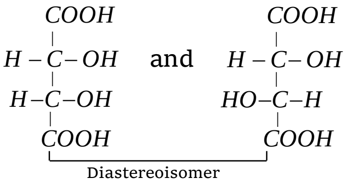
50. (a) $CH_3-CO-CH_3$ and CH_3-CH_2-CHO are functional isomers.

51. (b) Three isomers are possible

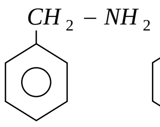


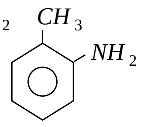
52. (d) Diastereoisomers – Optical isomers which are not mirror images of each other.

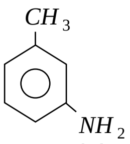
e.g.

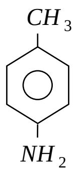


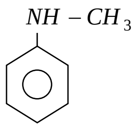
53. (b) C_7H_9N has 5 isomers


Benzyl amine


O–Methylaniline

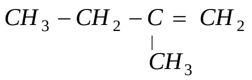

m–methyl aniline


p–methyl aniline

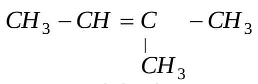

n–methyl aniline

54. (d) (1) $\underset{\text{Pent-1-ene}}{CH_3-CH_2-CH_2-CH=CH_2}$

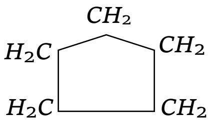
(2) $\underset{\text{Pent-2-ene}}{CH_3-CH_2-CH=CH-CH_3}$

(3) 
$CH_3-CH_2-\underset{CH_3}{\underset{|}{C}}=CH_2$

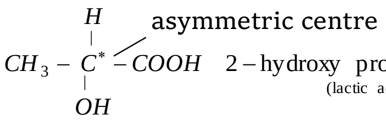
2–Methyl–1–butene

(4) 
$CH_3-CH=\underset{CH_3}{\underset{|}{C}}-CH_3$

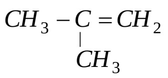
2–Methyl–2–butene

(5) 

Cyclopentane

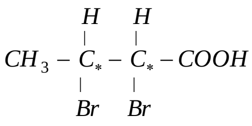
55. (d) 

$CH_3-\overset{H}{\underset{OH}{C^*}}-COOH$ 2 – hydroxy propanoic acid (lactic acid)

58. (d) 
$CH_3-\underset{CH_3}{\underset{|}{C}}=CH_2$

2-methyl propene does not show geometrical isomerism.

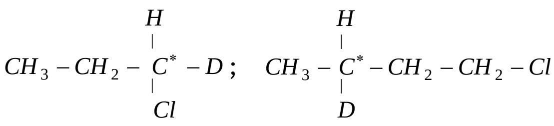
59. (b) Conformers - Conformation arises because of free rotation around $C-C$ bond axis.

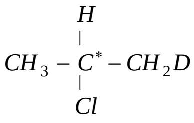
60. (d) 
$CH_3-\overset{H}{\underset{Br}{C_*}}-\overset{H}{\underset{Br}{C_*}}-COOH$

Number of enantiomers = 2^n (n = asymmetric Carbon atom) = 2^2 = 4.

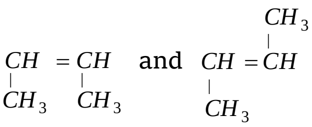
61. (b) $C_6H_5C\equiv N$ and $C_6H_5N\stackrel{\rightarrow}{=}C$ are functional isomers.

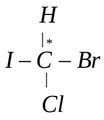
62. (a) $DCH_2-CH_2-CH_2-Cl$ Others are chiral


$CH_3-CH_2-\overset{H}{\underset{Cl}{C^*}}-D$; $CH_3-\overset{H}{\underset{D}{C^*}}-CH_2-CH_2-Cl$


$CH_3-\overset{H}{\underset{Cl}{C^*}}-CH_2D$

63. (d) Cis and trans 2-butene are geometrical isomers.

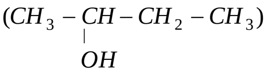

$\underset{CH_3}{CH}=\underset{CH_3}{CH}$ and $\underset{CH_3}{CH}=\overset{CH_3}{CH}$

64. (d) 
$I-\overset{H}{\underset{Cl}{C^*}}-Br$

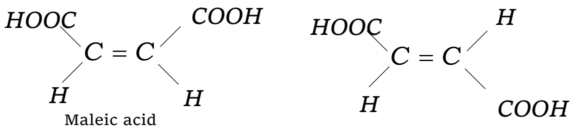
A carbon atom which is attached to four different atoms or groups is called a chiral or asymmetric carbon atom. such a carbon atom is often marked by an asterisk.

65. (b) $\underset{\text{Cyanide}}{R-C\equiv N}$ and $\underset{\text{Isocyanide}}{R-N\stackrel{\rightarrow}{=}C}$ are functional isomers.

66. (b) Glucose and fructose have similar molecular formula with difference of functional group, so they are functional isomers.

67. (b) 2-butanol 
$(CH_3-\underset{OH}{\underset{|}{CH}}-CH_2-CH_3)$ is optically active because it has asymmetric carbon atom.

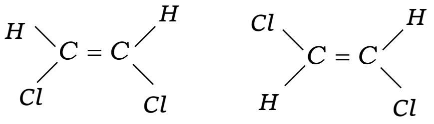
69. (d) Ethane has all single (σ) bonds so there is minimum resistance in bond rotation.

70. (a) 

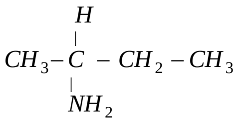
Maleic acid (cis isomer)

Fumaric acid (trans-isomer)

71. (a) $ClHC=CHCl$ two structures are possible

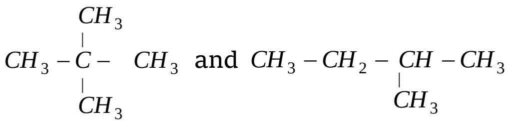


Geometrical isomerism

72. (c) 
$CH_3-\overset{H}{\underset{NH_2}{C}}-CH_2-CH_3$

Secondary butyl amine is optically active.

73. (c) Neopentane and isopentane are chain isomers.

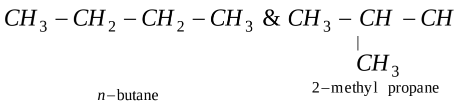

$CH_3-\overset{CH_3}{\underset{CH_3}{C}}-CH_3$ and $CH_3-CH_2-\underset{CH_3}{\underset{|}{CH}}-CH_3$

75. (a) Due to single bond there is no hindrance

77. (a) Only 1-phenyl-2-butene will exhibit *cis-trans* isomerism.

79. (a) Geometrical isomerism is not possible in propene.

80. (a) Two isomeric forms are possible for 2-methyl propane.

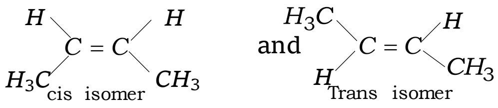


$CH_3-CH_2-CH_2-CH_3$ & $CH_3-\underset{\underset{CH_3}{|}}{CH}-CH_3$

n–butane 2–methyl propane

84. (d) Restricted rotation is essential condition for geometrical isomerism.

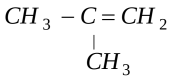
88. (a)



89. (b) Three isomeric structures are possible for C_4H_8

$H_2C=CH-CH_2-CH_3$

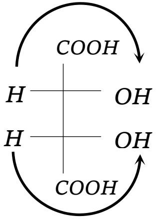
$CH_3-CH=CH-CH_3$



$CH_3-\underset{\underset{CH_3}{|}}{C}=CH_2$

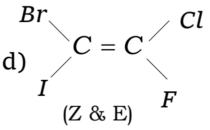
92. (a) Enantiomers have same chemical properties but different physical properties.

93. (a) Meso isomer have two achiral carbon with opposite spin so it becomes optically inactive

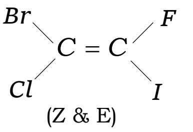


Meso tartaric acid

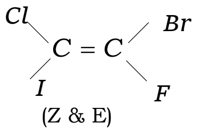
95. (d)



(Z & E)



(Z & E)



(Z & E)

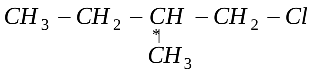
96. (b) Due to formation of the plane of symmetry by the syn addition of hydrogen in the triple bond, the compound formed is optically inactive.

101. (b) Racemic mixture is combination of d and l isomers.

102. (c) $Cl_2C=CH-CH_2-CH_2-CH_2$. It can't show geometrical isomerism due to unsymmetrical alkene.

103. (b) Geometrical isomerism.

104. (b)

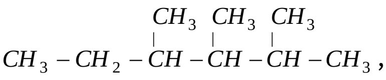


$CH_3-CH_2-\underset{\underset{CH_3}{|^*}}{CH}-CH_2-Cl$

105. (a) Functional isomerism

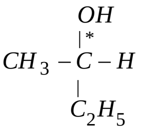
109. (b) Non superimposible on its mirror image.

112. (d)



$CH_3-CH_2-\underset{}{\overset{CH_3}{\overset{|}{CH}}}-\overset{CH_3}{\overset{|}{CH}}-\overset{CH_3}{\overset{|}{CH}}-CH_3$, it is a chiral compound.

114. (d)



$CH_3-\overset{OH}{\overset{|*}{\underset{\underset{C_2H_5}{|}}{C}}}-H$

In this structure chiral carbon is present that is why it is optically active.

115. (b) 2-chloro butane will be optically active.

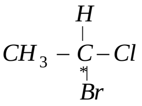
118. (b) Structures are mirror images of each other which are non super impossible so they are enantiomers.

120. (d) Both have one chiral carbon atom hence racemic mixture will be obtain

121. (b) Structure have 3-different atoms and group so it is unable to show geometrical isomerism

122. (c) Metamerism is shown by the different arrangement of alkyl group about functional group.

124. (b)

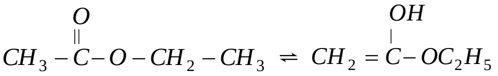


$CH_3-\overset{H}{\overset{|}{\underset{\underset{Br}{|^*}}{C}}}-Cl$, it is a chiral compound.

126. (c) CH_3-O-CH_3 and C_2H_5OH are functional isomers.

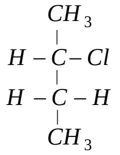
127. (c) Both are enantiomer.

128. (d) $CH_3COOC_2H_5$ shows tautomeric isomerism.

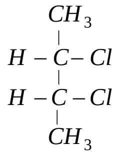


$CH_3-\overset{O}{\overset{||}{C}}-O-CH_2-CH_3 \rightleftharpoons CH_2=\overset{OH}{\overset{|}{C}}-OC_2H_5$

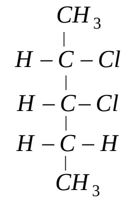
129. (b)



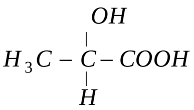
2 chlorobutane



2, 3 dichlorobutane



2, 3 dichloropentane

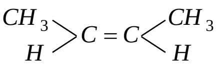


$H_3C-\overset{OH}{\overset{|}{\underset{\underset{H}{|}}{C}}}-COOH$

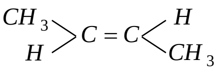
2 hydroxy propanoic acid

130. (d) Gaseous density of both ethanol and dimethyl ether would be same under identical condition of temperature and pressure while the rest of these three properties vapour pressure, boiling point and heat of vaporization will differ as ethanol has hydrogen bonding where as ether does not.

132. (a)



cis 2 butene

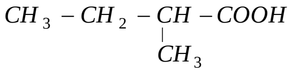


Trans 2 butene

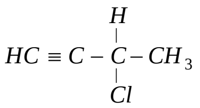
Cis-trans isomerism shown by compound which have double or triple bond by which they restrict their rotation, since 2 butyne have no hydrogen on triple bonded carbon.

$\underset{\text{2 butyne}}{CH_3-C\equiv C-CH_3}$ [It does not show cis-trans]

133. (d) Because it contain asymmetric carbon atom.

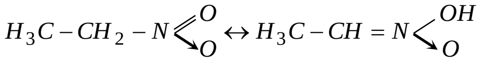


$CH_3-CH_2-\underset{\substack{|\\ CH_3}}{CH}-COOH$

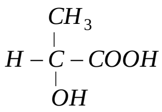
135. (b) 

$HC\equiv C-\overset{\substack{H\\ |}}{\underset{\substack{|\\ Cl}}{C}}-CH_3$ shows optical isomerism because of molecule is unsymmetrical. That is called chiral.

136. (c) Nitroalkanes exhibit tautomerism. In it, $\alpha-H-$ atom is labile and form nitrolic acid.

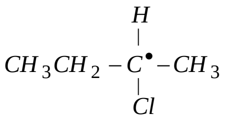


$H_3C-CH_2-N\begin{smallmatrix}\nearrow O\\ \searrow O\end{smallmatrix} \leftrightarrow H_3C-CH=N\begin{smallmatrix}\nearrow OH\\ \searrow O\end{smallmatrix}$

137. (b) 

$H-\overset{\substack{CH_3\\ |}}{\underset{\substack{|\\ OH}}{C}}-COOH$ shows optical isomerism due to presence of asymmetric carbon atom.

138. (a) 2-chloro butane has a chiral carbon atom, hence only it will show optical activity and will possess two enantiomers (one chiral carbon atom).



$CH_3CH_2-\overset{\substack{H\\ |}}{\underset{\substack{|\\ Cl}}{C^{\bullet}}}-CH_3$

139. (b) C_4H_7Cl is a monochloro derivative of C_4H_8 which itself exists in three isomeric forms.

(i) $CH_3-CH_2-CH=CH_2$: Its possible monochloro derivatives are :

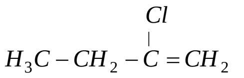
$CH_3-CH_2-CH=CH-Cl$

2 isomers : cis and trans forms

$CH_3-\underset{\substack{|\\ Cl}}{\overset{\bullet}{C}H}-CH=CH_2$

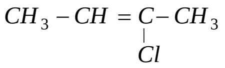
optically active (exists in two forms)

$ClCH_2-CH_2-CH=CH_2$ (one form)



$H_3C-CH_2-\overset{\substack{Cl\\ |}}{C}=CH_2$ (one form)

(ii) $CH_3-CH=CH-CH_3$: Its possible monochloro derivatives are :

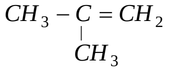


$CH_3-CH=\underset{\substack{|\\ Cl}}{C}-CH_3$

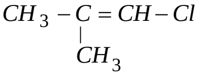
Exists in two geometrical forms

$CH_3-CH=CH-CH_2Cl$

Exists in two geometrical forms

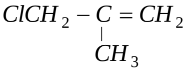
(iii) 

$CH_3-\underset{\substack{|\\ CH_3}}{C}=CH_2$: Its possible monochloro derivatives are



$CH_3-\underset{\substack{|\\ CH_3}}{C}=CH-Cl$

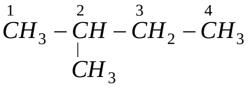
Only one form



$ClCH_2-\underset{\substack{|\\ CH_3}}{C}=CH_2$

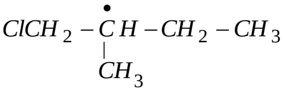
Only one form

Thus, the total acylic isomers forms of C_4H_7Cl are 12.

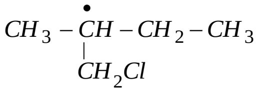
140. (d) 

$\overset{1}{CH_3}-\underset{\substack{|\\ CH_3}}{\overset{2}{CH}}-\overset{3}{CH_2}-\overset{4}{CH_3}$

Its monochloro derivatives are as follows :

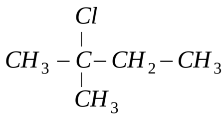
(i) 

$ClCH_2-\underset{\substack{|\\ CH_3}}{\overset{\bullet}{C}H}-CH_2-CH_3$

or 

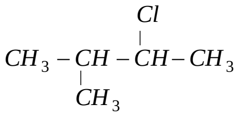
$CH_3-\underset{\substack{|\\ CH_2Cl}}{\overset{\bullet}{C}H}-CH_2-CH_3$

It will exist as enantiomeric pair (*d* and *l*-forms)

(ii) 

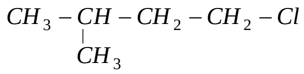
$CH_3-\overset{\substack{Cl\\ |}}{\underset{\substack{|\\ CH_3}}{C}}-CH_2-CH_3$

no asymmetric C atom

(iii) 

$CH_3-\underset{\substack{|\\ CH_3}}{CH}-\overset{\substack{Cl\\ |}}{CH}-CH_3$

It will exist as enantiomeric pair (*d*- and *l*-forms)

(iv) 

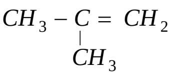
$CH_3-\underset{\substack{|\\ CH_3}}{CH}-CH_2-CH_2-Cl$

No asymmetric carbon atom

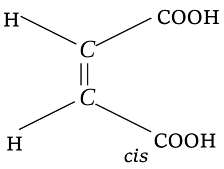
Hence, only two enantiomeric pairs will be obtained by the monochlorination of 2-methylbutane.

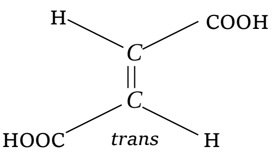
141. (d) When isomers have the structural formula but differ in the relative arrangement of atoms or groups in space with in the molecule, these are known as sterioisomers and the phenomenon as sterio isomerism. Stereoisomerism is of three types (i) Geometrical isomerism (ii) Optical isomerism (iii) Conformational isomerism.

144. (a) $CH_3=CH-CH_2-CH_3$; $CH_3-CH=CH-CH_3$;



$CH_3-\underset{\substack{|\\ CH_3}}{C}=CH_2$





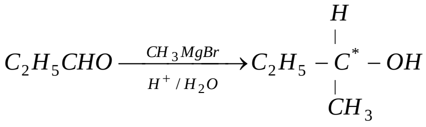
145. (c) and

146. (d) *Trans* configuration is more stable than *cis* configuration because in *cis*-configuration the *H* groups are thrown closely enough together to cause crowding or repulsion. Again between 1,2-and 1,3-configurations, in 1-3, the *OH* groups are placed further apart to minimise the repulsion. Hence, more stable is 1,3-configuration.

147. (a) Chirality of carbon compound is because of its tetrahedral nature of carbon.

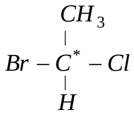
148. (c) $\underset{\text{1-chloro-2-nitroethene}}{O_2NHC=CHCl}$

For highly substituted alkenes *E* and *Z* system of nomenclature is used, which is based on a priority system developed by Cahn, Ingold and Prelog.

149. (b) 

$$C_2H_5CHO \xrightarrow[H^+/H_2O]{CH_3MgBr} C_2H_5-\overset{H}{\underset{CH_3}{C^*}}-OH$$

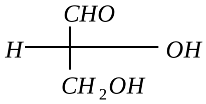
C^*-chiral carbon as all the four valencies are attached with different substituents or groups.

150. (b) 

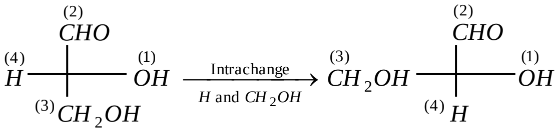
$Br-\overset{CH_3}{\underset{H}{C^*}}-Cl$ * asymmetric or chiral carbon

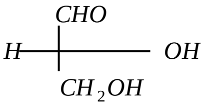
All the four valencies of carbon are satisfied with different atoms/substituents.

151. (c) The configuration in which, *OH* group are on right side, *H*-atom are on left side, *CHO* group are on upper side & CH_2OH are on lower side found in fischer projection known as *D*-configuration.

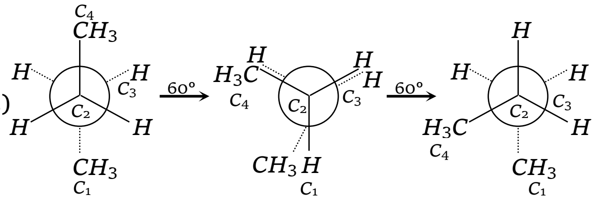


D-glyceraldehyde



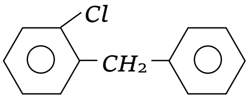
or 

Critical Thinking Questions

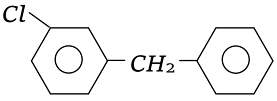
1. (c) 

Gauche

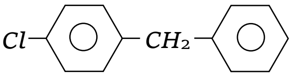
2. (d) Only four structural isomers are possible for diphenyl methane.



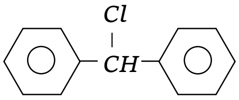
(i)



(ii

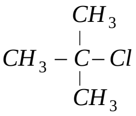


(ii

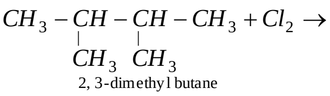


(iv

3. (c) SN^1 mechanism proceeds through carbocation intermediate.

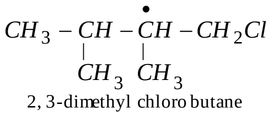


$CH_3-\overset{CH_3}{\underset{CH_3}{C}}-Cl$ provides stable carbocation intermediate because it has

4. (e) 

$$CH_3-\underset{CH_3}{CH}-\underset{CH_3}{CH}-CH_3+Cl_2\rightarrow$$

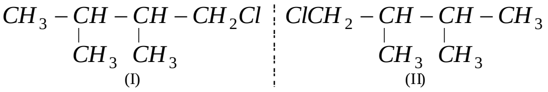
2, 3-dimethyl butane



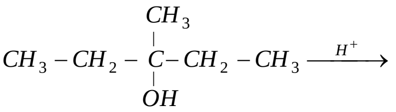
$$CH_3-\underset{CH_3}{CH}-\underset{CH_3}{\overset{\bullet}{CH}}-CH_2Cl$$

2, 3-dimethyl chloro butane

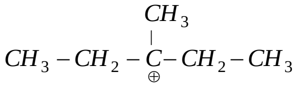
Due to the presence of chiral carbon it shows the optical activity and its mirror image are non superimposable so it shows one enantiomer pair.



$$\underset{\text{(I)}}{CH_3-\underset{CH_3}{CH}-\underset{CH_3}{CH}-CH_2Cl} \quad \vdots \quad \underset{\text{(II)}}{ClCH_2-\underset{CH_3}{CH}-\underset{CH_3}{CH}-CH_3}$$

5. (a) 

$$CH_3-CH_2-\overset{CH_3}{\underset{OH}{C}}-CH_2-CH_3\xrightarrow{H^+}$$

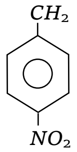


$$CH_3-CH_2-\overset{CH_3}{\underset{\oplus}{C}}-CH_2-CH_3$$

The more stable carbocation is generated thus more easily it will be dehydrated.

6. (b) This option is not characteristics of free radical chain reaction.

7. (c) Due to NO_2 group in benzene ring,

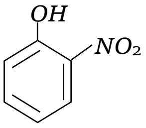


is most stable carbanion.

8. (d) Dissociation of proton from $CH_3-\overset{+}{N}H_3Cl^-$ is very difficult due to $-I$ effect of Cl^- and N^+ while in C_6H_5OH due to resonance stabilization of phenoxide ion proton eliminate easily similarly due to *H*-bonding in

$C_6H_5CH_2OH$ it can be eliminate and $CH_3C\equiv CH$ show acidic character by triple bond by which proton can be dissociate.

9. (b)

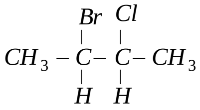


Electron withdrawing group increases acidic character due to $-I$ and $-R$ effect of NO_2 hence orthonitrophenol is most acidic.

10. (d) Halogenation on alkene occurs by electrophilic addition.

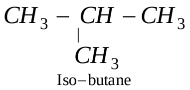
11. (c) The number of possible optical isomers $= 2^n$ (where 'n' is the number of chiral c-atoms) $= 2^3 = 8$

12. (c) 2-bromo, 3-chloro-butane has 2 chiral carbon atoms, hence has $2^2 = 4$ optical isomers.



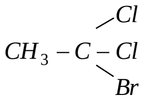
$$CH_3-\underset{H}{\overset{Br}{C}}-\underset{H}{\overset{Cl}{C}}-CH_3$$

13. (a) $\underset{n-\text{Butane}}{CH_3-CH_2-CH_2-CH_3}$,



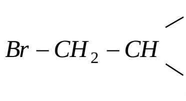
$$\underset{\text{Iso-butane}}{CH_3-\underset{CH_3}{CH}-CH_3}$$

14. (b) $C_2H_3Cl_2Br$ three isomers are possible



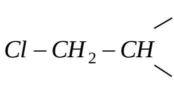
$$CH_3-C(Cl)_2-Br$$

1-bromo-1, 1-dichloroethane



$$Br-CH_2-CH(Cl)(Br)$$

1-bromo-2,2-di-chloroethane

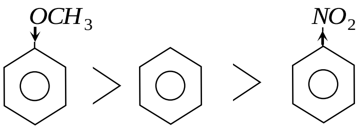


$$Cl-CH_2-CH(Br)(Cl)$$

1-bromo-1, 2-dichloroethane

15. (c) $D(+)$-tartaric acid has positive optical rotation and is derived from D $(+)$ glyceraldehyde.

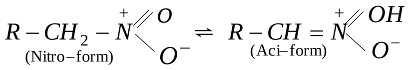
16. (c) I > II > III



Methoxy group is electron releasing it increases electron density of benzene nucleus while $-NO_2$ decreases electron density of benzene.

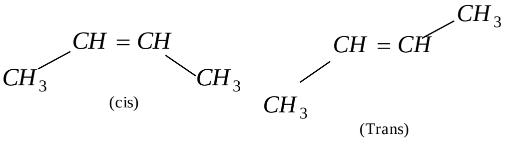
17. (c) Due to resistance benzyl carbonium ion is most stable.

18. (d)

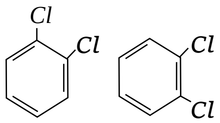


$$\underset{\text{(Nitro-form)}}{R-CH_2-\overset{+}{N}\begin{smallmatrix}\nearrow O\\ \searrow O^-\end{smallmatrix}} \rightleftharpoons \underset{\text{(Aci-form)}}{R-CH=\overset{+}{N}\begin{smallmatrix}\nearrow OH\\ \searrow O^-\end{smallmatrix}}$$

19. (b)



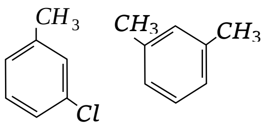
20. (d)



(i a) (i b)

Both 1, 2-dichloro benzene

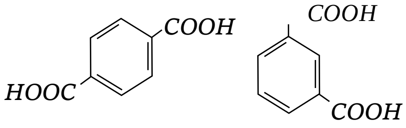
Hence, identical compounds.



(iia) (iib)

Both, 1, 3-dimethyl benzene

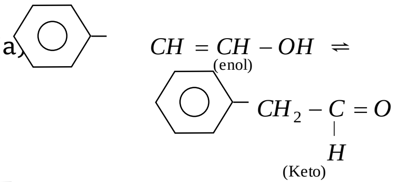
Hence, identical compounds.



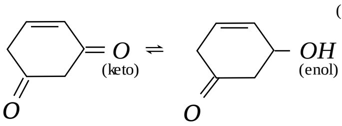
(iiia) (iiib)

(iiia) and (iiib) are position isomers.

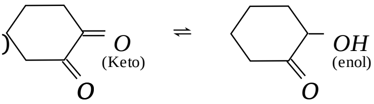
21. (a,c,d) (a)



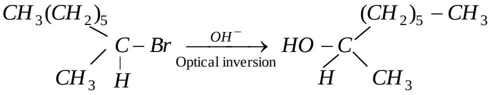
(c)



(d)



22. (c)



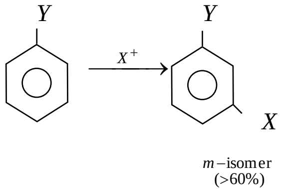
In this reaction inversion of configuration takes place this is called optical inversion. It is an example of SN^2 reaction (Bimolecular Nucleophillic Substitution).

23. (b) This option shows eclipsed form of ethane.

24. (c) 2nd and 4th forms of ethane are staggered.

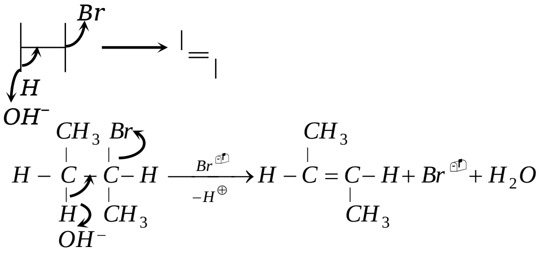
25. (b) $(CH_3)_3C^+$ 3° carbonium ion is most stable.

26. (a)



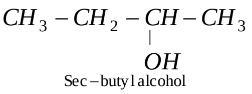
$Y = -COOH$ because it is meta directing group while $-NH_2$. $-OH$ and $-Cl$ are O and P directing groups.

27. (a)

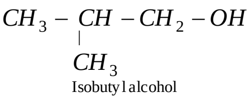


28. (c) $C_4H_{10}O$ have 7 isomers out of which 4 are alcohols and 3 are ethers.

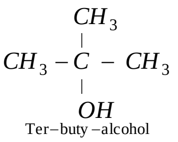
1. $\underset{n\text{–butyl alcohol}}{CH_3-CH_2-CH_2-CH_2-OH}$,

2. 

$\underset{\text{Sec–butyl alcohol}}{CH_3-CH_2-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_3}$

3. 

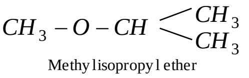
$\underset{\text{Isobutyl alcohol}}{CH_3-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_2-OH}$

4. 

$\underset{\text{Ter–buty –alcohol}}{CH_3-\overset{\displaystyle CH_3}{\overset{|}{\underset{\displaystyle OH}{\underset{|}{C}}}}-CH_3}$

5. $\underset{\text{Diethyl ether}}{CH_3-CH_2-O-CH_2-CH_3}$

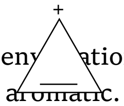
6. $\underset{\text{Methyl propyl ether}}{CH_3-O-CH_2-CH_2-CH_3}$

7. 

$\underset{\text{Methyl isopropyl ether}}{CH_3-O-CH\begin{matrix}CH_3\\CH_3\end{matrix}}$

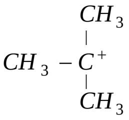
29. (a) According to Huckel rule for aromaticity the molecule must be planar, cyclic system having delocalised $(4n+2)\pi$ electron where n is an integer equal to 0, 1, 2, 3, thus the aromatic comp. have delocalised electron cloud of

2, 6, 10 or 14π electron cyclopropenyl cation have the 2π electron (n = 0) so it is aromatic.

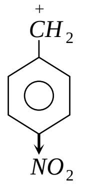


30. (d) $-COOH$ group is a deactivating group, hence benzoic acid is less reactive towards electrophilic substitution than phenol.

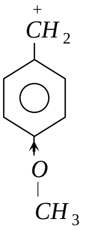
31. (c) In the triphenyl methyl carbonium ion the π electrons of all the three benzene rings are delocalised with the vacant p-orbital of central carbon atom. So, it is resonance stabilised. It is the most stable of all the carbonium ions given

The ion  $CH_3-\overset{\displaystyle CH_3}{\overset{|}{\underset{\displaystyle CH_3}{\underset{|}{C^+}}}}$ is stabilised by hyperconjugation, a second order resonance.

32. (b)

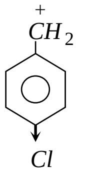


Nitro-group is electron withdrawing therefore decreases stability.



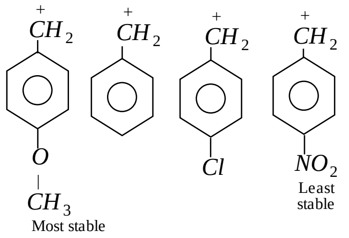
Methoxy group is electron releasing.

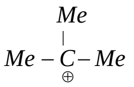
Therefore increases stability by donating electron.



Chlorine is also electron withdrawing but its effect is less than $-NO_2$ group.

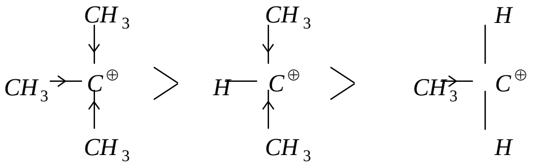
Hence, correct order of stability.



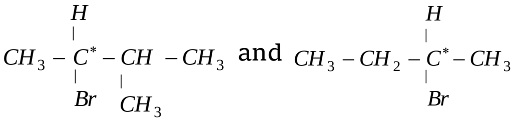
33. (b) 3° alcohols  $Me-\overset{\displaystyle Me}{\overset{|}{\underset{\oplus}{C}}}-Me$ is most stable carbocation

34. (b) Due to the increasing no. of hyperconjugative structures free radical stabilise following as $3° > 2° > 1°$.

35. (c) $3° > 2° > 1°$



36. (b,c)

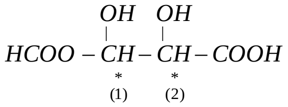


$$CH_3-\overset{H}{\underset{Br}{C^*}}-\underset{CH_3}{CH}-CH_3 \text{ and } CH_3-CH_2-\overset{H}{\underset{Br}{C^*}}-CH_3$$

37. (b) $\underset{\text{Diethyl thioether}}{C_2H_5-S-C_2H_5}$ and $\underset{\text{Methyl propyl thioether}}{CH_3-S-C_3H_7}$

are metamers.

38. (b)



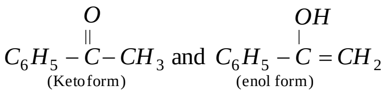
$$HCOO-\underset{(1)}{\underset{*}{\overset{OH}{CH}}}-\underset{(2)}{\underset{*}{\overset{OH}{CH}}}-COOH$$

Two carbon atoms in the molecule are asymmetric.

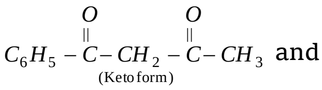
39. (a,b,d) $CH_3\ddot{N}H_2, R-\underset{..}{\ddot{O}}-, CH_3-Mg-\underset{..}{\ddot{Br}}:$ are nucleophiles due to presence of lone pairs.

40. (c) CH_3^- has the highest nucleophilicity.

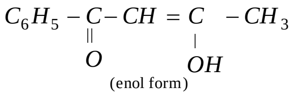
41. (c,d)



$$\underset{\text{(Keto form)}}{C_6H_5-\overset{O}{\overset{\|}{C}}-CH_3} \text{ and } \underset{\text{(enol form)}}{C_6H_5-\overset{OH}{C}=CH_2}$$

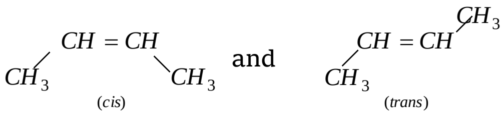


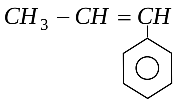
$$\underset{\text{(Keto form)}}{C_6H_5-\overset{O}{\overset{\|}{C}}-CH_2-\overset{O}{\overset{\|}{C}}-CH_3} \text{ and}$$



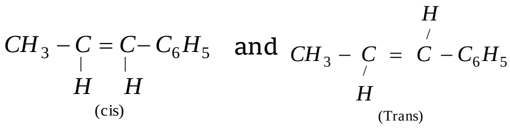
$$\underset{\text{(enol form)}}{C_6H_5-\underset{O}{\underset{\|}{C}}-CH=\underset{OH}{C}-CH_3}$$

42. (a,c) 2-butene





1-phenyl propene

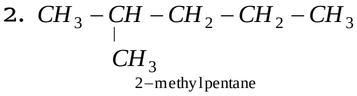


43. (c) CH_3CN behaves both as nucleophile and electrophile.

44. (c) 2^n, n = no. of asymmetric carbon atoms.

45. (b) 1. $\underset{\text{n-hexane}}{CH_3-CH_2-CH_2-CH_2-CH_2-CH_3}$

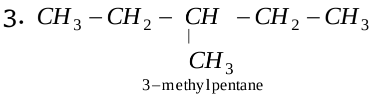
2.



$$CH_3-\underset{CH_3}{CH}-CH_2-CH_2-CH_3$$

2-methylpentane

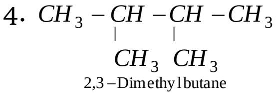
3.



$$CH_3-CH_2-\underset{CH_3}{CH}-CH_2-CH_3$$

3-methylpentane

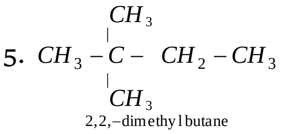
4.



$$CH_3-\underset{CH_3}{CH}-\underset{CH_3}{CH}-CH_3$$

2,3-Dimethylbutane

5.



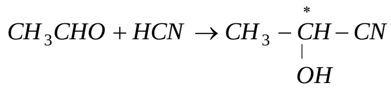
$$CH_3-\overset{CH_3}{\underset{CH_3}{C}}-CH_2-CH_3$$

2,2,-dimethylbutane

46. (c) Stability of carbanions increase with increase in *s*-character of hybrid orbitals of carbon bearing charge, hence correct order is : $sp^3 < sp^2 < sp$.

47. (b) $\underset{1.20\,Å}{C_2H_2} < \underset{1.34\,Å}{C_2H_4} < \underset{1.39\,Å}{C_6H_6} < \underset{1.54\,Å}{C_2H_6}$

48. (d)

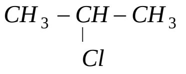


$$CH_3CHO + HCN \rightarrow CH_3-\overset{*}{\underset{OH}{CH}}-CN$$

(Both *d* and *l* forms are obtained) Hence, product will be a racemic mixture.

49. (d) Molecule 'A' is benzene because in benzene bond length is between single and double bond.

50. (a) Two isomers



$CH_3-\underset{Cl}{CH}-CH_3$ and $CH_3-CH_2-CH_2Cl$ are possible for C_3H_7Cl.

Assertion & Reason

1. (a) It is fact that aniline is better nucleophile than anilium ion. Anilium ion contain +*ve* charge, which reduces the tendency to donate lone pair of electron $\underset{\text{Anilium ion}}{C_6H_5NH_3^+}$.

Therefore, both assertion and reason are true.

2. (b) Neopentane is isomer of pentane and neopentane forms only one substitution product. Both assertion and reason are true but reason is not a correct explaination of assertion. Neopentane forms mono substituted product due to presence of four identical methyl groups present on carbon atom.

3. (c) The assertion that *trans*-2 butene reacts with Br_2 to product meso-2, 3-dibromobutane is correct but it does not involve *syn*-addition of Br_2.

4. (d) Here both assertion and reason are incorrect because *cis*-1, 3-dihydroxy cyclohexane exist in chair conformation and in chair conformation hydrogen bonding is present.

5. (a) Hydroxy ketones are not directly used in Grignard reagent. Grignard reagents are very reactive. Therefore, they react with hydroxyl group. Here both are correct.

6. (a) The assertion that on keeping benzyl bromide in acetone water it produces benzyl alcohol is correct. Because $C_6H_5CH_2Br$ hydrolysed to produce $C_6H_5CH_2OH$. This conversion is of SN^2 mechanism.

7. (b) Catenation property of carbon is primarily due to its small size. Electronic configuration and unique strength of carbon-carbon bonds.

8. (e) Olefins are unsaturated hydrocarbons containing two hydrogen atoms less than the corresponding paraffin *i.e.* there is one double bond between two carbon atoms in their molecules and they have the general formula C_nH_{2n}.

9. (b) Less reactivity of saturated hydrocarbons are due to presence of single bonds between carbon atoms.

10. (b) Glucose is insoluble in ether.

11. (a) An alkyl group attached to the positively charged carbon of a carbonium ion tends to release electrons towards that carbon; thus the positive charges gets dispersed as the alkyl group becomes some what positively charged itself. More the number of alkyl groups, the greater is the dispersal of positive charge and therefore more easily it will be formed.

12. (b) Heterolytic fission occurs when the two atoms differ considerably in their electronegativities and shared pair of electrons is carried by more electronegative atom.

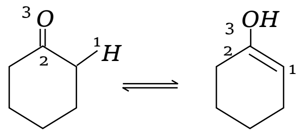
13. (d) The order of reactivity of carbonium ions is $1° > 2° > 3°$.

Carbon atom in carbonium ion is in sp^2 state of hybridisation. The three hybridized orbitals lie in the same plane and are involved in the formation of three σ bonds with three atoms or groups while the unhybridised *p*-orbital remains vacant.

14. (b) Since free radicals contain odd electrons, so they are short lived and they readily try to pair up the odd electrons to form neutral molecules, that is why they are highly reactive.

15. (b) Each carbon atom in ethylene is attached to two hydrogen atoms by single covalent bonds and to another carbon atoms by a double bond. Since each carbon is attached to three other atoms, it uses sp^2 hybrid orbitals and an unhybridised p_z orbital to form its bond. Each $C-H$ bond is a σ bond resulting from the overlap of $1s$ orbital of hydrogen atom and sp^2 orbital of a carbon atom. One $C-C$ bond results from the linear overlap of sp^2 orbitals one from each carbon atom. One π bond results from the lateral overlap of two unhybridised p_z orbitals, one from each carbon atom.

16. (a) In cyclohexanone keto enol tautomerism is as follows



Keto Enol

17. (e) The staggered form is more stable than the eclipsed form because the potential energy of staggered form in which the bond pairs of two carbons are far away from each other is minimum. Also the *H*-atoms are as far apart as possible and non bonded interaction between them is maximum. In occupied form, the *H*-atom are very close and so the increased overlap between them non-bonded orbitals is repulsive. That is why staggered form is more stable than eclipsed form.

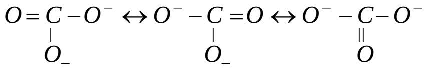
18. (b) Trans isomer is more stable than cis isomer because in cis isomer, the bulky groups are on the same side of the double bond. The steric repulsion of the groups makes the cis isomer less stable than the trans isomer in which the bulky groups are far apart. (They are on the opposite side of the double bond).

19. (e) 1, 2-propadiene is not optically active because the terminal sp^2-hybridised carbons have the same atoms *i.e.* H-atoms. As a result, it has a plane of symmetry passing through the three carbon atoms and hence the molecule is optically inactive.

20. (b) Lactic acid is a chiral molecule because it has a chiral carbon atom or asymmetric carbon atom and is therefore optically active.

21. (e) Resonance structures contain the same number of unpaired electrons.

22. (b) CO_3^{2-} shows resonance and thus all the three bonds are of identical bond length.



$$O=\underset{\substack{|\\O_-}}{C}-O^- \leftrightarrow O^- -\underset{\substack{|\\O_-}}{C}=O \leftrightarrow O^- -\underset{\substack{\|\\O}}{C}-O^-$$