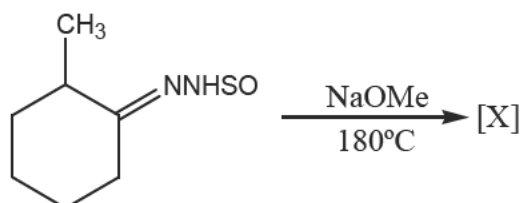
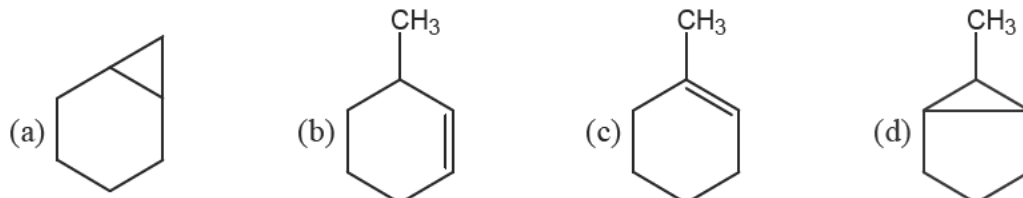


10. In the reaction,



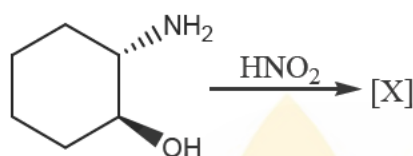
the major product [X] is



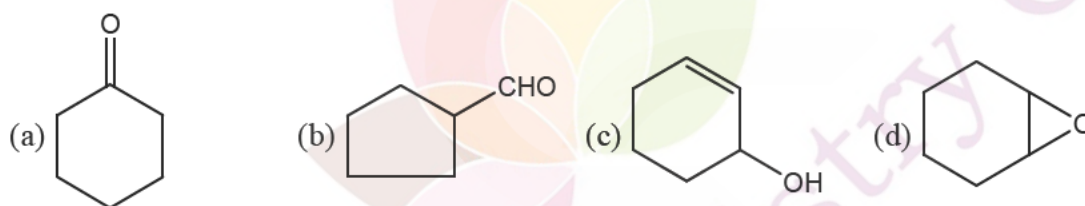
11. Among the following, a pair of resolvable configurational enantiomers is given by

- (a) cis-1, 2-dimethylcyclohexane (b) cis-1, 3-dimethylcyclohexane
 (c) cis-1, 4-dimethylcyclohexane (d) trans-1, 3-dimethylcyclohexane

12. In the reaction,



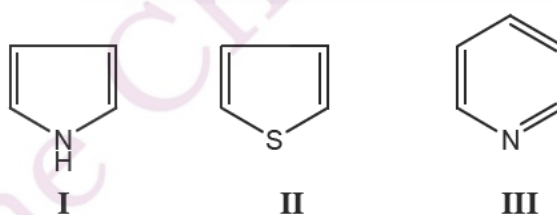
the major product [X] is:



13. The decreasing order of isoelectric point for the following α -amino acids is

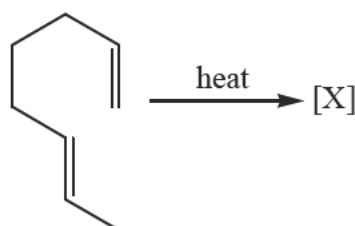
- Lysine Alanine Glutamic acid
 (I) (II) (III)
 (a) I > II > III (b) II > I > III (c) III > I > II (d) I > III > II

14. The decreasing order of the reactivity of the following compounds towards electrophiles is

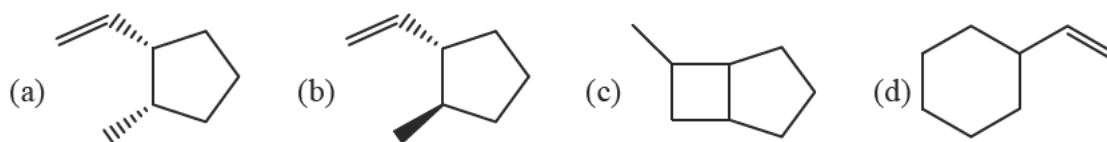


- (a) II > I > III (b) II > III > I (c) III > I > II (d) I > II > III

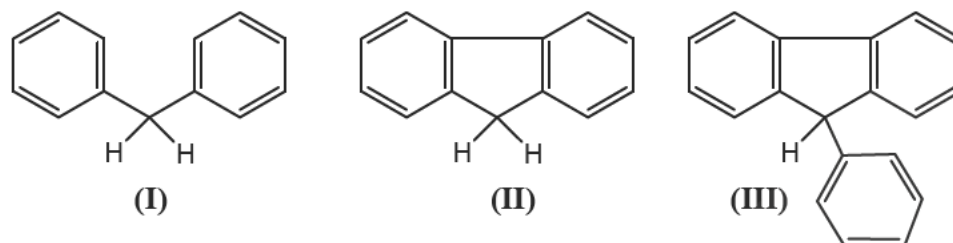
15. In the reaction,



the major product [X] is

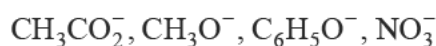


16. The decreasing order of acidity of marked **H** of the following molecules is



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

17. The decreasing order of nucleophilicity for the following anions is



(a) $\text{CH}_3\text{CO}_2^- > \text{CH}_3\text{O}^- > \text{C}_6\text{H}_5\text{O}^- > \text{NO}_3^-$ (b) $\text{CH}_3\text{O}^- > \text{NO}_3^- > \text{C}_6\text{H}_5\text{O}^- > \text{CH}_3\text{CO}_2^-$
 (c) $\text{CH}_3\text{O}^- > \text{C}_6\text{H}_5\text{O}^- > \text{CH}_3\text{CO}_2^- > \text{NO}_3^-$ (d) $\text{C}_6\text{H}_5\text{O}^- > \text{CH}_3\text{O}^- > \text{NO}_3^- > \text{CH}_3\text{CO}_2^-$

18. The molar entropy of crystalline CO at absolute zero is

(a) Zero (b) $-R \ln 2$ (c) $R \ln 2$ (d) $2R \ln 2$

19. For an ideal gas

(a) $\left(\frac{\partial P}{\partial T}\right)_V \left(\frac{\partial T}{\partial V}\right)_P \left(\frac{\partial V}{\partial P}\right)_T = 0$ (b) $\left(\frac{\partial P}{\partial T}\right)_V \left(\frac{\partial T}{\partial V}\right)_P \left(\frac{\partial V}{\partial P}\right)_T = -1$
 (c) $\left(\frac{\partial P}{\partial T}\right)_V \left(\frac{\partial T}{\partial V}\right)_P \left(\frac{\partial V}{\partial P}\right)_T = +1$ (d) $\left(\frac{\partial P}{\partial T}\right)_V \left(\frac{\partial T}{\partial V}\right)_P \left(\frac{\partial V}{\partial P}\right)_T = +2$

20. Among W (work), Q (heat), U (internal energy) and S (entropy)

(a) W and U are path functions but Q and S are state functions.
 (b) W and S are path functions but Q and U are state functions.
 (c) S and U are path functions but Q and W are state functions.
 (d) W and Q are path functions but U and S are state functions.

21. For eigen functions $\psi_1 = \sqrt{\frac{1}{b}} \sin\left(\frac{\pi x}{b}\right)$ and $\psi_2 = \sqrt{\frac{2}{b}} \sin\left(\frac{2\pi x}{b}\right)$ of particle in a 1-D box of length

$b(0 \leq x \leq b)$

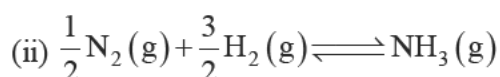
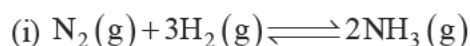
(a) ψ_1 is normalized but not orthogonal to ψ_2
 (b) ψ_1 is normalized but not orthogonal to ψ_2
 (c) ψ_2 is normalized and orthogonal to ψ_1
 (d) ψ_2 is neither normalized nor orthogonal to ψ_1

22. The bond order of C_2 molecule is

(a) 0 (b) 1 (c) 2 (d) 3

23. Sulfur can exist in four phases. The possible number of triple points is
 (a) 1 (b) 2 (c) 3 (d) 4
24. The standard reduction potentials at 298K for single electrodes are given below:
- | Electrode | Electrode Potential (volt) |
|----------------------|----------------------------|
| Mg ²⁺ /Mg | -2.34 |
| Zn ²⁺ /Zn | -0.76 |
| Fe ²⁺ /Fe | -0.44 |
- From this we can infer that
 (a) Zn can reduce both Mg²⁺ and Fe²⁺ (b) Fe can reduce both Mg²⁺ and Zn²⁺
 (c) Mg can reduce both Zn²⁺ and Fe²⁺ (d) Mg can reduce Zn²⁺ but not Fe²⁺.

25. For the pair of reactions given below



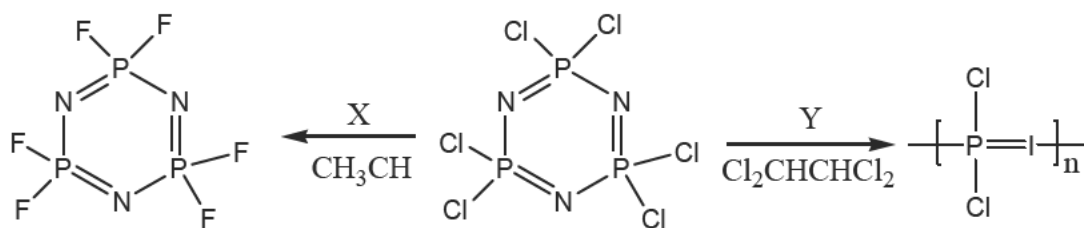
If at a particular temperature, K_{p1} and K_{p2} are the equilibrium constants for reactions (i) and (ii) respectively, then

- (a) $K_{p1} = 2K_{p2}$ (b) $K_{p1} = 2K_{p2}^2$ (c) $K_{p1} = K_{p2}^2$ (d) $K_{p1}^2 = K_{p2}$

Q.26 – Q.55 : Carry TWO marks each.

26. According to VSEPR model, the shape of $[\text{XeOF}_5]^-$ is
 (a) Octahedral (b) Trigonal bipyramidal
 (c) square pyramidal (d) pentagonal monopyrarnidal
27. The number of unpaired electron(s) present in the species $[\text{Fe}(\text{H}_2\text{O})_5(\text{NO})]^{2+}$ which is formed during 'brown ring test' is:
 (a) 2 (b) 3 (c) 4 (d) 5
28. Fe_3O_4 and Co_3O_4 are metal oxides having spinel structure. Considering their CFSEs, the correct statment regarding their structure is
 (a) both have normal spinel structure
 (b) both have inverse spinel structure
 (c) Fe_3O_4 has normal and Co_3O_4 has inverse spinel structure
 (d) Fe_3O_4 has inverse and Co_3O_4 has normal spinel structure.
29. The mechanism of the reaction between $[\text{Fe}(\text{CN})_6]^{4-}$ and $[\text{Fe}(\text{bpy})_3]^{3+}$ (bpy = 2, 2'-bipyridine) is
 (a) outer-sphere electron-transfer (b) inner-sphere electron-transfer
 (c) self-exchange reaction (d) ligand-exchange followed by electron transfer.
30. The d-d absorption band of $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ is split due to
 (a) presence of octahedral geometry
 (b) static Jahn-Teller distortion
 (c) dynamic Jahn-Teller distortion
 (d) presence of trigonal bipyramidal geometry.
31. The crystal-field symbol for the ground-state of $[\text{Mn}(\text{CN})_6]^{4-}$ is
 (a) ${}^2T_{2g}$ (b) ${}^1A_{1g}$ (c) 5E_g (d) ${}^6A_{1g}$

32. In the following reactions:



the reagent/conditions X and Y are

(a) X = BF_3 ; Y = heating at 1250°C

(b) X = NaF ; Y = heating at 25°C

(c) X = NH_4F ; Y = HCl

(d) X = $\text{CF}_3\text{SO}_3\text{H}$; Y = H_2SO_4

33. $[\text{CoCl}_4]^{2-}$ is a blue coloured complex. Controlled-treatment of this complex with water generates two isomeric light pink colour complexes of composition $[\text{Co}(\text{H}_2\text{O})_4\text{Cl}_2]$.

Identify the correct point groups for $[\text{CoCl}_4]^{2-}$ and two isomeric complexes

$[\text{Co}(\text{H}_2\text{O})_4\text{Cl}_2]$.

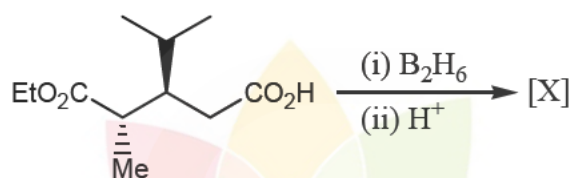
(d) D_{2h} and (C_{2v} and C_{2h})

(b) T_d and (C_{2v} and D_{4h})

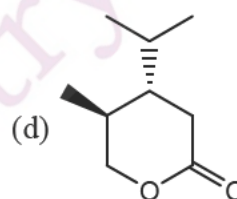
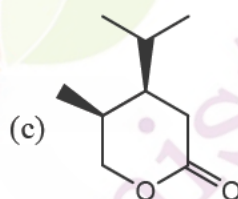
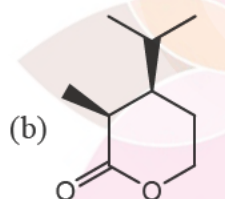
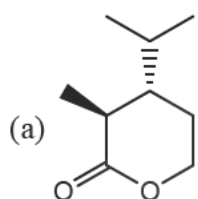
(c) D_{4h} and (C_{2v} and D_{4h})

(d) T_d and (C_{2v} and C_{4v})

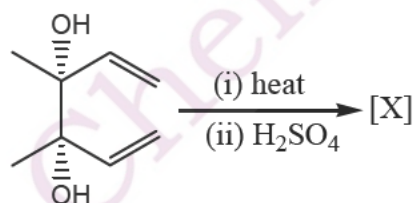
34. In the reaction



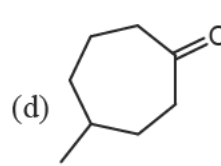
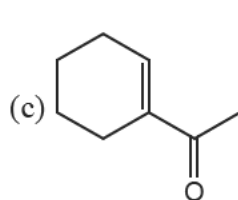
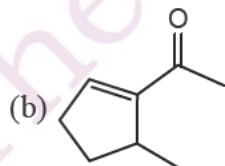
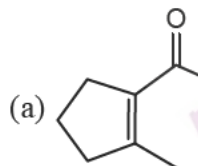
the major product [X] is:



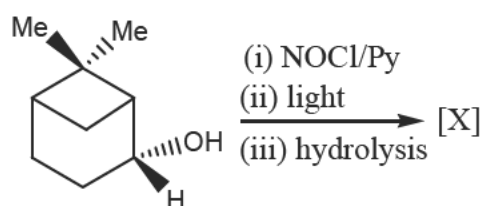
35. In the reaction,



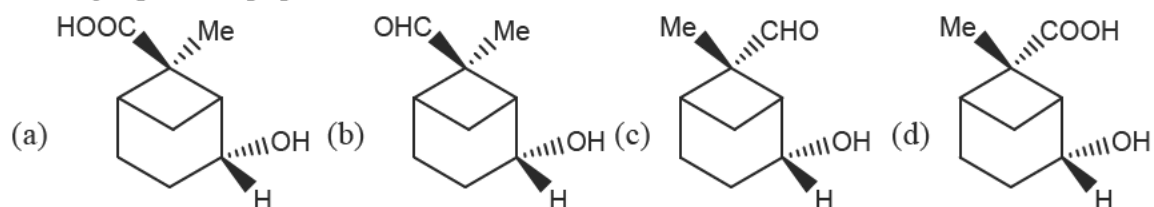
the major product [X] is:



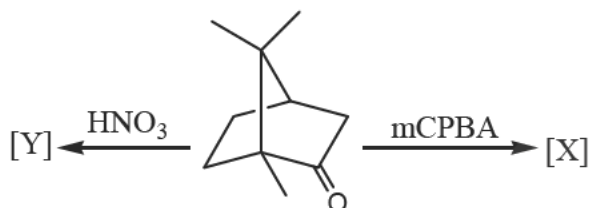
36. In the following reaction sequence



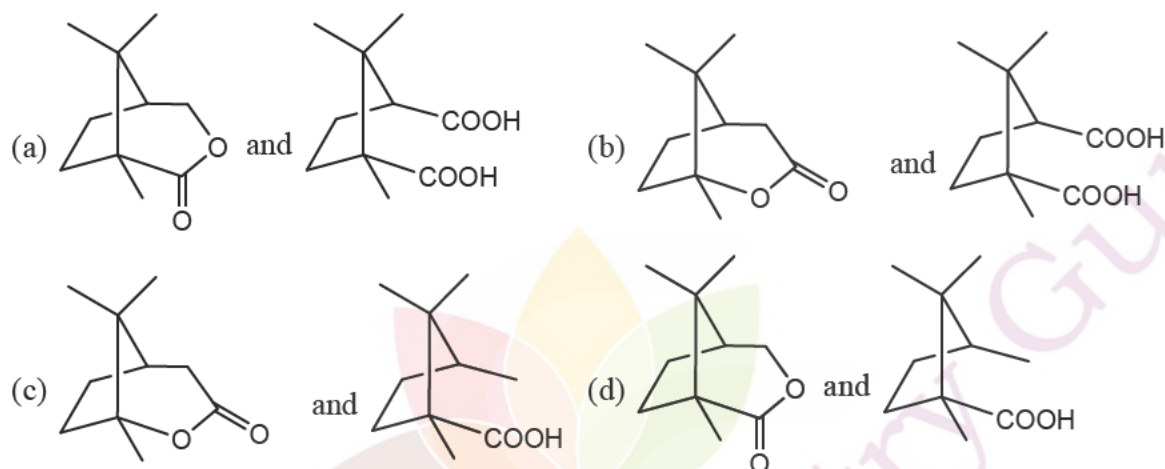
the major product [X] is



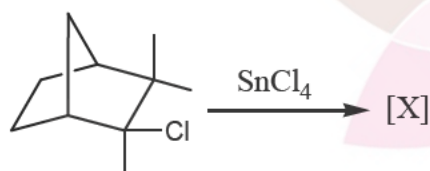
37. In the reaction,



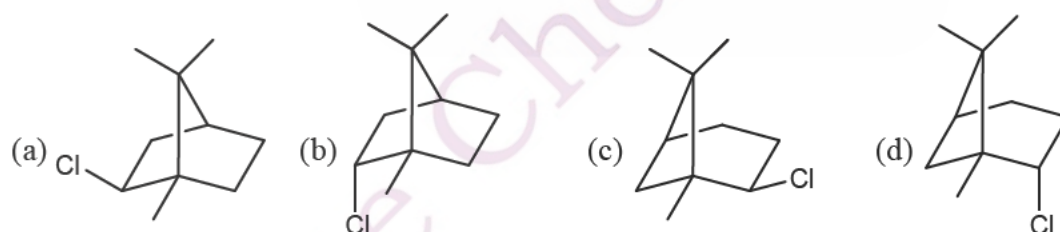
the major products, [X] and [Y], respectively, are



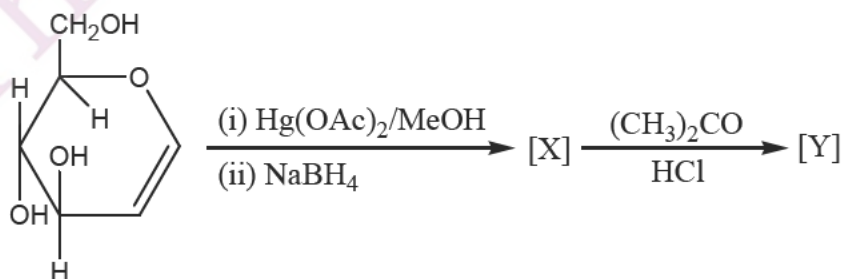
38. In the reaction,



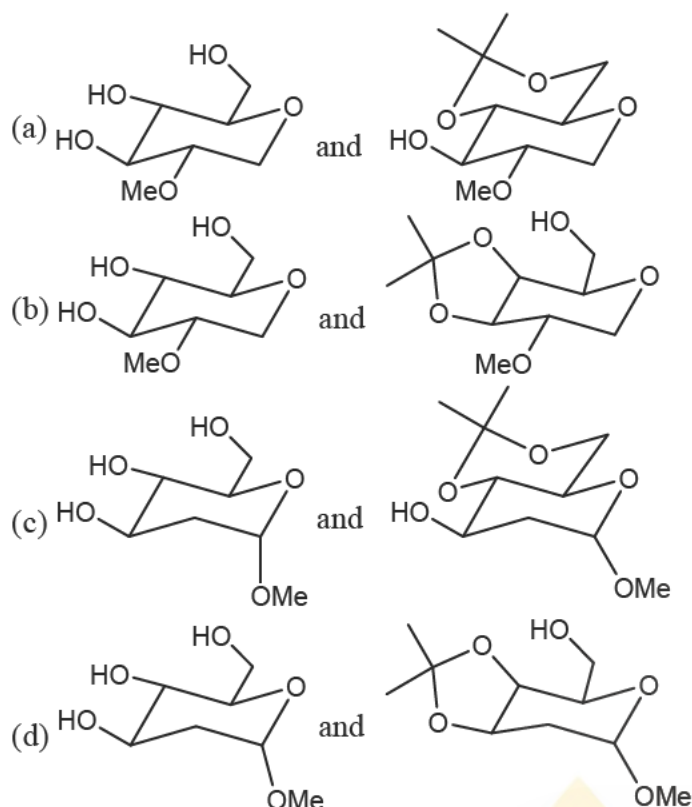
the major product [X] is



39. In the reaction sequence



the major products, [X] and [Y] respectively, are



40. The change in entropy when two moles of Argon gas are heated at constant volume from 300K to 500K is:

(a) $-12.74 \text{ J K}^{-1} \text{ mole}^{-1}$ (b) $-6.37 \text{ J K}^{-1} \text{ mole}^{-1}$
 (c) $6.37 \text{ J K}^{-1} \text{ mole}^{-1}$ (d) $12.74 \text{ J K}^{-1} \text{ mole}^{-1}$

41. At any temperature T, the fugacity coefficient (γ) is given by

$$\ln \gamma = \int_0^P \frac{Z-1}{P'} dP'$$

where Z is the compressibility factor. The fugacity coefficient of a real gas governed by equations of state, $P(V-b) = RT$ with 'b' a constant is given by

(a) $\frac{RT}{bP}$ (b) $\frac{RT}{e^{bP}}$ (c) $\frac{bP}{RT}$ (d) $\frac{bP}{e^{RT}}$

42. The specific rate constant of decomposition of a compound is represented by

$$\ln k = 5.0 - \frac{12000}{T}$$

The activation energy of decomposition for this compound at 300K is

(a) 24 kcal/mole (b) 12 kcal/mole (c) 24 cal/mole (d) 12 cal/mole

43. The commutator $[x^3, p_x]$ is equal to

(a) $-\frac{3\hbar x^2}{2\pi i}$ (b) $\frac{\hbar x}{2\pi i}$ (c) $\frac{\hbar x^2}{2\pi i}$ (d) $\frac{3\hbar x^2}{2\pi i}$

44. An electron of mass 'm' is confined to a one dimensional box of length 'b'. If it makes a radiative transition from second excited state to the ground state, the frequency of the photon emitted is

(a) $\frac{9h}{8mb^2}$ (b) $\frac{3h}{8mb^2}$ (c) $\frac{h}{mb^2}$ (d) $\frac{2h}{mb^2}$

45. The point group of ClF_3 molecule and its corresponding number of irreducible representation are respectively.
 (a) C_{3v} and 4 (b) C_{2v} and 4 (c) C_{3v} and 3 (d) C_{2v} and 3
46. The most populated rotational state for HCl ($B = 8.5 \text{ cm}^{-1}$) at 300 K is:
 (a) 2 (b) 3 (c) 5 (d) 7
47. The ratio of life times of two states that gives rise to line widths of 1.0 cm^{-1} and 0.2 cm^{-1} respectively is:
 (a) 1 : 2 (b) 1 : 5 (c) 2 : 1 (d) 5 : 1

Common Data Questions:**Common data for Q.48 and Q.49:**

A six-coordinate transition-metal complex is ESR and Mossbauer active. The effective magnetic moment of this complex is -5.9 B.M.

48. The metal-ion along with its oxidation state and the number of unpaired electron present are
 (a) Fe(II) and 4 (b) Mn(II) and 5 (c) Fe(III) and 1 (d) Fe(III) and 5
49. The complex is
 (a) $[\text{Mn}(\text{H}_2\text{O})_6]^{2+}$ (b) $[\text{Fe}(\text{CN})_6]^{3-}$ (c) $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ (d) $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$

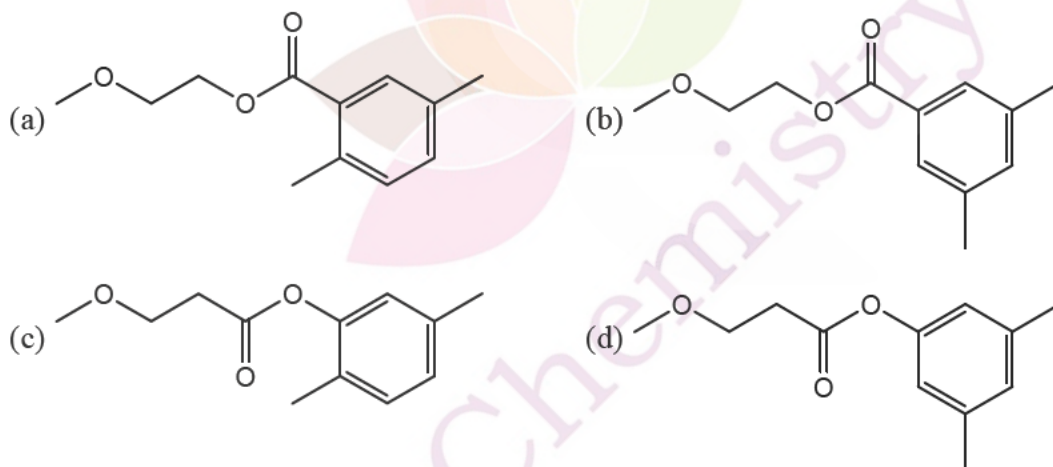
Common data for Q.50 and Q.51:

An organic compound [X] ($\text{C}_{12}\text{H}_{16}\text{O}_3$) exhibits the following spectral data IR: -1720 cm^{-1}

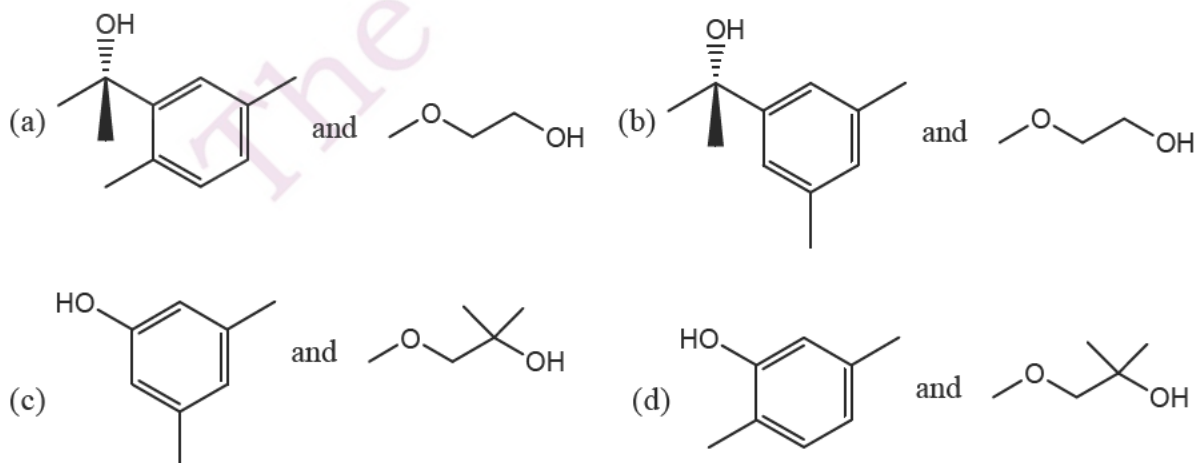
$^1\text{H NMR}$: 2.35 (s, 6H), 3.30 (s, 3H), 3.83 (t, 2H), 4.42 (t, 2H), 7.07 (s, 1H), 7.58 (s, 2H)

The compound [X] with an excess of MeMgBr gives a 1 : 1 mixture of compounds [Y] and [Z]. The compound [Z] exhibits the following $^1\text{H NMR}$ data: 2.0(bs, 1H), 3.30 (s, 3H), 3.56(t, 2H), 3.70 (t, 2H)

50. The compound [X] is:

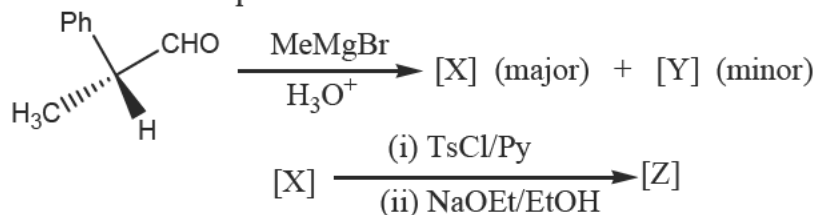


51. The compound [Y] is:

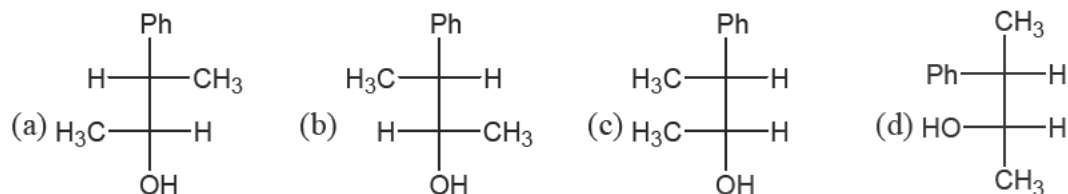


Linked Answer Q.52 and Q.53:

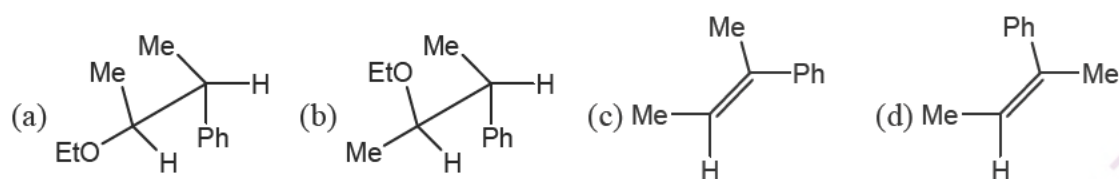
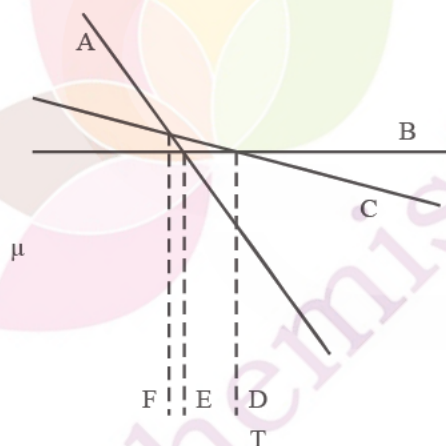
In the reaction sequence



52. The compound [X] is:



53. The compound [Z] is:

**Statement for Linked Answer Q.54 and Q.55:**In the μ vs T diagram for different phases of the same substance at one atmospheric pressure, the lines A, B and C compound to

54. Based on the above diagram.

- (a) A represents the change in chemical potential as a function of temperature for the solid phase, B for the liquid and C for the gas.
- (b) A represents the change in chemical potential as a function of temperature for the gas phase, B for the gas and C for the solid
- (c) A represents the change in chemical potential as a function of temperature for the liquid phase, B for the gas and C for the solid
- (d) A represents the change in chemical potential as a function of temperature for the gas phase, B for the gas and C for the liquid.

55. From the same diagram

- (a) D represents boiling point, E sublimation point and F melting point.
- (b) E represents boiling point, D sublimation point and F melting point.
- (c) E represents melting point, F sublimation point and D boiling point.
- (d) D represents melting point, F boiling point and E sublimation point.

***** END OF THE QUESTION PAPER *****