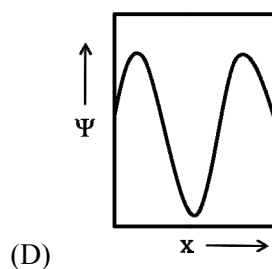
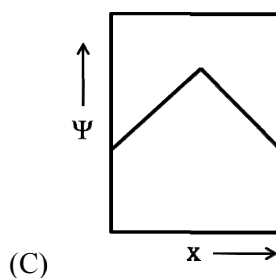
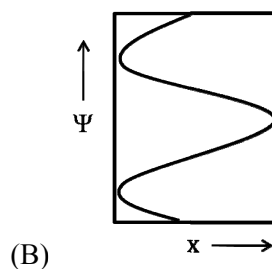
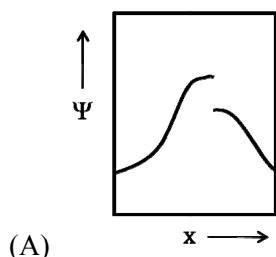


**Useful information - CY Chemistry**

Avogadro constant	= $6.022 \times 10^{23} \text{ mol}^{-1}$
Planck constant	= $6.626 \times 10^{-34} \text{ J s}$
Mass of an electron	= $9.109 \times 10^{-31} \text{ Kg}$
Charge of an electron	= $1.602 \times 10^{-19} \text{ C}$
Universal gas constant	= $8.314 \text{ J K}^{-1} \text{ mol}^{-1} = 0.0831 \text{ L bar K}^{-1} \text{ mol}^{-1}$
Boltzmann constant	= $1.38 \times 10^{-23} \text{ J K}^{-1}$
1 atm pressure	= $101325 \text{ N m}^{-2}$
Faraday constant	= $96485 \text{ C mol}^{-1}$
2.303 RT/F at 298 K	= $0.059 \text{ V}$

**Q. 1 – Q. 25 carry one mark each.**

Q.1 Which one of the following plots represents an acceptable wavefunction?



Q.2 When the operator,  $-\hbar^2 d^2/dx^2$ , operates on the function  $e^{-ikx}$ , the result is

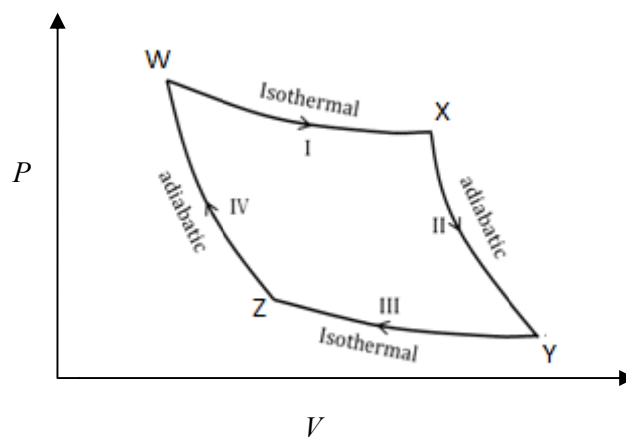
(A)  $k^2 \hbar^2 e^{-ikx}$

(B)  $ik^2 \hbar^2 e^{-ikx}$

(C)  $i\hbar^2 e^{-ikx}$

(D)  $\hbar^2 e^{-ikx}$

Q.3



From the above Carnot cycle undergone by an ideal gas, identify the processes in which the change in internal energy is **NON-ZERO**.

(A) I and II

(B) II and IV

(C) II and III

(D) I and IV

Q.4 For an ideal gas with molar mass  $M$ , the molar translational entropy at a given temperature is proportional to

(A)  $M^{3/2}$

(B)  $M^{1/2}$

(C)  $e^M$

(D)  $\ln(M)$

Q.5 Which one of the following defines the absolute temperature of a system?

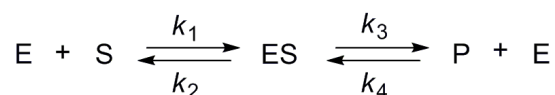
- (A)  $\left(\frac{\partial U}{\partial S}\right)_V$       (B)  $\left(\frac{\partial A}{\partial S}\right)_V$       (C)  $\left(\frac{\partial H}{\partial S}\right)_V$       (D)  $\left(\frac{\partial G}{\partial S}\right)_V$

Q.6 Which of the following properties are characteristic of an ideal solution?

- (i)  $(\Delta_{\text{mix}}G)_{T,P}$  is negative  
 (ii)  $(\Delta_{\text{mix}}S)_{T,P}$  is positive  
 (iii)  $(\Delta_{\text{mix}}V)_{T,P}$  is positive  
 (iv)  $(\Delta_{\text{mix}}H)_{T,P}$  is negative

- (A) (i) and (iv)      (B) (i) and (ii)      (C) (i) and (iii)      (D) (iii) and (iv)

Q.7 The expression for the equilibrium constant ( $K_{\text{eq}}$ ) for the enzyme catalyzed reaction given below, is



- (A)  $\frac{k_1 k_3}{k_2 k_4}$       (B)  $\frac{k_1 k_2}{k_3 k_4}$       (C)  $\frac{k_2 k_3}{k_1 k_4}$       (D)  $\frac{k_1 k_4}{k_2 k_3}$

Q.8 Given the  $E^0$  values for the following reaction sequence,



the computed value of  $E^0$  for  $\text{Mn}^{6+} \rightarrow \text{Mn}^{2+}$  (in volts) is \_\_\_\_\_

Q.9 The absorption spectrum of  $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$  in solution comprises of a maximum with a shoulder. The reason for the shoulder is

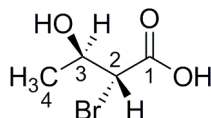
- (A) ligand-to-metal charge transfer (LMCT)  
 (B) metal-to-ligand charge transfer (MLCT)  
 (C) Jahn-Teller distortion  
 (D) nephelauxetic effect

Q.10 The ease of formation of the adduct,  $\text{NH}_3 \cdot \text{BX}_3$  (where, X = F, Cl, Br) follows the order

- (A)  $\text{BBr}_3 < \text{BCl}_3 < \text{BF}_3$       (B)  $\text{BCl}_3 < \text{BF}_3 < \text{BBr}_3$   
 (C)  $\text{BF}_3 < \text{BCl}_3 < \text{BBr}_3$       (D)  $\text{BBr}_3 < \text{BF}_3 < \text{BCl}_3$

- Q.11 An efficient catalyst for hydrogenation of alkenes is  $[\text{Rh}(\text{PPh}_3)_3\text{Cl}]$ . However,  $[\text{Ir}(\text{PPh}_3)_3\text{Cl}]$  does not catalyze this reaction, because
- (A)  $\text{PPh}_3$  binds stronger to Ir than to Rh      (B) Cl binds stronger to Ir than to Rh  
(C)  $\text{PPh}_3$  binds stronger to Rh than to Ir      (D) Cl binds stronger to Rh than to Ir
- Q.12 Among the given pH values, the  $\text{O}_2$  binding efficiency of hemoglobin is maximum at
- (A) 6.8      (B) 7.0      (C) 7.2      (D) 7.4
- Q.13 The intense red color of  $[\text{Fe}(\text{bpy})_3]^{2+}$  ( $\text{bpy} = 2,2'$ -bipyridine) is due to
- (A) metal-to-ligand charge transfer (MLCT)      (B) ligand-to-metal charge transfer (LMCT)  
(C)  $d-d$  transition      (D) inter-valence charge transfer (IVCT)
- Q.14 The compound with planar geometry is
- (A)  $\text{N}(t\text{-Bu})_3$       (B)  $\text{NPh}_3$       (C)  $\text{NF}_3$       (D)  $\text{N}(\text{SiH}_3)_3$
- Q.15 The electrical conductivity of a metal
- (A) increases with increasing temperature  
(B) decreases with increasing temperature  
(C) is independent of temperature  
(D) shows oscillatory behaviour with temperature
- Q.16 Which one of the following statements is **INCORRECT**?
- (A) Frenkel defect is a cation vacancy and a cation interstitial.  
(B) Frenkel defect is an anion vacancy and a cation interstitial.  
(C) Density of a solid remains unchanged in case of Frenkel defects.  
(D) Density of a solid decreases in case of Schottky defects.

- Q.17 The absolute configuration of  $\text{C}2$  and  $\text{C}3$  in the following compound is

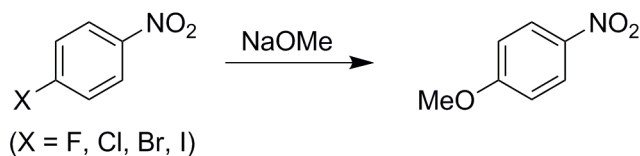


- (A)  $2R, 3S$       (B)  $2S, 3R$       (C)  $2S, 3S$       (D)  $2R, 3R$

Q.18 Among the following compounds, the one that is non-aromatic, is



Q.19 The correct order of reactivity of *p*-halonitrobenzenes in the following reaction is

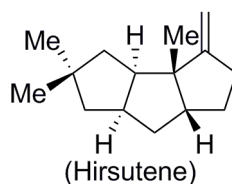


- (A) *p*-chloronitrobenzene > *p*-iodonitrobenzene > *p*-fluoronitrobenzene > *p*-bromonitrobenzene  
 (B) *p*-fluoronitrobenzene > *p*-chloronitrobenzene > *p*-bromonitrobenzene > *p*-iodonitrobenzene  
 (C) *p*-iodonitrobenzene > *p*-bromonitrobenzene > *p*-chloronitrobenzene > *p*-fluoronitrobenzene  
 (D) *p*-bromonitrobenzene > *p*-fluoronitrobenzene > *p*-iodonitrobenzene > *p*-chloronitrobenzene

Q.20 Tollen's test is **NEGATIVE** for

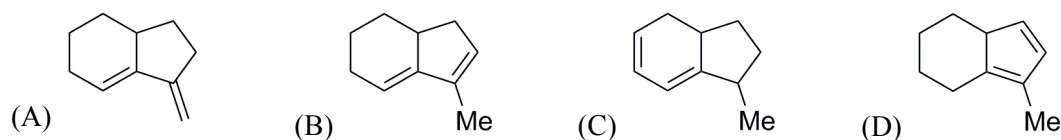
- (A) mannose (B) maltose (C) glucose (D) sucrose

Q.21 The compound given below is a

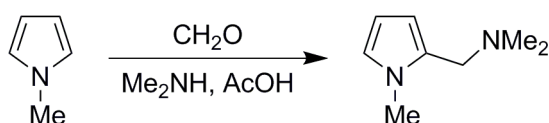


- (A) sesterterpene (B) monoterpene (C) sesquiterpene (D) triterpene

Q.22 Amongst the following, the compound that **DOES NOT** act as a diene in Diels-Alder reaction is

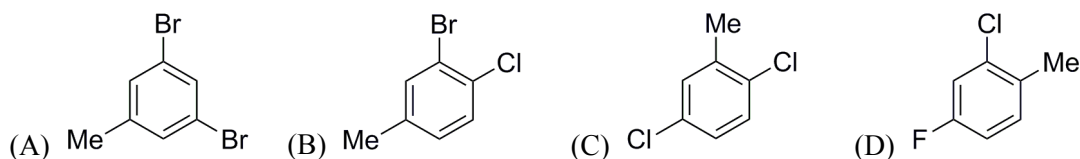


Q.23 The following conversion is an example of



- (A) Arndt-Eistert homologation (B) Mannich reaction  
 (C) Michael addition (D) Chichibabin amination reaction

- Q.24 The mass spectrum of a dihalo compound shows peaks with relative intensities of 1:2:1 corresponding to  $M$ ,  $M+2$  and  $M+4$  ( $M$  is the mass of the molecular ion), respectively. The compound is



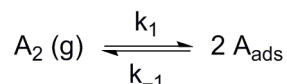
- Q.25 Reaction of benzaldehyde and *p*-methylbenzaldehyde under McMurry coupling conditions ( $\text{TiCl}_3$  and  $\text{LiAlH}_4$ ) gives a mixture of alkenes. The number of alkenes formed is \_\_\_\_\_

**Q. 26 – Q. 55 carry two marks each.**

- Q.26 The difference in the ground state energies (kJ/mol) of an electron in one-dimensional boxes of lengths 0.2 nm and 2 nm is \_\_\_\_\_

- Q.27 The mean ionic activity coefficient of 0.001 molal  $\text{ZnSO}_4$  (aq) at 298 K according to the Debye-Hückel limiting law is (Debye-Hückel constant is  $0.509 \text{ molal}^{-1/2}$ ) \_\_\_\_\_

- Q.28 The process given below follows the Langmuir adsorption isotherm.



If  $\theta$  denotes the surface coverage and  $P$  denotes the pressure, the slope of the plot of  $1/\theta$  versus  $1/\sqrt{P}$  is

- (A)  $1/(K_{\text{eq}})^2$       (B)  $1/K_{\text{eq}}$       (C)  $-1/K_{\text{eq}}$       (D)  $1/(K_{\text{eq}})^{1/2}$
- Q.29 For a gas phase unimolecular reaction at temperature 298 K, with a pre-exponential factor of  $2.17 \times 10^{13} \text{ s}^{-1}$ , the entropy of activation ( $\text{J K}^{-1} \text{ mol}^{-1}$ ) is \_\_\_\_\_

- Q.30 A liquid has vapor pressure of  $2.02 \times 10^3 \text{ N m}^{-2}$  at 293 K and heat of vaporization of  $41 \text{ kJ mol}^{-1}$ . The boiling point of the liquid (in Kelvin) is \_\_\_\_\_

Q.31 The rotational partition function of a diatomic molecule with energy levels corresponding to  $J = 0$  and 1, is (where,  $\epsilon$  is a constant)

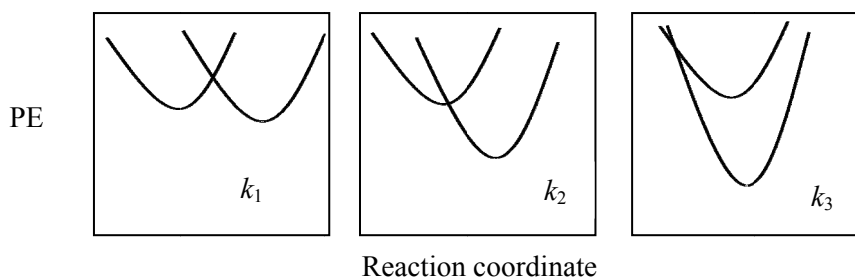
- (A)  $1+e^{-2\epsilon}$                       (B)  $1+3e^{-2\epsilon}$                       (C)  $1+e^{-3\epsilon}$                       (D)  $1+3e^{-3\epsilon}$

Q.32 The internal energy of an ideal gas follows the equation  $U = 3.5 PV + k$ , where  $k$  is a constant. The gas expands from an initial volume of  $0.25 \text{ m}^3$  to a final volume of  $0.86 \text{ m}^3$ . If the initial pressure is  $5 \text{ N m}^{-2}$ , the change in internal energy (in Joules) is (given  $PV^{1.3} = \text{constant}$ ) \_\_\_\_\_

Q.33 The solubility product of  $\text{AgBr(s)}$  is  $5 \times 10^{-13}$  at 298 K. If the standard reduction potential of the half-cell,  $E_{\text{Ag}|\text{AgBr(s)}|\text{Br}^-}^0$  is 0.07 V, the standard reduction potential,  $E_{\text{Ag}^+|\text{Ag}}^0$  (in volts) is \_\_\_\_\_.

Q.34 One mole of a substance is heated from 300 K to 400 K at constant pressure. The  $C_p$  of the substance is given by,  $C_p (\text{J K}^{-1}\text{mol}^{-1}) = 5 + 0.1 T$ . The change in entropy, in  $\text{J K}^{-1}\text{mol}^{-1}$ , of the substance is \_\_\_\_\_

Q.35 The potential energy (PE) versus reaction coordinate diagrams for electron transfer reactions with rate constants  $k_1$ ,  $k_2$  and  $k_3$ , are given below. The increasing order of the rate constants is



- (A)  $k_2 < k_3 < k_1$                       (B)  $k_2 < k_1 < k_3$                       (C)  $k_3 < k_2 < k_1$                       (D)  $k_3 < k_1 < k_2$

Q.36 The distance between two successive (110) planes in a simple cubic lattice with lattice parameter ' $a$ ' is

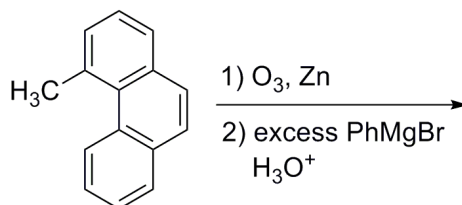
- (A)  $\sqrt{2} a$                       (B)  $\sqrt{3} a$                       (C)  $2\sqrt{2} a$                       (D)  $\frac{a}{\sqrt{2}}$

- Q.37 The percent transmittance of  $8 \times 10^{-5}$  M solution of  $\text{KMnO}_4$  is 39.8 when measured at 510 nm in a cell of path length of 1 cm. The absorbance and the molar extinction coefficient (in  $\text{M}^{-1} \text{cm}^{-1}$ ) of this solution are, respectively,
- (A) 0.30 and 4500      (B) 0.35 and 4800      (C) 0.4 and 5000      (D) 0.48 and 5200
- Q.38 The value of 'g' and the number of signals observed for the reference standard, diphenylpicrylhydrazyl (DPPH), in the solid state ESR spectrum are, respectively,
- (A) 2.0036 and 1      (B) 2.0036 and 3      (C) 2.2416 and 1      (D) 2.2416 and 3
- Q.39 Ammonolysis of  $\text{S}_2\text{Cl}_2$  in an inert solvent gives
- (A)  $\text{S}_2\text{N}_2$       (B)  $\text{S}_2\text{N}_2\text{Cl}_2$       (C)  $\text{S}_2\text{N}_2\text{H}_4$       (D)  $\text{S}_4\text{N}_4$
- Q.40 The complexes  $\text{K}_2[\text{NiF}_6]$  and  $\text{K}_3[\text{CoF}_6]$  are
- (A) both paramagnetic      (B) both diamagnetic  
(C) paramagnetic and diamagnetic, respectively      (D) diamagnetic and paramagnetic, respectively
- Q.41 The point group of  $\text{IF}_7$  is
- (A)  $D_{6h}$       (B)  $D_{5h}$       (C)  $C_{6v}$       (D)  $C_{5v}$
- Q.42 When one CO group is replaced by  $\text{PPh}_3$  in  $[\text{Cr}(\text{CO})_6]$ , which one of the following statements is **TRUE**?
- (A) The Cr-C bond length increases and CO bond length decreases  
(B) The Cr-C bond length decreases and CO bond length decreases  
(C) The Cr-C bond length decreases and CO bond length increases  
(D) The Cr-C bond length increases and CO bond length increases
- Q.43 Identify X in the reaction,  $[\text{Pt}(\text{NH}_3)_4]^{2+} + 2 \text{HCl} \rightarrow \text{X}$
- (A) *cis*- $[\text{PtCl}_2(\text{NH}_3)_2]$       (B) *trans*- $[\text{PtCl}_2(\text{NH}_3)_2]$   
(C)  $[\text{PtCl}(\text{NH}_3)_3]^+$       (D)  $[\text{PtCl}_3(\text{NH}_3)]^-$
- Q.44 Identify the function of hemocyanin and the metal responsible for it.
- (A)  $\text{O}_2$  transport and Fe      (B)  $\text{O}_2$  transport and Cu  
(C) electron transport and Fe      (D) electron transport and Cu

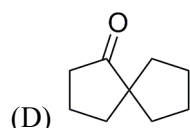
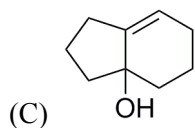
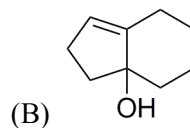
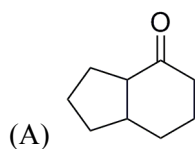
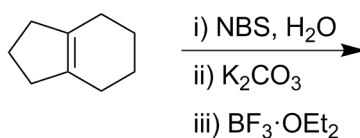


Q.45 The limiting current (in  $\mu\text{A}$ ) from the reduction of  $3 \times 10^{-4} \text{ M Pb}^{2+}$ , using a dropping mercury electrode (DME) with characteristics,  $m = 3.0 \text{ mg s}^{-1}$  and  $t = 3\text{s}$ , is (diffusion coefficient of  $\text{Pb}^{2+} = 1.2 \times 10^{-5} \text{ cm}^2 \text{ s}^{-1}$ ) \_\_\_\_\_

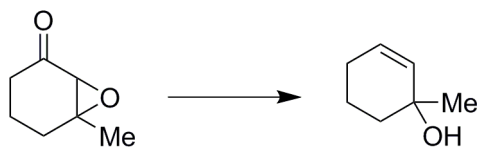
Q.46 The number of possible stereoisomers obtained in the following reaction is \_\_\_\_\_



Q.47 The major product formed in the following reaction is



Q.48 The most suitable reagent(s) to effect the following transformation is



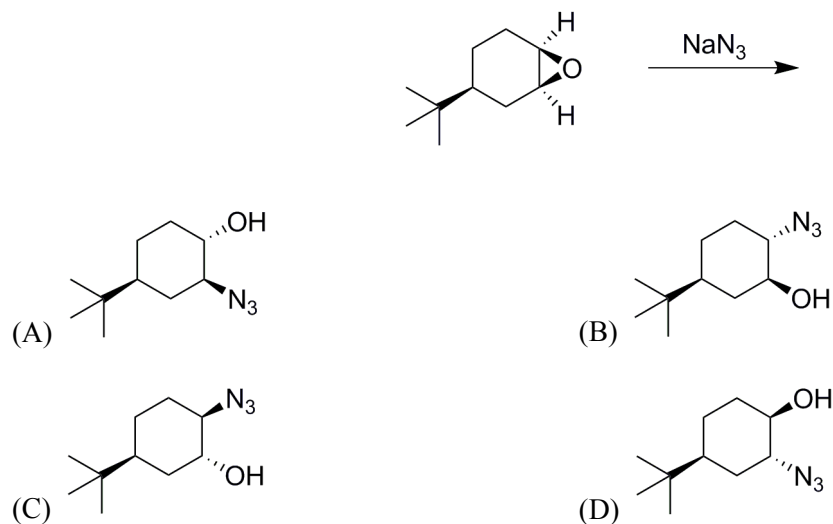
(A)  $\text{N}_2\text{H}_4$ ,  $\text{KOH}$ , heat

(B)  $\text{TsNHNH}_2$ ,  $\text{CF}_3\text{COOH}$

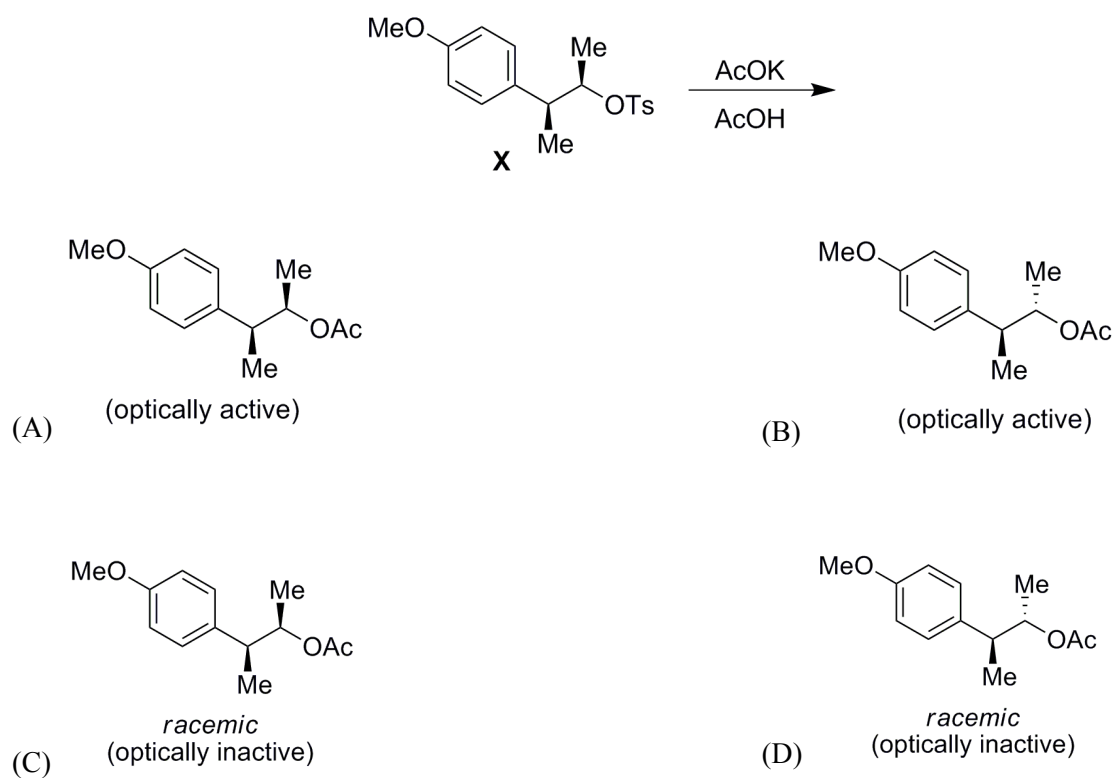
(C)  $\text{LiAlH}_4$

(D)  $\text{Na}$ , liq.  $\text{NH}_3$

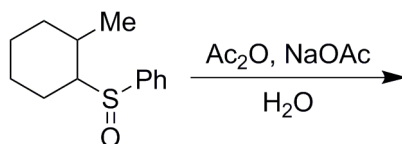
Q.49 The major product formed in the following reaction is



Q.50 Solvolysis of the optically active compound X gives, mainly

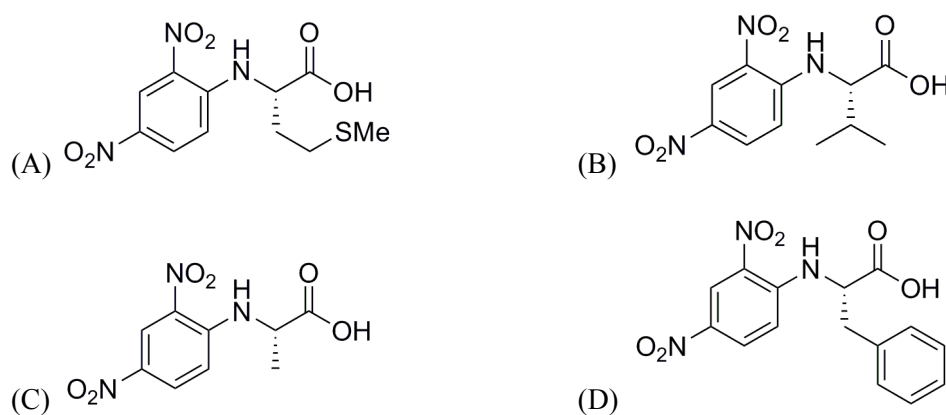


Q.51 The major product formed in the following reaction is

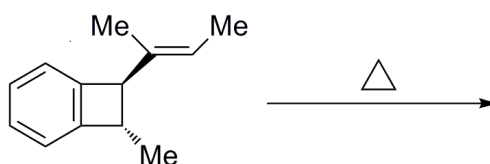


- (A) (B) (C) (D)

Q.52 The tetrapeptide, Ala-Val-Phe-Met, on reaction with Sanger's reagent, followed by hydrolysis gives

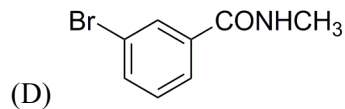
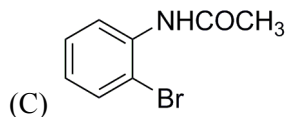
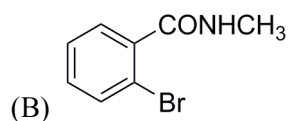
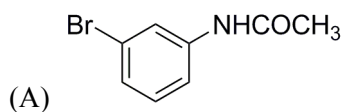


Q.53 The major product formed in the following reaction is

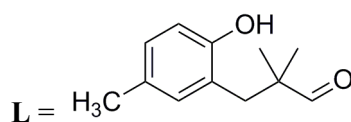
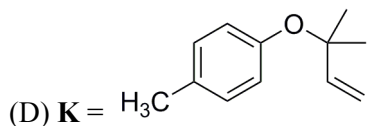
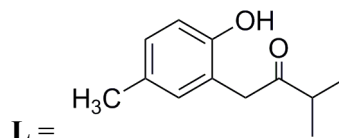
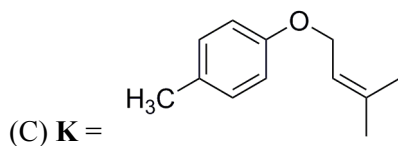
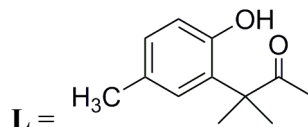
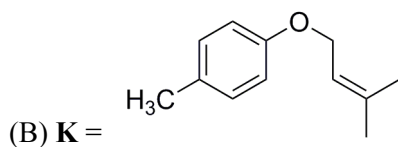
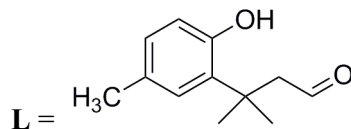
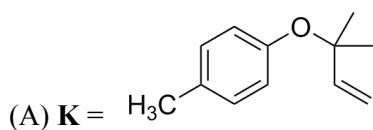
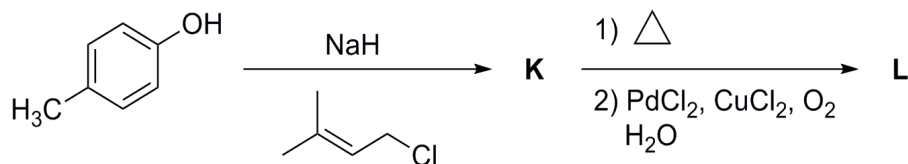


- (A) (B) (C) (D)

Q.54 The Beckmann rearrangement of a bromoacetophenone oxime ( $C_8H_8BrNO$ ) gives a major product having the following  $^1H$  NMR ( $\delta$ , ppm): 9.89 (s, 1H), 7.88 (s, 1H), 7.45 (d, 1H,  $J = 7.2$  Hz), 7.17 (m, 1H), 7.12 (d, 1H,  $J = 7.0$  Hz), 2.06 (s, 3H). The structure of the product is



Q.55 The major products, **K** and **L** formed in the following reactions are



**END OF THE QUESTION PAPER**