

Paper Specific Instructions

1. The examination is of 3 hours duration. There are a total of 60 questions carrying 100 marks. The entire paper is divided into three sections, **A**, **B** and **C**. All sections are compulsory. Questions in each section are of different types.
2. **Section – A** contains a total of 30 **Multiple Choice Questions (MCQ)**. Each MCQ type question has four choices out of which only **one** choice is the correct answer. Questions Q.1 – Q.30 belong to this section and carry a total of 50 marks. Q.1 – Q.10 carry 1 mark each and Questions Q.11 – Q.30 carry 2 marks each.
3. **Section – B** contains a total of 10 **Multiple Select Questions (MSQ)**. Each MSQ type question is similar to MCQ but with a difference that there may be **one or more than one** choice(s) that are correct out of the four given choices. The candidate gets full credit if he/she selects all the correct answers only and no wrong answers. Questions Q.31 – Q.40 belong to this section and carry 2 marks each with a total of 20 marks.
4. **Section – C** contains a total of 20 **Numerical Answer Type (NAT)** questions. For these NAT type questions, the answer is a real number which needs to be entered using the virtual keyboard on the monitor. No choices will be shown for these type of questions. Questions Q.41 – Q.60 belong to this section and carry a total of 30 marks. Q.41 – Q.50 carry 1 mark each and Questions Q.51 – Q.60 carry 2 marks each.
5. In all sections, questions not attempted will result in zero mark. In **Section – A (MCQ)**, wrong answer will result in **NEGATIVE** marks. For all 1 mark questions, 1/3 marks will be deducted for each wrong answer. For all 2 marks questions, 2/3 marks will be deducted for each wrong answer. In **Section – B (MSQ)**, there is **NO NEGATIVE** and **NO PARTIAL** marking provisions. There is **NO NEGATIVE** marking in **Section – C (NAT)** as well.
6. Only Virtual Scientific Calculator is allowed. Charts, graph sheets, tables, cellular phone or other electronic gadgets are **NOT** allowed in the examination hall.
7. The Scribble Pad will be provided for rough work.

SECTION – A
MULTIPLE CHOICE QUESTIONS (MCQ)

Q. 1 – Q.10 carry one mark each.

Q.1 On hydrolysis, aluminium carbide produces

- (A) CH_4 (B) C_2H_6 (C) C_2H_4 (D) C_2H_2

Q.2 Carbonic anhydrase is an example of

- (A) Hydrolysis enzyme (B) Redox enzyme
(C) O_2 transport protein (D) Heme protein

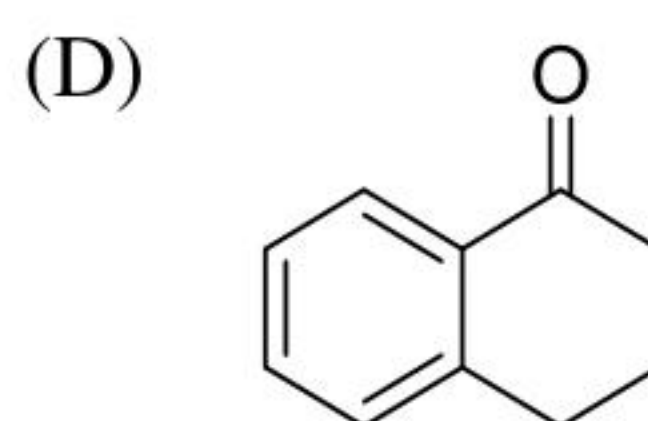
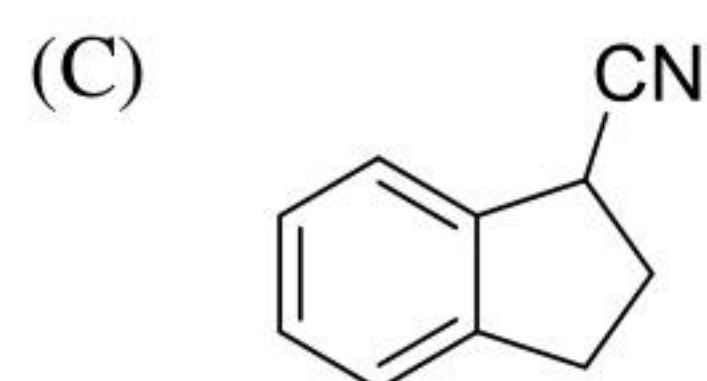
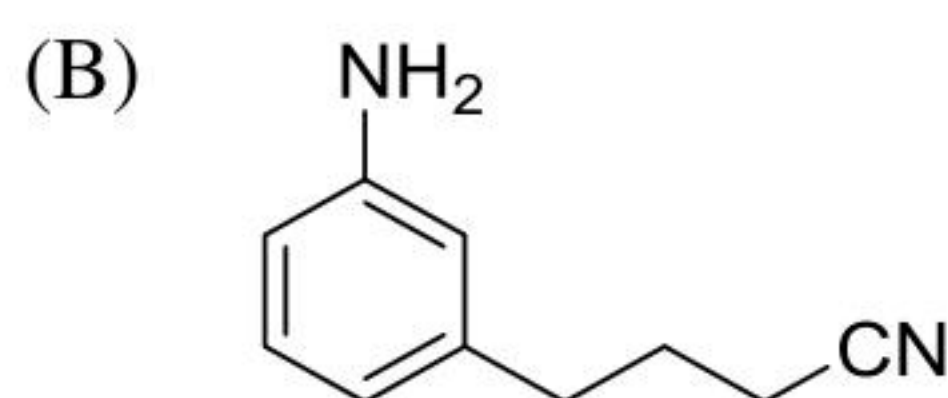
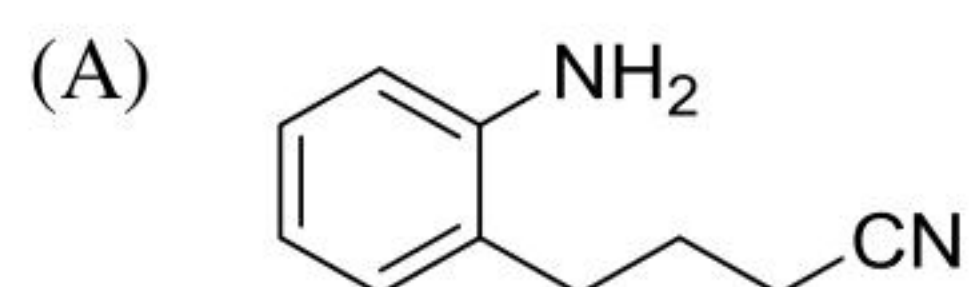
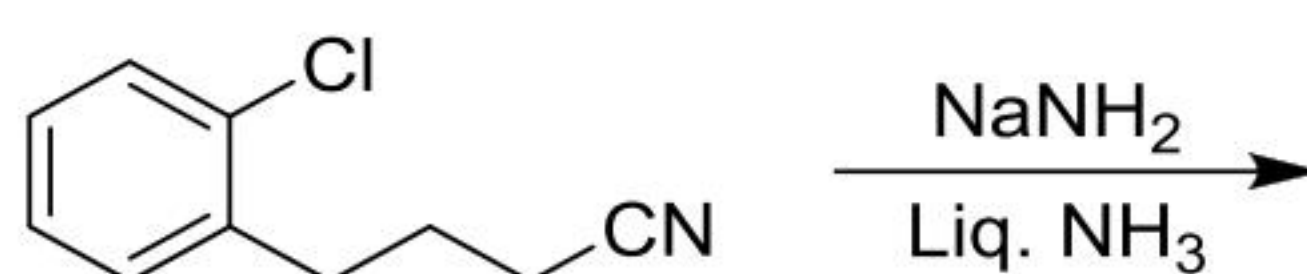
Q.3 The **CORRECT** order of melting points of group 15 trifluorides is

- (A) $\text{PF}_3 < \text{AsF}_3 < \text{SbF}_3 < \text{BiF}_3$ (B) $\text{BiF}_3 < \text{SbF}_3 < \text{PF}_3 < \text{AsF}_3$
(C) $\text{PF}_3 < \text{SbF}_3 < \text{AsF}_3 < \text{BiF}_3$ (D) $\text{BiF}_3 < \text{AsF}_3 < \text{SbF}_3 < \text{PF}_3$

Q.4 NaF, KF, MgO and CaO are crystalline solids. They have NaCl structure. Their lattice energies vary in the order

- (A) $\text{NaF} < \text{KF} < \text{MgO} < \text{CaO}$
(B) $\text{KF} < \text{NaF} < \text{CaO} < \text{MgO}$
(C) $\text{MgO} < \text{CaO} < \text{NaF} < \text{KF}$
(D) $\text{CaO} < \text{MgO} < \text{KF} < \text{NaF}$

Q.5 The major product formed in the following reaction is



Q.6 The compound that contains the most acidic hydrogen is

- (A) $\text{H}_2\text{C}=\text{CH}_2$ (B) $\text{HC}\equiv\text{CH}$ (C) $\text{H}_2\text{C}=\text{C}=\text{CH}_2$ (D) $\text{H}_3\text{C}-\text{CH}_3$

Q.7 The C-2 epimer of D-glucose is

- (A) D-Mannose (B) D-Fructose (C) D-Galactose (D) D-Gulose

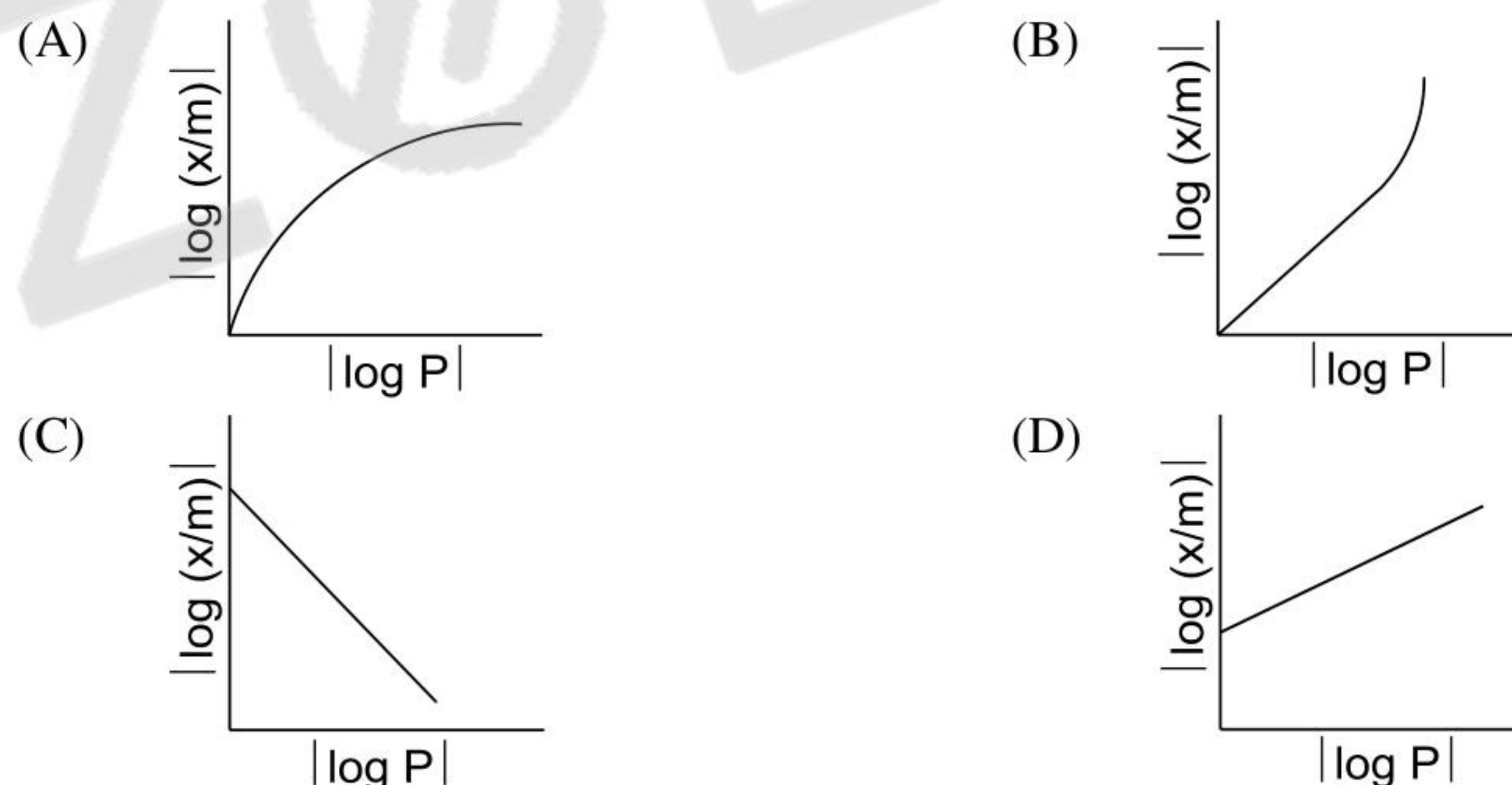
Q.8 The value of integral $\int_{-2}^{+2} x e^{-2x^2} dx$ is

- (A) 0 (B) $\frac{1}{2}$ (C) 1 (D) 2

Q.9 The number of crystal systems and the number of Bravais lattices are, respectively,

- (A) 14 and 7 (B) 7 and 32 (C) 32 and 14 (D) 7 and 14

Q.10 For adsorption of a gas on a solid surface, the plot that represents Freundlich isotherm is (x = mass of gas, m = mass of adsorbent, P = pressure)

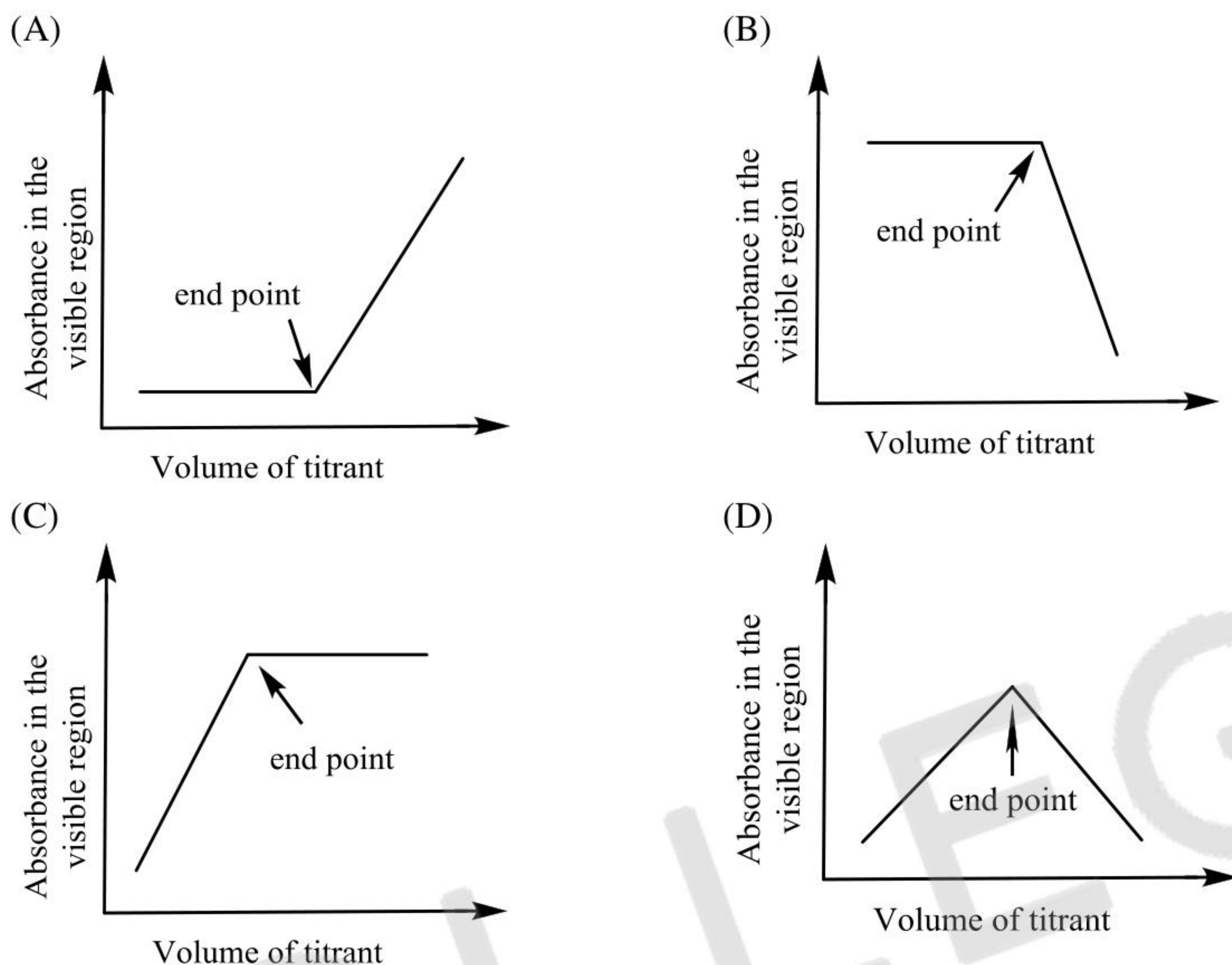


Q. 11 – Q. 30 carry two marks each.

Q.11 With respect to periodic properties, the **CORRECT** statement is

- (A) Electron affinity order is $\text{F} > \text{O} > \text{Cl}$
(B) First ionisation energy order is $\text{Al} > \text{Mg} > \text{K}$
(C) Atomic radius order is $\text{N} > \text{P} > \text{As}$
(D) Ionic radius order is $\text{K}^+ > \text{Ca}^{2+} > \text{Mg}^{2+}$

Q.12 Which plot represents a spectrophotometric titration, where the titrant alone absorbs light in the visible region?



Q.13 Among the following metal carbonyl species, the one with the highest metal-carbon back bonding is

- (A) $[\text{Ti}(\text{CO})_6]^{2-}$ (B) $[\text{V}(\text{CO})_6]^-$ (C) $\text{Cr}(\text{CO})_6$ (D) $[\text{Mn}(\text{CO})_6]^+$

Q.14 The **CORRECT** order of Δ_o (the octahedral crystal field splitting of d orbitals) values for the following anionic metal complexes is

- (A) $[\text{Ir}(\text{CN})_6]^{3-} < [\text{Rh}(\text{CN})_6]^{3-} < [\text{RhI}_6]^{3-} < [\text{CoI}_6]^{3-}$
 (B) $[\text{CoI}_6]^{3-} < [\text{RhI}_6]^{3-} < [\text{Rh}(\text{CN})_6]^{3-} < [\text{Ir}(\text{CN})_6]^{3-}$
 (C) $[\text{CoI}_6]^{3-} < [\text{Rh}(\text{CN})_6]^{3-} < [\text{RhI}_6]^{3-} < [\text{Ir}(\text{CN})_6]^{3-}$
 (D) $[\text{Ir}(\text{CN})_6]^{3-} < [\text{CoI}_6]^{3-} < [\text{Rh}(\text{CN})_6]^{3-} < [\text{RhI}_6]^{3-}$

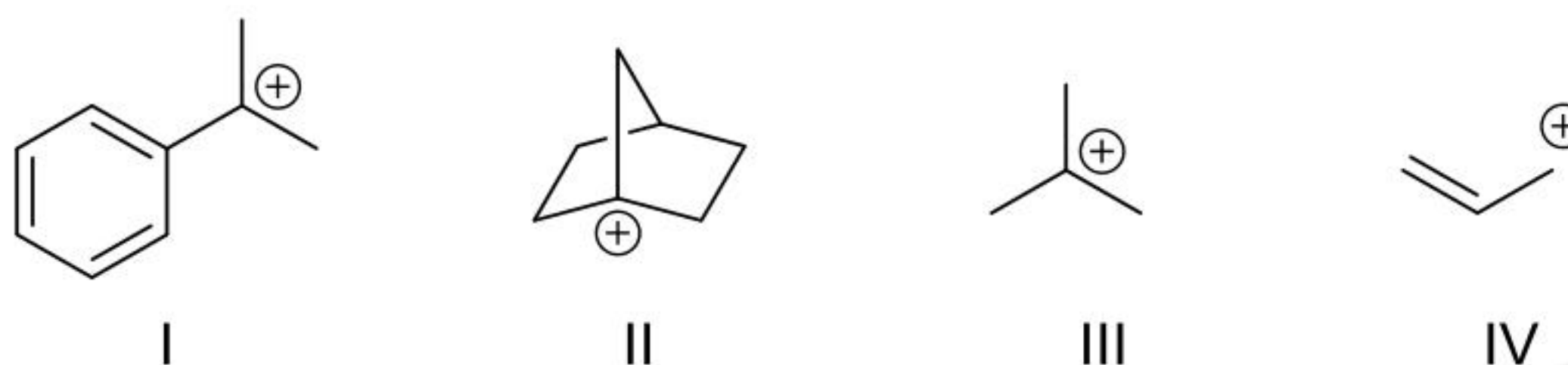
Q.15 The decay modes of ^{14}C and ^{14}O are

- (A) β decay
 (B) positron emission
 (C) β decay and positron emission, respectively
 (D) positron emission and β decay, respectively

Q.16 Consider the following four xenon compounds: XeF_2 , XeF_4 , XeF_6 and XeO_3 . The pair of xenon compounds expected to have non-zero dipole moment is

- (A) XeF_4 and XeF_6 (B) XeF_2 and XeF_4
 (C) XeF_2 and XeO_3 (D) XeF_6 and XeO_3

Q.17 The **CORRECT** order of stability for the following carbocations is

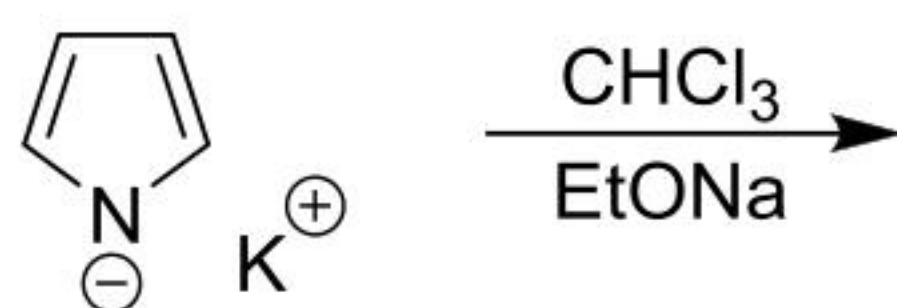


- (A) $\text{I} < \text{III} < \text{IV} < \text{II}$ (B) $\text{III} < \text{II} < \text{IV} < \text{I}$
 (C) $\text{II} < \text{IV} < \text{III} < \text{I}$ (D) $\text{IV} < \text{III} < \text{I} < \text{II}$

Q.18 Among the dimethylcyclohexanes, which one can be obtained in enantiopure form?

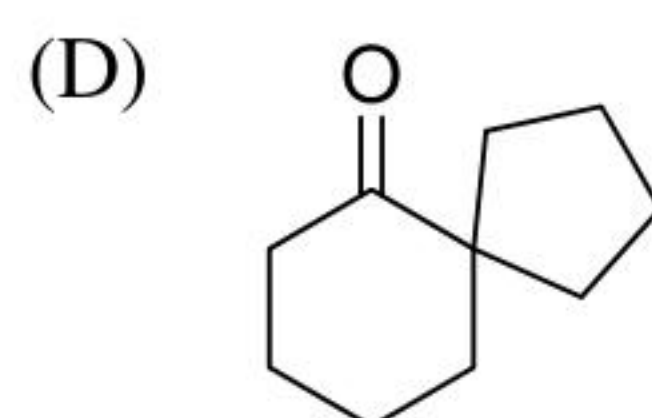
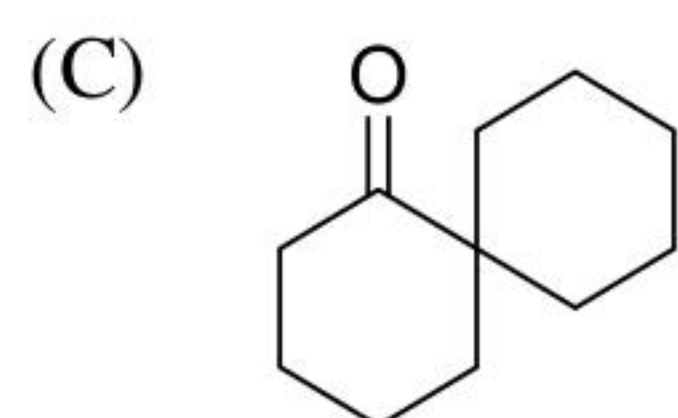
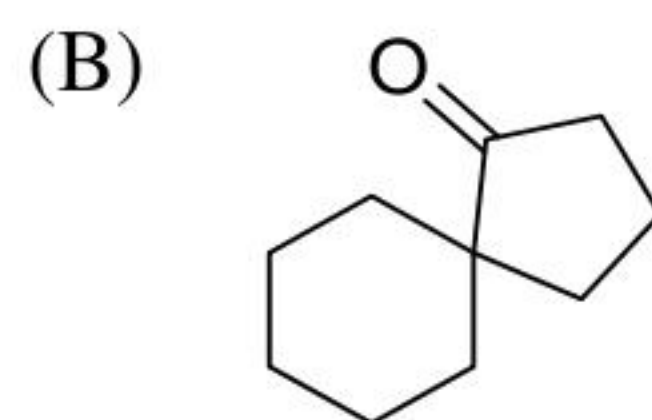
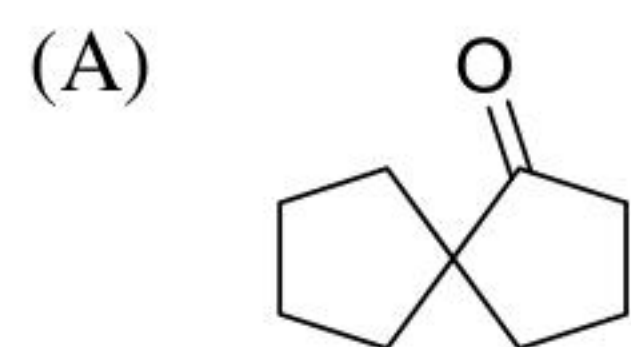
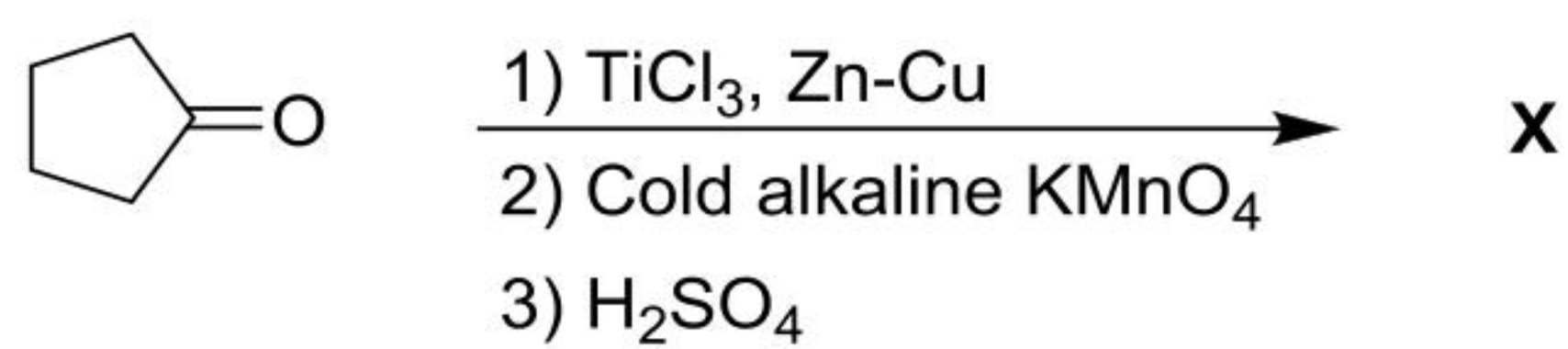


Q.19 The major product formed in the following reaction is

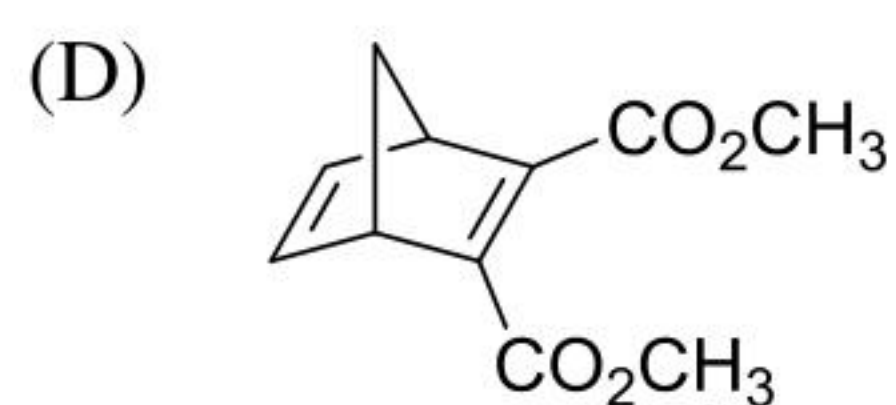
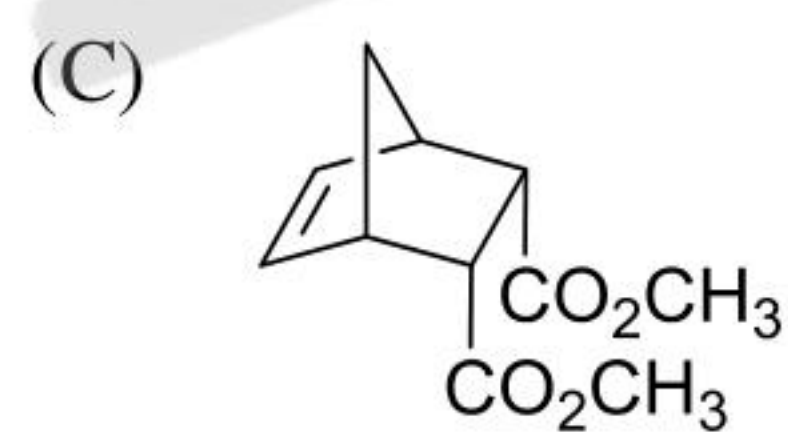
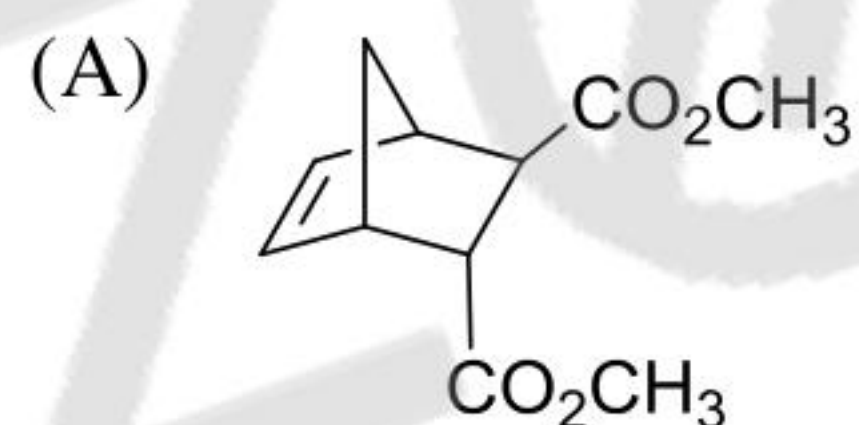
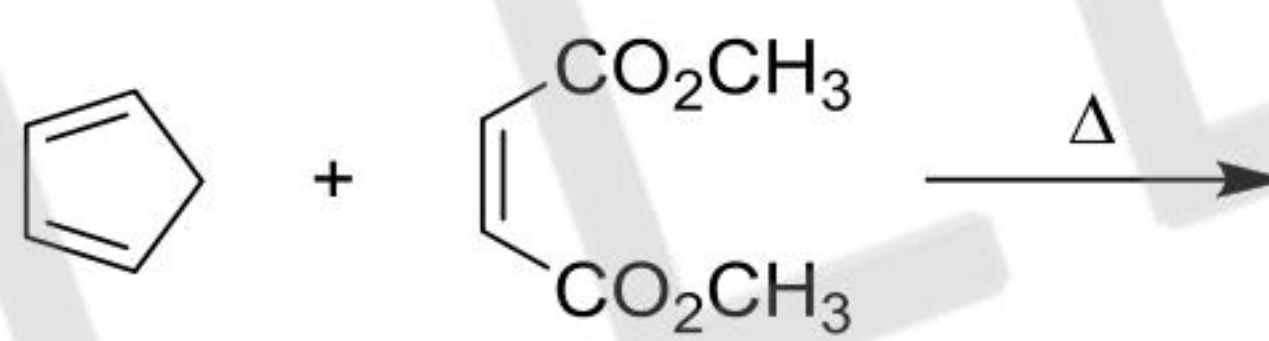


- (A) 2-chloropyridine (B) 2-ethoxypyridine
 (C) 3-chloropyridine (D) 3-ethoxypyridine

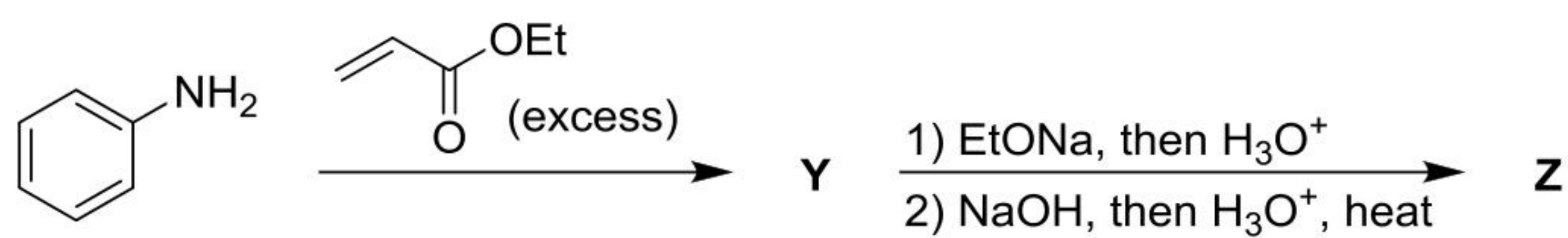
Q.20 The product **X** in the following reaction sequence is



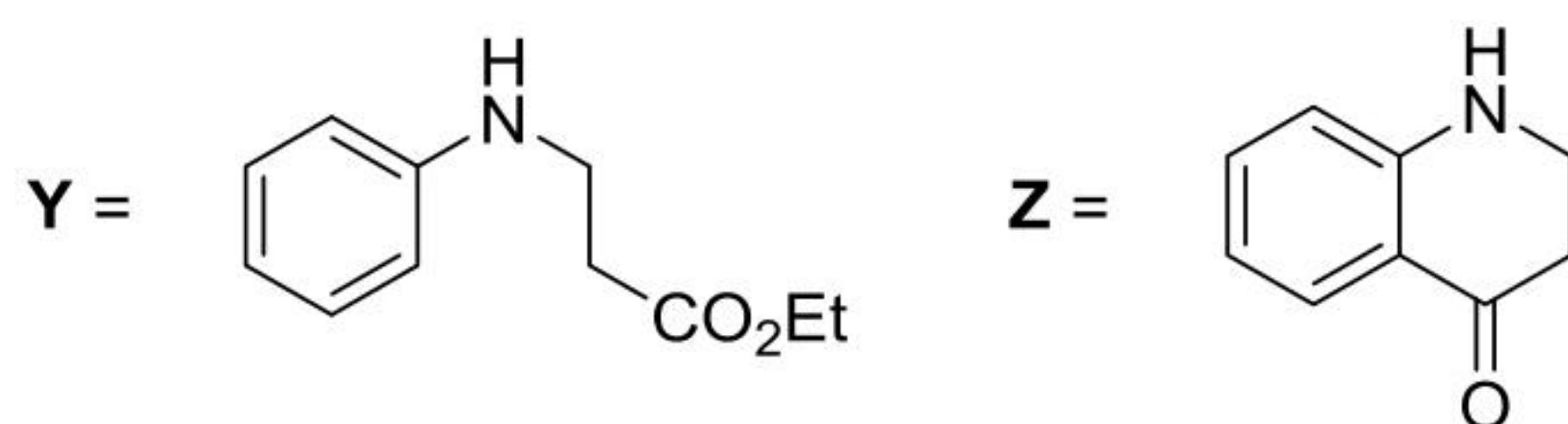
Q.21 The major product formed in the following reaction is



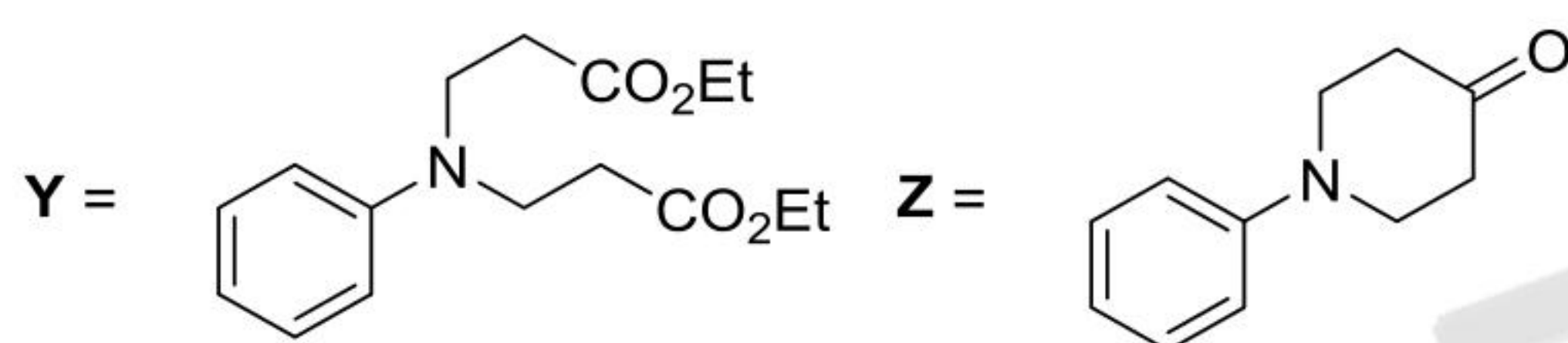
Q.22 The major products **Y** and **Z** in the following reaction sequence are



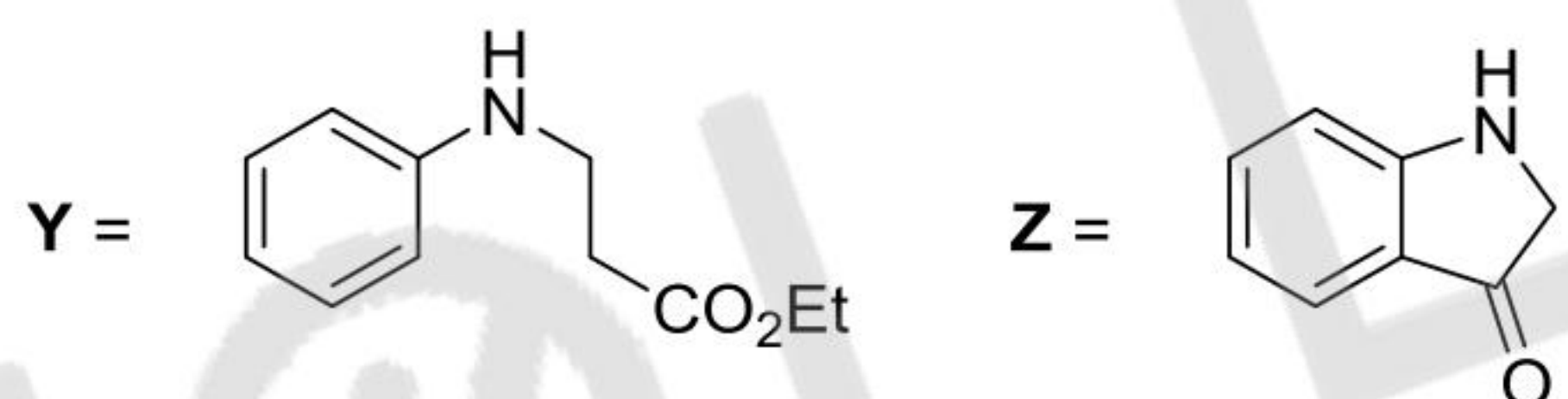
(A)



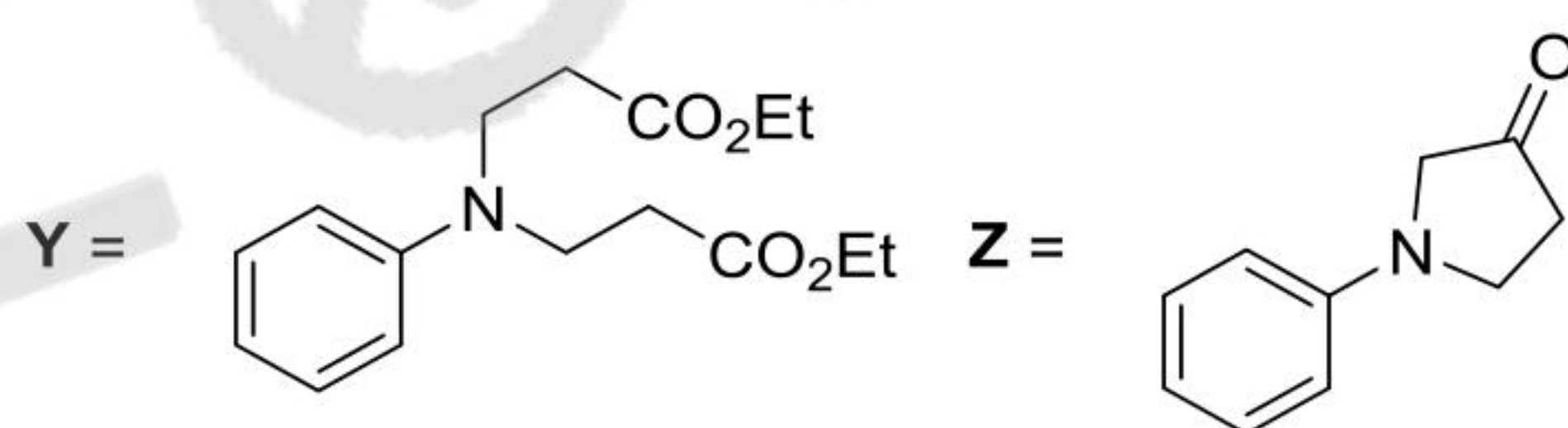
(B)



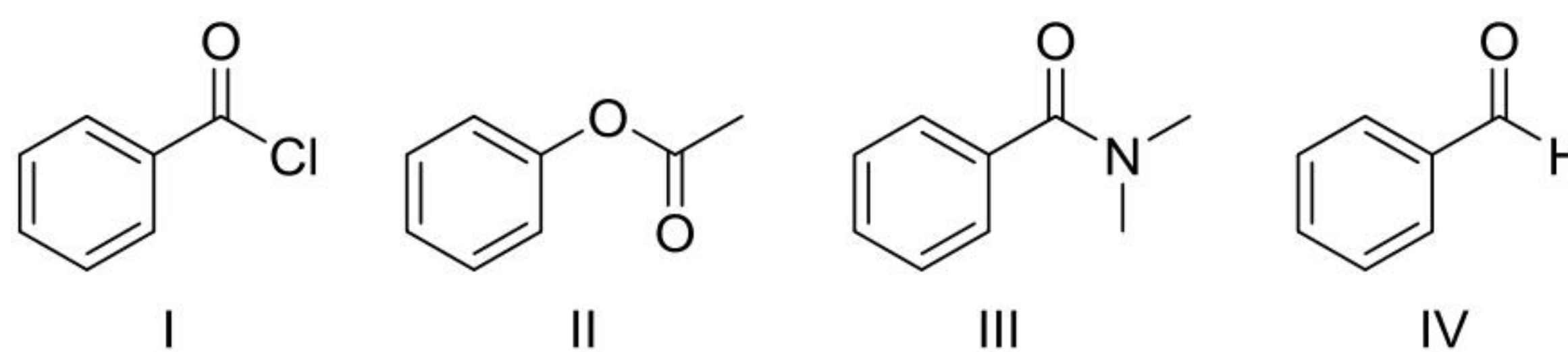
(C)



(D)



Q.23 The **CORRECT** order of carbonyl stretching frequencies for the following compounds is



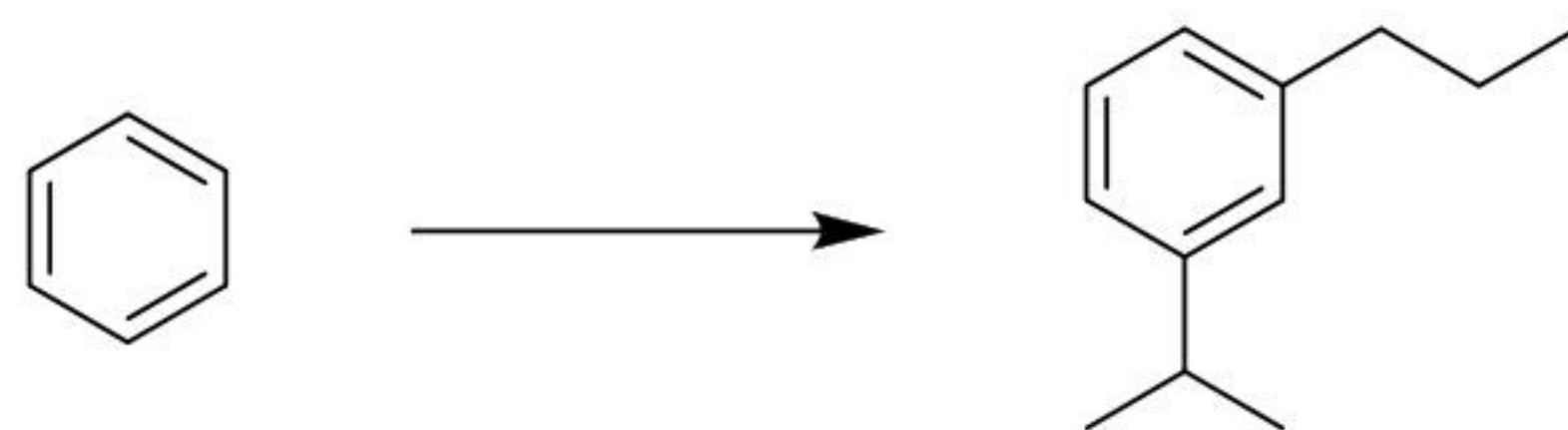
(A) II < I < III < IV

(B) I < III < II < IV

(C) IV < II < III < I

(D) III < IV < II < I

Q.24 The sequence of three steps involved in the following conversion is



- (A) (i) Friedel-Crafts alkylation; (ii) Reduction; (iii) Friedel-Crafts acylation
 (B) (i) Friedel-Crafts acylation; (ii) Friedel-Crafts alkylation; (iii) Reduction
 (C) (i) Friedel-Crafts acylation; (ii) Reduction; (iii) Friedel-Crafts alkylation
 (D) (i) Friedel-Crafts alkylation; (ii) Friedel-Crafts acylation; (iii) Reduction

Q.25 The **CORRECT** expression that corresponds to reversible and adiabatic expansion of an ideal gas is

- (A) $\Delta U = 0$ (B) $\Delta H = 0$ (C) $\Delta S = 0$ (D) $\Delta G = 0$

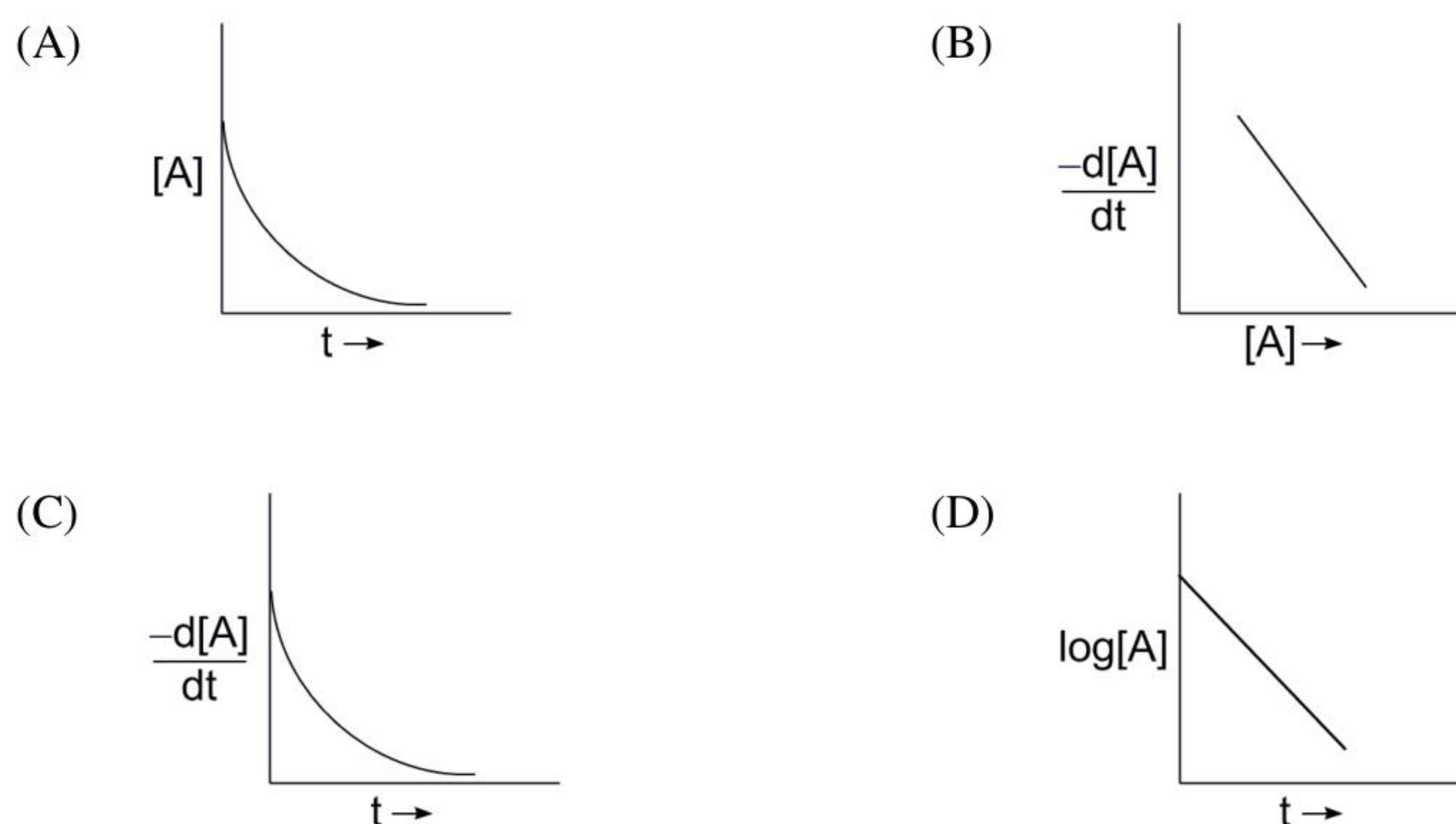
Q.26 The electrolyte AB_2 ionises in water as



The mean ionic activity coefficient ($\gamma_{\pm}$) is

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

Q.27 The reaction, $A \longrightarrow \text{Products}$, follows first-order kinetics. If $[A]$ represents the concentration of reactant at time t , the **INCORRECT** variation is shown in



Q.28 The behavior of Cl_2 is closest to ideal gas behavior at

- (A) 100°C and 10.0 atm
- (B) 0°C and 0.50 atm
- (C) 200°C and 0.50 atm
- (D) -100°C and 10.0 atm

Q.29 A vector $\vec{A} = \vec{i} + x\vec{j} + 3\vec{k}$ is rotated through an angle and is also doubled in magnitude resulting in $\vec{B} = 4\vec{i} + (4x - 2)\vec{j} + 2\vec{k}$. An acceptable value of x is

- (A) 1
- (B) 2
- (C) 3
- (D) $\frac{4}{3}$

Q.30 With reference to the variation of molar conductivity (Λ_m) with concentration for a strong electrolyte in an aqueous solution, the **CORRECT** statement is

- (A) The asymmetry effect contributes to decrease Λ_m whereas the electrophoretic effect contributes to increase Λ_m
- (B) The asymmetry effect contributes to increase Λ_m whereas the electrophoretic effect contributes to decrease Λ_m
- (C) Both asymmetry effect and electrophoretic effect contribute to decrease Λ_m
- (D) Both asymmetry effect and electrophoretic effect contribute to increase Λ_m

SECTION - B

MULTIPLE SELECT QUESTIONS (MSQ)

Q. 31 – Q. 40 carry two marks each.

Q.31 Which of the following metal(s) is(are) extracted from its(their) sulfide ore(s) by self-reduction/air reduction method?

- (A) Cu
- (B) Al
- (C) Au
- (D) Pb

Q.32 In a saturated calomel electrode, the saturation is with respect to

- (A) KCl
- (B) Hg_2Cl_2
- (C) HgCl_2
- (D) AgCl

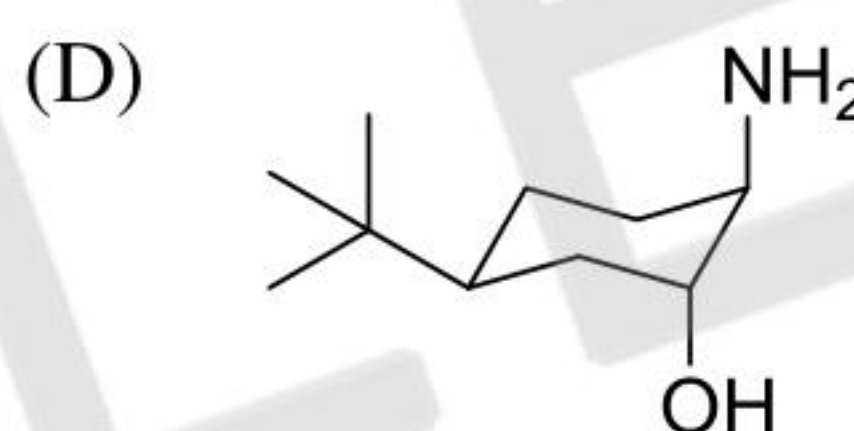
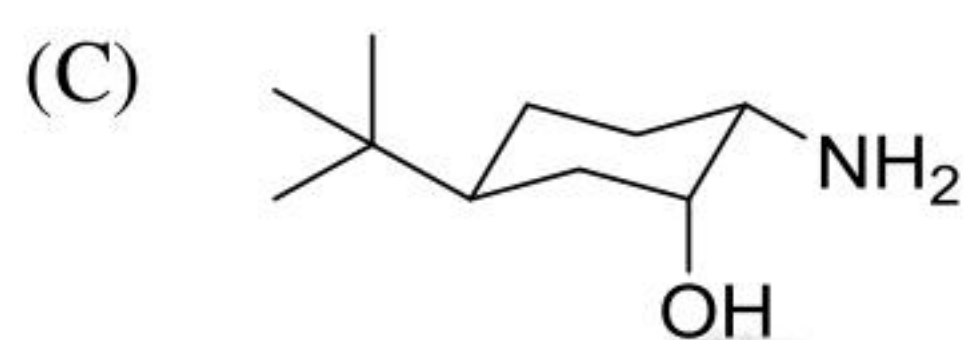
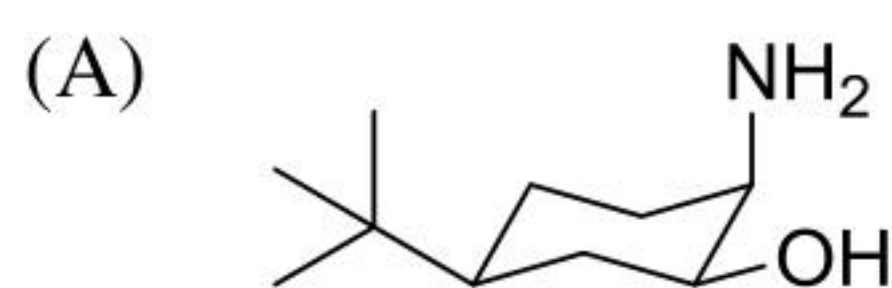
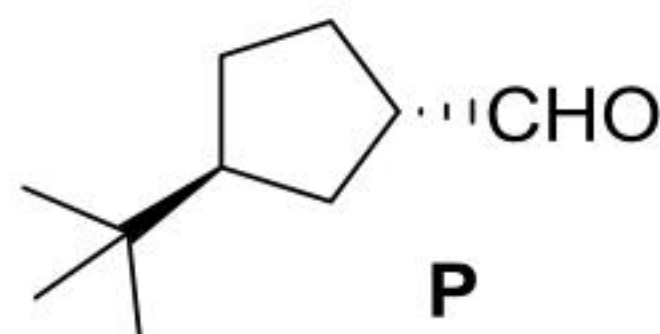
Q.33 Consider the following six solid binary oxides: CaO , Al_2O_3 , PbO , Cs_2O , SiO_2 and Sb_2O_3 . The pair(s) of ionic oxides is(are)

- (A) CaO and Al_2O_3
- (B) CaO and PbO
- (C) Cs_2O and Al_2O_3
- (D) SiO_2 and Sb_2O_3

Q.34 Choose the **CORRECT** answer(s) with respect to the magnesium-EDTA titration carried out in the pH range 7 – 10.5, using Solochrome black as indicator

- (A) Magnesium–indicator complex is more stable than the magnesium–EDTA complex
- (B) At the end point, the colour changes from red to blue
- (C) After the end point, the colour of the solution is due to the indicator
- (D) pH range of 7 – 10.5 is necessary for observing the specific colour change

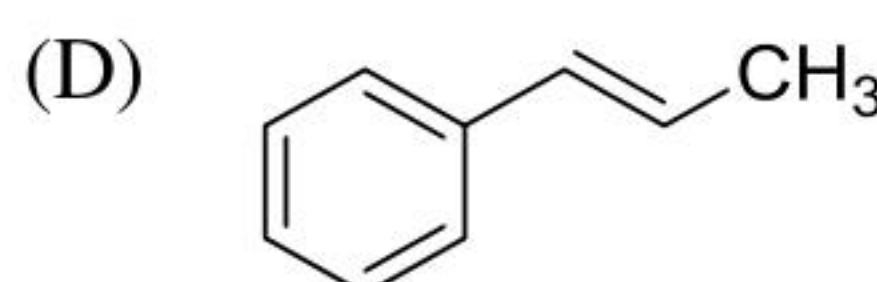
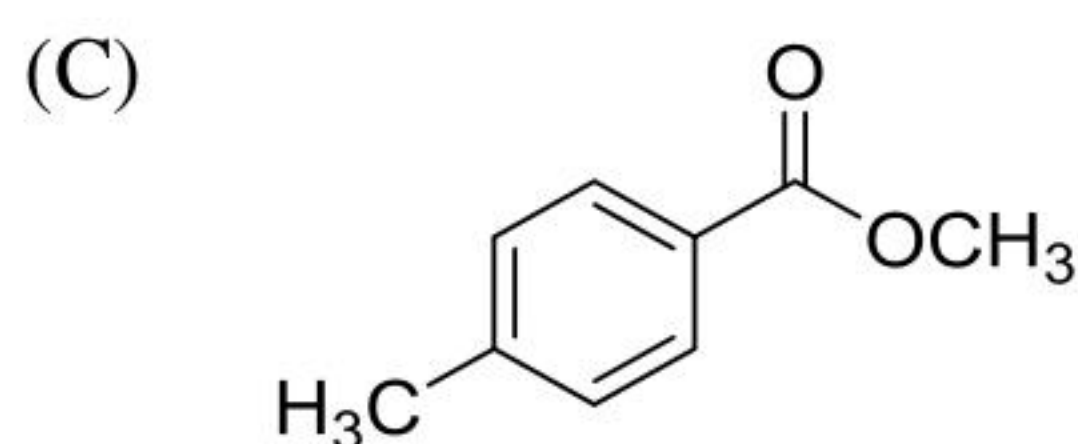
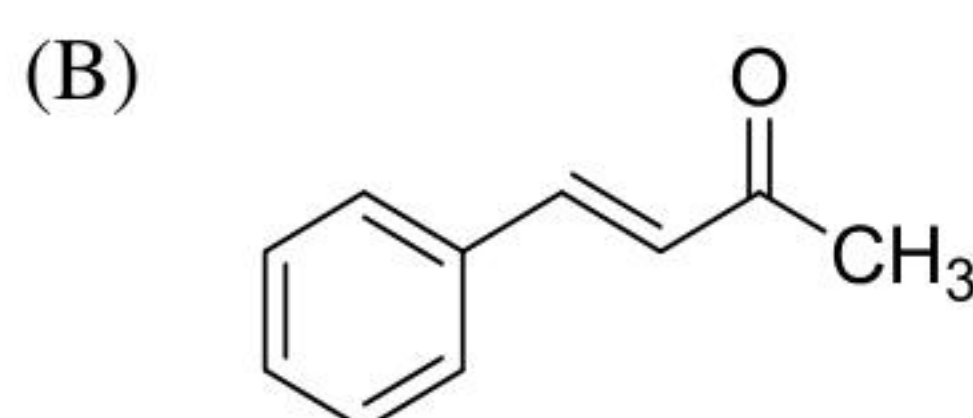
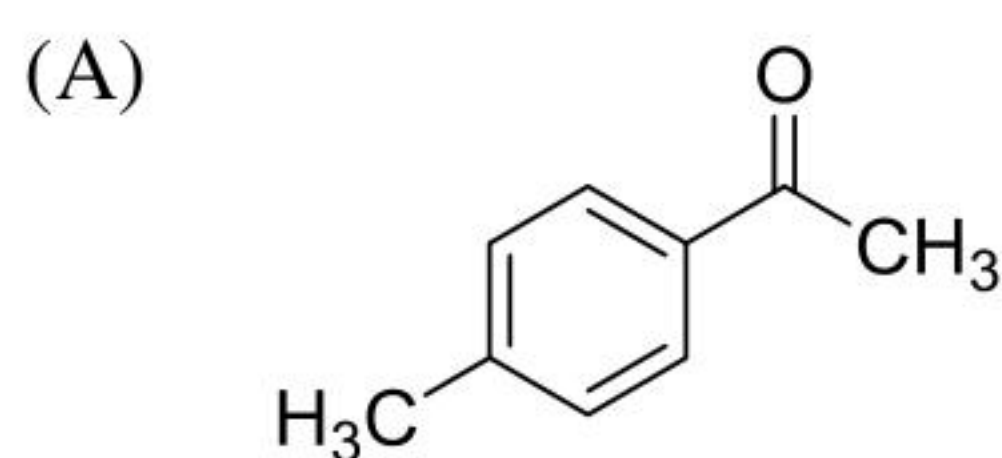
Q.35 On reaction with NaNO_2 and HCl , which of the following amino alcohol(s) will yield compound **P**?



Q.36 The **CORRECT** statement(s) about carbene is(are)

- (A) Carbene is a neutral species
- (B) Carbene is an intermediate in the Curtius rearrangement
- (C) Carbene can insert into both σ and π -bonds
- (D) Carbene is generated from amines on reaction with nitrous acid

Q.37 The compound(s) that shows(show) positive haloform test is(are)



- Q.38 Tetrapeptide(s) that gives(give) the following product on reaction with Sanger's reagent followed by hydrolysis is(are)



- (A) Ala-Gly-Leu-Phe (B) Asp-Phe-Leu-Pro
(C) Asp-Gly-Tyr-Phe (D) Ala-Phe-Tyr-Pro
- Q.39 Which of the following set(s) of quantum numbers is(are) **NOT** allowed?
- (A) $n = 3, l = 2, m_l = -1$ (B) $n = 4, l = 0, m_l = -1$
(C) $n = 3, l = 3, m_l = -3$ (D) $n = 5, l = 3, m_l = +2$

- Q.40 The **CORRECT** expression(s) for isothermal expansion of 1 mol of an ideal gas is(are)

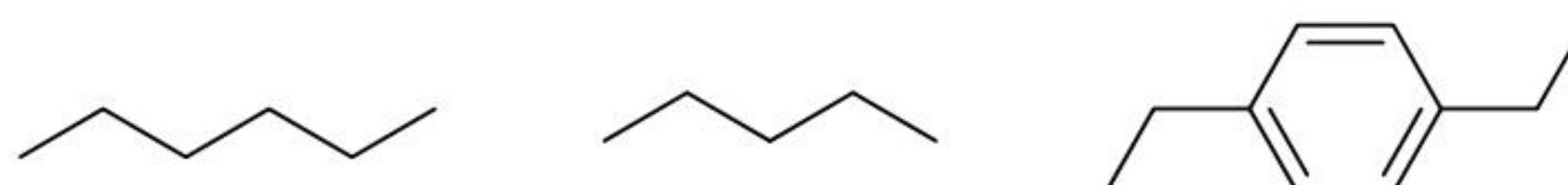
- (A) $\Delta A = RT \ln \frac{V_{initial}}{V_{final}}$ (B) $\Delta G = RT \ln \frac{V_{initial}}{V_{final}}$
(C) $\Delta H = RT \ln \frac{V_{final}}{V_{initial}}$ (D) $\Delta S = R \ln \frac{V_{final}}{V_{initial}}$

SECTION – C

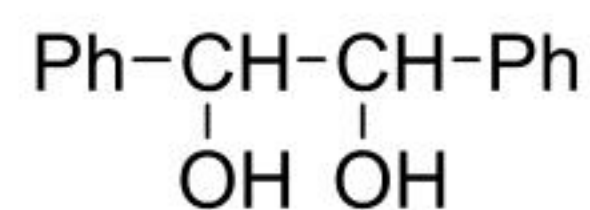
NUMERICAL ANSWER TYPE (NAT)

Q. 41 – Q. 50 carry one mark each.

- Q.41 The number of possible isomers for $[\text{Pt}(\text{py})(\text{NH}_3)\text{BrCl}]$ is _____. (py is pyridine)
- Q.42 The volume of 0.3 M ferrous ammonium sulphate solution required for the completion of redox titration with 20 mL of 0.1 M potassium dichromate solution is _____ mL.
- Q.43 Among the following hydrocarbon(s), how many of them would give rise to three groups of proton NMR peaks with 2:2:3 integration ratio?



Q.44 The number of stereoisomers possible for the following compound is _____.



Q.45 The number of hydrogen bond(s) present in a guanine-cytosine base pair is _____.

Q.46 The time for 50% completion of a zero order reaction is 30 min. Time for 80% completion of this reaction is _____ min.

Q.47 Consider the reaction $\text{CO}(g) + \frac{1}{2} \text{O}_2(g) \longrightarrow \text{CO}_2(g)$.

The value of ΔU for the reaction at 300 K is $-281.8 \text{ kJ mol}^{-1}$. The value of ΔH at same temperature is _____ kJ mol^{-1} (rounded up to the first decimal place).
[$R = 8.3 \text{ J K}^{-1} \text{ mol}^{-1}$]

Q.48 The nuclear spin quantum number (I) of a nucleus is $\frac{3}{2}$. When placed in an external magnetic field, the number of possible spin energy states it can occupy is _____.

Q.49 The value of C_v for 1 mol of N_2 gas predicted from the principle of equipartition of energy, ignoring vibrational contribution, is _____ $\text{J K}^{-1} \text{ mol}^{-1}$ (rounded up to two decimal places).
[$R = 8.3 \text{ J K}^{-1} \text{ mol}^{-1}$]

Q.50 Assuming ideal gas behavior, the density of O_2 gas at 300 K and 1.0 atm is _____ g L^{-1} (rounded up to two decimal places).
[$R = 0.082 \text{ L atm mol}^{-1} \text{ K}^{-1}$, molar mass of $\text{O}_2 = 32$]

Q. 51 – Q. 60 carry two marks each.

Q.51 How many of the following interhalogen species have 2 lone pairs of electrons on the central atom?

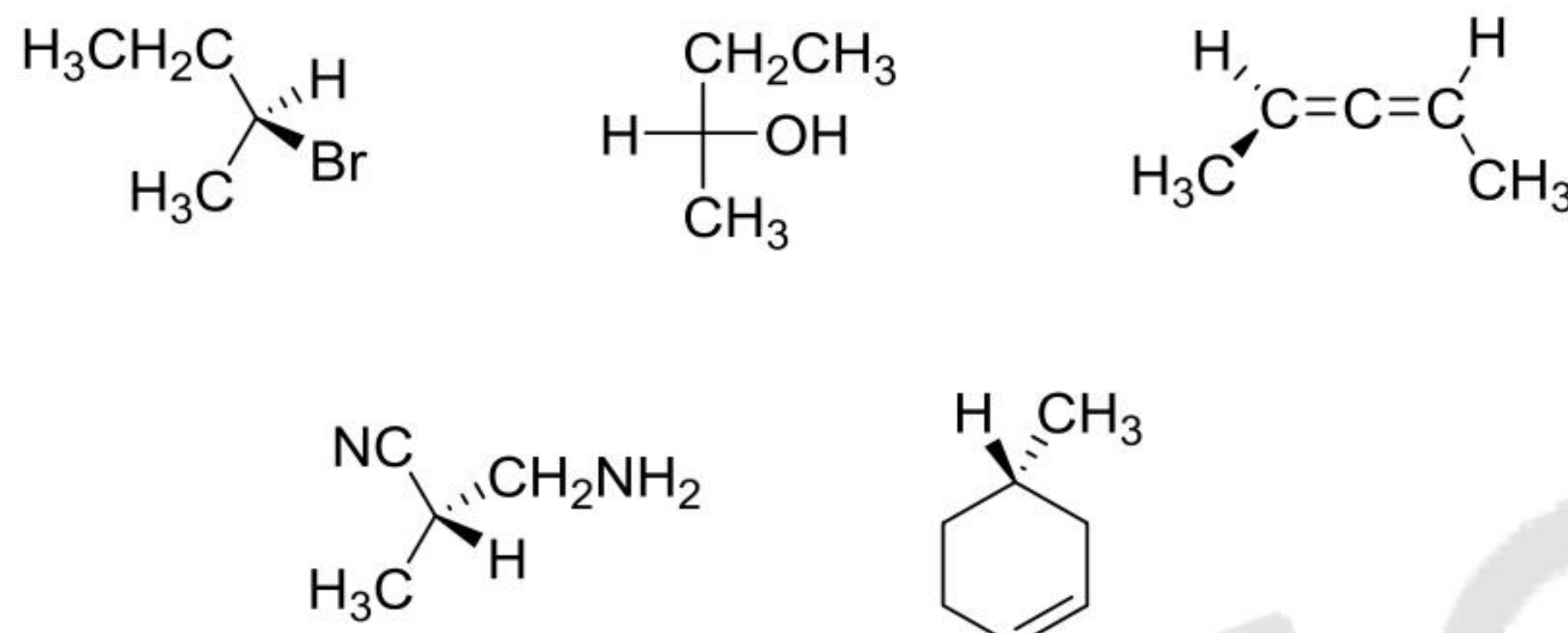


Q.52 ^{24}Na decays to one-fourth of its initial amount in 29.8 hours. Its decay constant is _____ hour^{-1} (rounded up to four decimal places).

Q.53 The magnitude of crystal field stabilization energy (CFSE) of octahedral $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ complex is 7680 cm^{-1} . The wavelength at the maximum absorption (λ_{max}) of this complex is _____ nm (rounded up to the nearest integer).

Q.54 Elemental analysis of an organic compound containing C, H and O gives percentage composition: C: 39.9 % and H: 6.7 %. If the molecular weight of the compound is 180, the number of carbon atoms present in the molecule is_____.

Q.55 The number of compounds having *S*-configuration among the following is _____.



Q.56 The *emf* of a standard cadmium cell is 1.02 V at 300 K. The temperature coefficient of the cell is $-5.0 \times 10^{-5} \text{ V K}^{-1}$. The value of ΔH° for the cell is _____ kJ mol^{-1} (rounded up to two decimal places).
[1 F = 96500 C mol^{-1}]

Q.57 For the reaction $\text{H}_2(\text{g}) + \frac{1}{2} \text{O}_2(\text{g}) \longrightarrow \text{H}_2\text{O}(\text{l})$, the following information is given
T = 300 K

$$\begin{aligned} \Delta \bar{H}^\circ &= -285 \text{ kJ mol}^{-1} & \bar{S}_{\text{H}_2\text{O}}^\circ(\text{l}) &= 70 \text{ J K}^{-1} \text{ mol}^{-1} \\ \bar{S}_{\text{O}_2}^\circ(\text{g}) &= 204 \text{ J K}^{-1} \text{ mol}^{-1} & \bar{S}_{\text{H}_2}^\circ(\text{g}) &= 130 \text{ J K}^{-1} \text{ mol}^{-1} \end{aligned}$$

$\Delta \bar{S}_{\text{universe}}^\circ$ for the reaction is _____ $\text{J K}^{-1} \text{ mol}^{-1}$.

Q.58 For H_2 molecule, the fundamental vibrational frequency ($\bar{\nu}_e$) can be taken as 4400 cm^{-1} . The zero-point energy of the molecule is _____ kJ mol^{-1} (rounded up to two decimal places).
[$h = 6.6 \times 10^{-34} \text{ J s}$, $c = 3 \times 10^8 \text{ m s}^{-1}$, $N_A = 6 \times 10^{23} \text{ mol}^{-1}$]

Q.59 The solubility of PbI_2 in 0.10 M $\text{KI}(\text{aq})$ is _____ $\times 10^{-7} \text{ M}$ (rounded up to two decimal places).
[The solubility product, $K_{\text{sp}} = 7.1 \times 10^{-9}$]

Q.60 The electron of a hydrogen atom is in its n^{th} Bohr orbit having de Broglie wavelength of $13.4 \text{ \AA}$. The value of n is _____ (rounded up to the nearest integer).
[Radius of n^{th} Bohr orbit = $0.53n^2 \text{ \AA}$, $\pi = 3.14$]

END OF THE QUESTION PAPER