PART II-CHEMISTRY

SECTION 1 (Maximum Marks: 32)

This section contains **EIGHT (08)** questions.

•Each question has **FOUR** options for correct answer(s). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct option(s).

• For each question, choose the option(s) corresponding to (all) the correct answer(s).

• Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 If only (all) the correct option(s) is (are) chosen.

Partial Marks : +3 If all the four options are correct but ONLY three options are chosen.

Partial Marks : +2 If three or more options are correct but ONLY two options are chosen, both of which are correct options.

Partial Marks : +1 If two or more options are correct but ONLY one option is chosen and it is a correct option.

Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).

Negative Marks : -1 In all other cases.

• **For Example:** in a question, If (A), (B) and (D) are the ONLY three options corresponding to correct answers, then choosing ONLY (A), (B) and (D) will get +4 marks;

choosing ONLY (A) and (B) will get +2 marks;

choosing ONLY (A) and (D) will get +2 marks;

choosing ONLY (B) and (D) will get +2 marks;

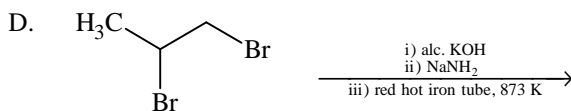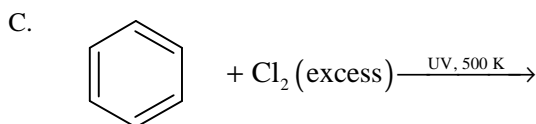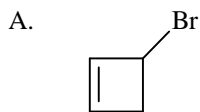choosing ONLY (A) will get +1 mark;

choosing ONLY (B) will get +1 mark;
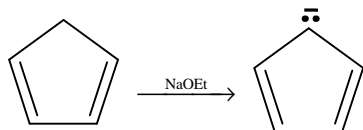
choosing ONLY (D) will get +1 mark;

Choosing no option (i.e. the question is unanswered) will get 0 marks; and choosing any other combination of options will get – 1 mark.
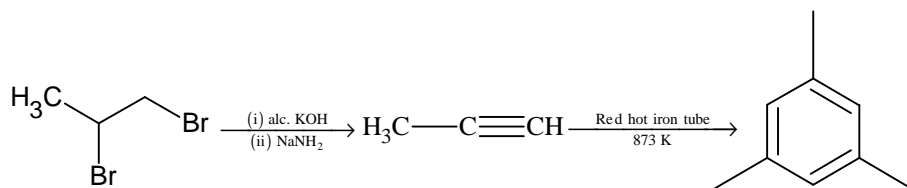
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*Q.1. Choose the correct option(s) that give(s) an aromatic compound as the major product
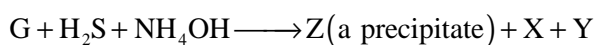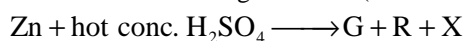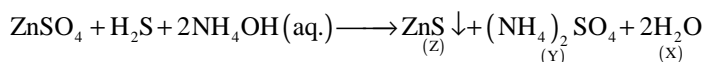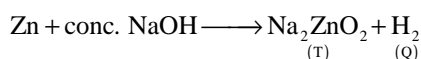
Sol. **B, D**

(B)

(D)

2.   Consider the following reactions (unbalanced)

$$Zn + \text{hot conc. } H_2SO_4 \longrightarrow G + R + X$$

$$Zn + \text{conc.NaOH} \longrightarrow T + Q$$

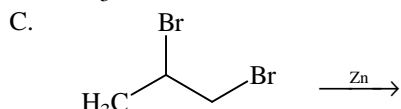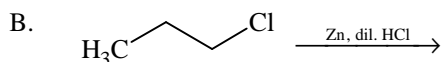$$G + H_2S + NH_4OH \longrightarrow Z(\text{a precipitate}) + X + Y$$

Choose the correct option(s)
A.   The oxidation state of Zn in T is +1
B.   R is a V-shaped molecule
C.   Z is dirty white in colour
D.   Bond order of Q is 1 in its ground state

Sol. **B, C, D**

$$\underset{\text{(hot \& conc.)}}{Zn + H_2SO_4} \longrightarrow \underset{\text{(G)}}{ZnSO_4} + \underset{\text{(R)}}{SO_2} + \underset{\text{(X)}}{H_2O}$$

$$Zn + \text{conc. NaOH} \longrightarrow \underset{\text{(T)}}{Na_2ZnO_2} + \underset{\text{(Q)}}{H_2}$$

$$ZnSO_4 + H_2S + 2NH_4OH(\text{aq.}) \longrightarrow \underset{\text{(Z)}}{ZnS} \downarrow + \underset{\text{(Y)}}{(NH_4)_2 SO_4} + \underset{\text{(X)}}{2H_2O}$$
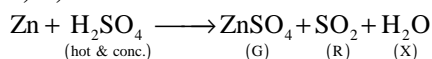
*Q.3.   Which of the following reactions produce(s) propane as a major product?

A. $\xrightarrow{\text{NaOH, CaO, }\Delta}$

B. $\xrightarrow{\text{Zn, dil. HCl}}$

C. $\xrightarrow{\text{Zn}}$

D. $+ H_2O \xrightarrow{\text{electrolysis}}$
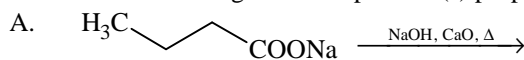
Sol. **A, B**
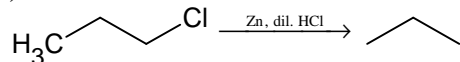
4.   Choose the correct option(s) from the following:
A.   Cellulose has only α-D-glucose units that are joined by glycosidic linkages
B.   Teflon is prepared by heating tetrafluoroethene in presence of a persulphate catalyst at high pressure
C.   Natural rubber is polyisoprene containing *trans* alkene units
D.   Nylon-6 has amide linkages

Sol. **B, D**

*Q.5. The ground state energy of hydrogen atom is – 13.6 eV. Consider an electronic state ψ of He^+ whose energy, azumuthal quantum number and magnetic quantum number are -3.4 eV, 2 and 0, respectively. Which of the following statement(s) is(are) true for the state ψ ?

A. It is a 4d state
B. It has 2 angular nodes
C. It has 3 radial nodes
D. The nuclear charge experienced by the electron in this state is less than 2e, where e is the magnitude of the electronic charge

Sol. **A, B**

$$-3.4 = \frac{-13.6 \times 2^2}{n^2}$$
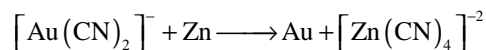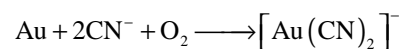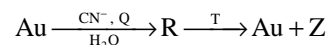
$n = 4$
$\ell = 2$
Subshell = 4d
Angular nodes = $\ell = 2$
Radial nodes = $n - \ell - 1 = 4 - 2 - 1 = 1$

6. The cyanide process of gold extraction involves leaching out gold from its ore with CN^- in the presence of Q in water to form R. Subsequently, R is treated with T to obtain Au and Z. Choose the correct option(s)

A. Z is $\left[Zn(CN)_4 \right]^{2-}$
B. T is Zn
C. R is $\left[Au(CN)_4 \right]^-$
D. Q is O_2

Sol. **A, B, D**

$$Au \xrightarrow[H_2O]{CN^-, Q} R \xrightarrow{T} Au + Z$$

$$Au + 2CN^- + O_2 \longrightarrow \left[Au(CN)_2 \right]^-$$

$$\left[Au(CN)_2 \right]^- + Zn \longrightarrow Au + \left[Zn(CN)_4 \right]^{-2}$$

7. With reference to *aqua regia*, choose the correct option(s)
A. The yellow colour of *aqua regia* is due to the presence of NOCl and Cl_2
B. *Aqua regia* is prepared by mixing conc. HCl and conc. HNO_3 in 3 : 1 (*v/v*) ratio
C. Reaction of gold with *aqua regia* produces an anion having Au in +3 oxidation state
D. Reaction of gold with *aqua regia* produces NO_2 in the absence of air

Sol. **A, C**

$$Au + HNO_3 + 3HCl \longrightarrow HAuCl_4 + NO + H_2O$$
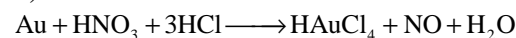
Yellow colour of aqua – regia is due to NOCl and Cl_2.
In aqua regia HCl and HNO_3 are in 3:1 molar ratio

8. Choose the correct option(s) for the following reaction sequence

CHO

$$\xrightarrow[\substack{\text{ii) AgNO}_3,\text{NH}_4\text{OH} \\ \text{iii) Zn-Hg, conc. HCl}}]{\text{i) Hg}^{2+},\text{ dil.H}_2\text{SO}_4} Q \xrightarrow[\substack{\text{pyridine} \\ \text{ii) AlCl}_3}]{\text{i) SOCl}_2} R \xrightarrow[\text{conc. HCl}]{\text{Zn-Hg}} S$$

MeO
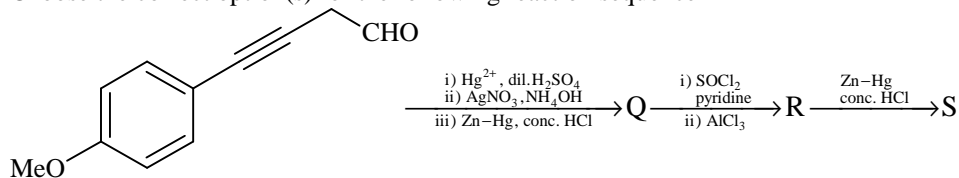
Consider Q, R and S as major products
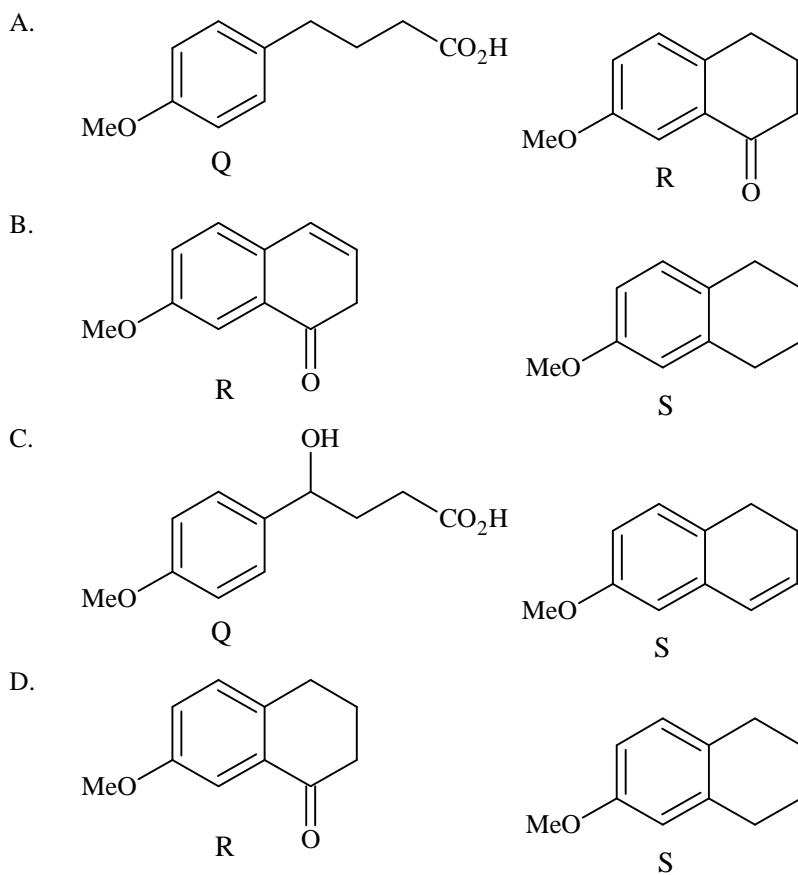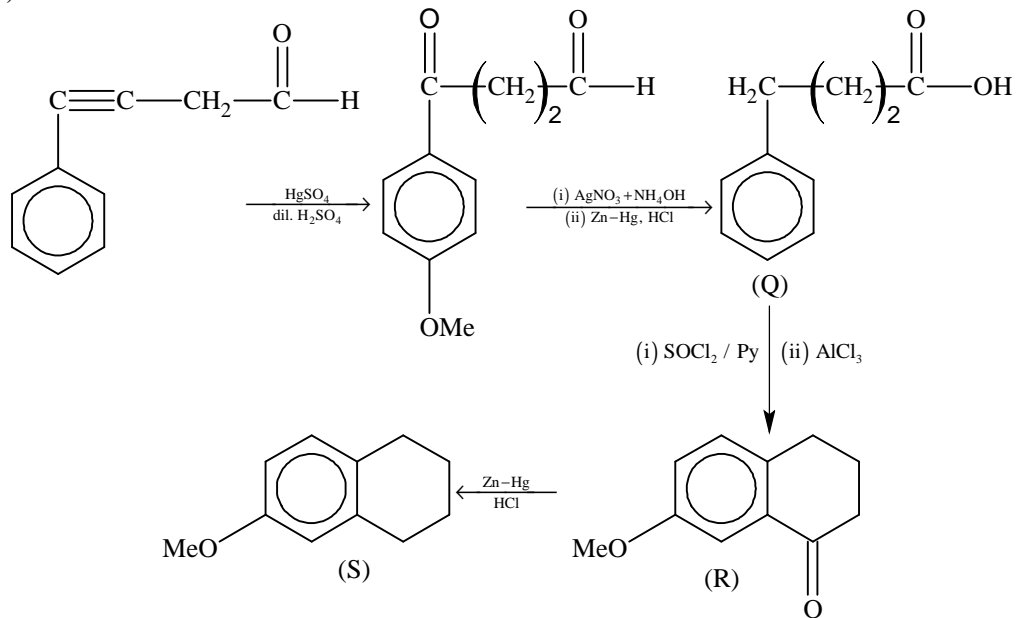
A.

MeO

Q

MeO

R O

B.

MeO

R O

MeO

S

C.

OH

MeO

Q

MeO

S

D.

MeO

R O

MeO

S

Sol. **A, B**

*Q.1. Total number of isomers, considering both structural and stereoisomers, of cyclic ethers with the molecular formula C_4H_8O is_____

Sol. **10.00**
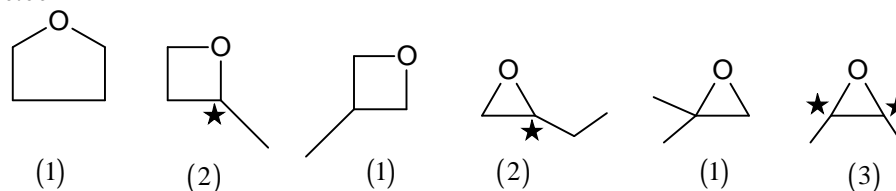
*Q.2. The mole fraction of urea in an aqueous urea solution containing 900 g of water is 0.05. If the density of the solution is 1.2 g cm^{-3}, the molarity of urea solution is_____
(Given data: Molar masses of urea and water are 60 g mol^{-1} and 18 g mol^{-1}, respectively)\

Sol. **2.98**

Let mole of urea = x

$$\frac{x}{x + \frac{900}{18}} = 0.05, \quad x = \frac{50}{19}$$

$$\text{Mass of solution} = \frac{50}{19} \times 60 + 900 = \frac{20100}{19}$$

$$\text{Volume of solution} = \frac{20100}{19 \times 1.2} \text{ ml}$$

$$= \frac{20.1}{19 \times 1.2} \text{ litre}$$

$$\text{Molarity} = \frac{\frac{50}{19}}{\frac{20.1}{19 \times 1.2}} = \frac{50 \times 1.2}{20.1} = \frac{60}{20.1} \cong 2.985$$

3. Total number of *cis* N-Mn-Cl bond angles (that is, Mn – N and Mn – Cl bonds in *cis* positions) present in a molecule of *cis*-[Mn(en)$_2$Cl$_2$] complex is_____(en = NH$_2$CH$_2$CH$_2$NH$_2$)

Sol. **6.00**
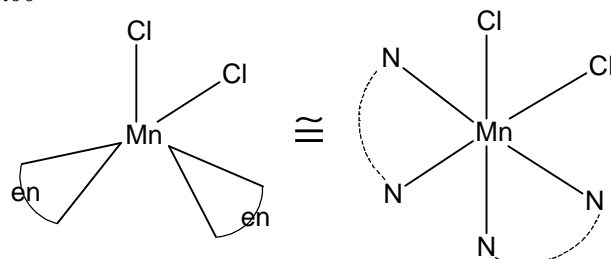
*Q. 4.   The amount of water produced (in g) in the oxidation of 1 mole of rhombic sulphur by conc. HNO_3 to a compound with the highest oxidation state of sulphur is_____
(Given data : Molar mass of water = 18 g mol^{-1})

Sol.   **288.00**

$$S_8 + 48HNO_3 \longrightarrow 8H_2SO_4 + 48NO_2 + 16H_2O$$

Mass of $H_2O = 18 \times 16 = 288$ gram

5.   The decomposition reaction $2N_2O_5(g) \overset{\Delta}{\longrightarrow} 2N_2O_4(g) + O_2(g)$ is started in a closed cylinder under isothermal isochoric condition at an initial pressure of 1 atm. After $Y \times 10^3$ s, the pressure inside the cylinder is found to be 1.45 atm. If the rate constant of the reaction is 5×10^{-4} s^{-1}, assuming ideal gas behaviour, the value of **Y** is_____

Sol.   **2.30**

Unit of K represent it is first order reaction.

$$2N_2O_5 \longrightarrow 2N_2O_4 + O_2$$
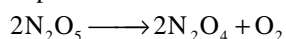
$t = 0$ 1   0   0

$t = t$ $1-P$ P $P/2$

$$1-P+P+\frac{P}{2}=1.45$$

$$\frac{P}{2} = 0.45, \; p = 0.9$$

$$t = \frac{2.303}{2 \times 5 \times 10^{-4}} \log \frac{1}{1-P}$$

$$y \times 10^{-3} = \frac{2.303}{2 \times 5 \times 10^{-4}} \log \frac{1}{1-0.9} = \frac{2.303}{2 \times 5 \times 10^{-4}} \log 10$$

$$Y = 2.30$$

*Q.6.   Total number of hydroxyl groups present in a molecule of the major product **P** is_____

$$\xrightarrow[\text{ii) dil. KMnO}_4 \text{(excess), 273 K}]{\text{i) H}_2\text{,Pd−BaSO}_4\text{,quinoline}} P$$
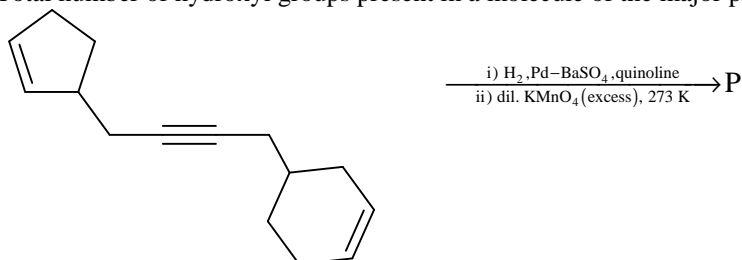
Sol.   **6.00**

SECTION 3 (Maximum Marks: 12)

- This section contains **TWO (02)** questions.
- Each List-Match set has **TWO (02)** Multiple Choice Questions.
- Each List-Match set has two lists: **List-I** and **List-II.**
- **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U).
- **FOUR** options are given in each Multiple Choice Question based on **List-1** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.
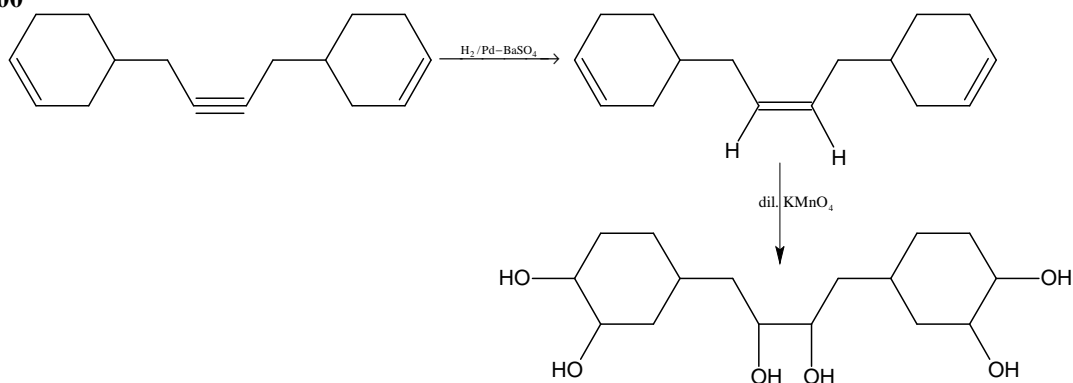
  Answer to each question will be evaluated according to the following marking scheme:

  Full Marks : +3 If ONLY the option corresponding to the correct combination is chosen.

  Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered).

  Negative Marks : –1 In all other cases.

Answer the following by appropriately matching the lists based on the information given in the paragraph

*Q.1.   Consider the Bohr's model of a one-electron atom where the electron moves around the nucleus. In the following, List-I contains some quantities for the nth orbit of the atom and List-II contains options showing how they depend on n.

	LIST–I		LIST–II
(I)	Radius of the nth orbit	(P)	$\propto n^{-2}$
(II)	Angular momentum of the electron in the nth orbit	(Q)	$\propto n^{-1}$
(III)	Kinetic energy of the electron in the nth orbit	(R)	$\propto n^{0}$
(IV)	Potential energy of the electron in the nth orbit	(S)	$\propto n^{1}$
		(T)	$\propto n^{2}$
		(U)	$\propto n^{1/2}$

Which of the following options has the correct combination considering List-I and List-II?

Options

A. (III), (P)

B. (IV), (U)

C. (III), (S)

D. (IV), (Q)

Sol.   **A**

Answer the following by appropriately matching the lists based on the information given in the paragraph

*Q.2.   Consider the Bohr's model of a one-electron atom where the electron moves around the nucleus. In the following, List-I contains some quantities for the nth orbit of the atom and List-II contains options showing how they depend on n.

	LIST–I		LIST–II
(I)	Radius of the nth orbit	(P)	$\propto n^{-2}$
(II)	Angular momentum of the electron in the nth orbit	(Q)	$\propto n^{-1}$
(III)	Kinetic energy of the electron in the nth orbit	(R)	$\propto n^{0}$
(IV)	Potential energy of the electron in the nth orbit	(S)	$\propto n^{1}$
		(T)	$\propto n^{2}$
		(U)	$\propto n^{1/2}$

Which of the following options has the correct combination considering List-I and List-II?

Options

A. (I), (T)

B. (II), (R)

C. (I), (P)

D. (II), (Q)

Sol.   **A**

Sol(1-2). $KE = \dfrac{13.6Z^2}{n^2}$ eV / atom

$PE = \dfrac{-2 \times 13.6Z^2}{n^2}$ eV / atom

$Radius = 0.529\dfrac{n^2}{Z}$ Å

Angular momentum of electron (mvr) $= \dfrac{nh}{2\pi}$

Answer the following by appropriately matching the lists based on the information given in the paragraph

3.   List-I includes starting materials and reagents of selected chemical reactions. List-II gives structures of compounds that may be formed as intermediate products and/or final products from the reactions of List-I.

LIST–I

(I)

i) DIBAL–H
ii) dil. HCl
iii) NaBH$_4$
iv) conc. H$_2$SO$_4$

(II)

i) O$_3$
ii) Zn, H$_2$O
iii) NaBH$_4$
iv) conc. H$_2$SO$_4$

(III)

i) KCN
ii) H$_3$O$^+$, Δ
iii) LiAlH$_4$
iv) conc. H$_2$SO$_4$

(IV)

i) LiAlH$_4$
ii) conc. H$_2$SO$_4$

LIST–II

(P)

(Q)

(R)

(S)

(T)

(U)

Which of the following options has the correct combination considering List-I and List-II?
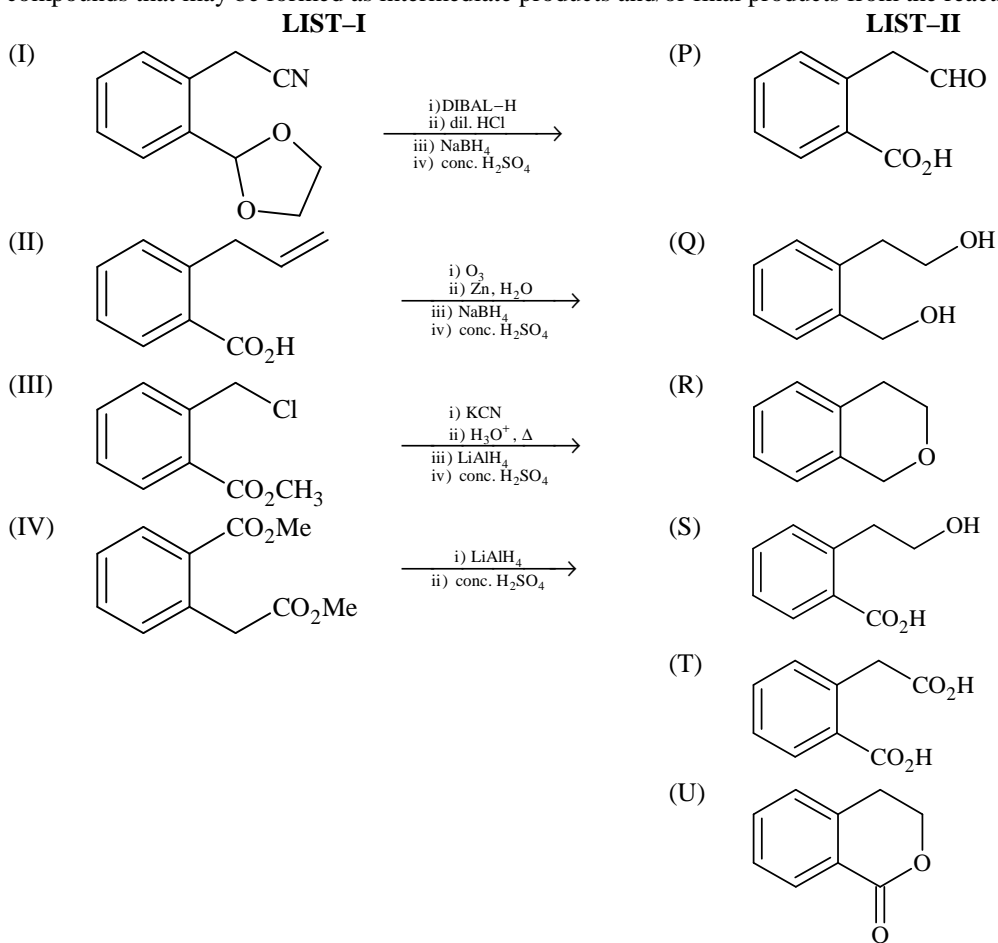
Options

A. (II), (P), (S), (T)

B. (II), (P), (S), (U)

C. (I), (S), (Q), (R)

D. (I), (Q), (T), (U)

Sol.   **B**

Answer the following by appropriately matching the lists based on the information given in the paragraph

4. List-I includes starting materials and reagents of selected chemical reactions. List-II gives structures of compounds that may be formed as intermediate products and/or final products from the reactions of List-I.

<div style="text-align:center">LIST–I   LIST–II</div>

(I) [structure: benzene with CH₂CN group and 1,3-dioxolane group ortho]

i) DIBAL−H
ii) dil. HCl
iii) NaBH₄
iv) conc. H₂SO₄

(P) [structure: benzene with CHO and CO₂H ortho]

(II) [structure: benzene with allyl group and CO₂H ortho]

i) O₃
ii) Zn, H₂O
iii) NaBH₄
iv) conc. H₂SO₄

(Q) [structure: benzene with CH₂CH₂OH and CH₂OH ortho]

(III) [structure: benzene with CH₂Cl and CO₂CH₃ ortho]

i) KCN
ii) H₃O⁺, Δ
iii) LiAlH₄
iv) conc. H₂SO₄

(R) [structure: isochroman]

(IV) [structure: benzene with CO₂Me and CH₂CO₂Me ortho]

i) LiAlH₄
ii) conc. H₂SO₄

(S) [structure: benzene with CH₂CH₂OH and CO₂H ortho]

(T) [structure: benzene with CH₂CO₂H and CO₂H ortho]

(U) [structure: isochroman-1-one]

Which of the following options has the correct combination considering List-I and List-II?

Options
A. (IV), (Q), (U)
B. (IV), (Q), (R)
C. (III), (S), (R)
D. (III), (T), (U)

Sol.   **B**

Sol(3-4).   **(i)**

[reaction scheme: starting material (I) → (i)DIBAL−H / (ii) dil. HCl → dialdehyde intermediate → (iii)NaBH₄ / (iv) conc. H₂SO₄ → isochroman]

(ii)

[reaction scheme: starting material (II) with COOH → (i)O₃ / (ii)Zn/H₂O → aldehyde with COOH intermediate → (iii)NaBH₄ / (iv) conc. H₂SO₄ → isochroman-1-one]

(iii)

Reaction (iii): o-(chloromethyl) methyl benzoate → (i) KCN, (ii) H$_3$O$^+$, Δ → 2-(carboxymethyl)benzoic acid → (iii) LiAlH$_4$, (iv) conc. H$_2$SO$_4$ → isochroman

(iv)

Reaction (iv): dimethyl 2-(methoxycarbonylmethyl)benzoate (CO$_2$Me and CH$_2$CO$_2$Me) → (i) LiAlH$_4$ → 2-(2-hydroxyethyl)benzyl alcohol (CH$_2$OH and CH$_2$—CH$_2$OH) → (ii) conc. H$_2$SO$_4$ → isochroman