



# JEE (ADVANCED) 2019 PAPER-2

[PAPER WITH SOLUTION]

HELD ON SUNDAY 27TH MAY, 2019

## CHEMISTRY

### SECTION 1 (Maximum Marks : 32)

- This section contains **EIGHT (08)** questions.
- Each question has **FOUR** options. **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 and both of which are correct.  
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 answer, 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.

- 01.** The ground state energy of hydrogen atoms is  $-13.6$  eV. Consider an electronic state  $\psi$  of  $\text{He}^+$  whose energy, azimuthal 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  $\psi$ ?
- (1) It is a 4d state
  - (2) It has 2 angular nodes
  - (3) The nuclear charge experienced by the electron in this state is less than  $2e$ . where  $e$  is the magnitude of the electronic charge
  - (4) It has 3 radial nodes

**Ans. (1, 2)**

**Sol.** For  $\text{He}^+$

$$E = -3.4 \text{ e.V} = -13.6 \frac{Z^2}{n^2} \text{ e.V}$$

$$\text{or, } -3.4 = -13.6 \times \frac{2^2}{n^2}$$

$$\text{or, } n = 4$$

$\ell = 2$  means d-orbital

$m_\ell = 0$  means,  $d_{z^2}$

So, It is  $4d_{z^2}$

It has two angular nodes(in conical form)

$$\text{Number of radial nodes} = n - \ell - 1 = 4 - 2 - 1 = 1$$

Also, no screening effect in one electron system so, nuclear charge experienced by electron =  $2e$ .

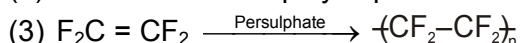
**02.** Choose the correct option(s) from the following

- (1) Nylon-6-has amide linkages
- (2) Natural rubber is polyisoprene containing trans alkene units
- (3) Teflon is prepared by heating tetrafluoroethene in presence of a persulphate catalyst at high pressure
- (4) Cellulose has only  $\alpha$ -D-glucose units that are joined by glycosidic linkages

**Ans. (1,3)**

**Sol.** (1) Nylon-6 has amide linkage :  $\left[ \text{NH}-(\text{CH}_2)_5-\overset{\text{O}}{\parallel}{\text{C}} \right]_n$

(2) Natural rubber is polyisoprene containing cis alkene units

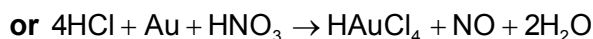
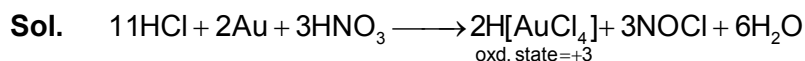


(4) Cellulose has only  $\beta$ -D glucose units

**03.** With reference to aqua regia, choose the correct option(s)

- (1) Reaction of gold with aqua regia produces an anion having Au in +3 oxidation state
- (2) Reaction of gold with aqua regia produces  $\text{NO}_2$  in the absence of air
- (3) The yellow colour of aqua regia is due to the presence of  $\text{NOCl}$  and  $\text{Cl}_2$
- (4) Aqua regia is prepared by mixing conc.  $\text{HCl}$  and conc.  $\text{HNO}_3$  in 3:1 (v/v) ratio

**Ans. (1,3,4)**

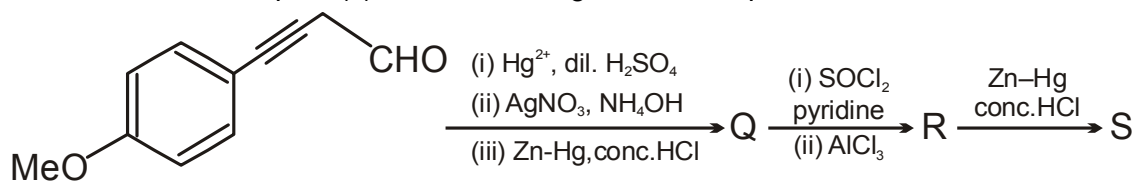


( $\text{NO}_2$  is not produced in the absence of air)

$\text{Cl}_2(\text{g})$  is yellow green gas. It's presence makes solution appear yellow.

Aqua regia is prepared by mixing 3 parts  $\text{HCl}$  and 1 part  $\text{HNO}_3$

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

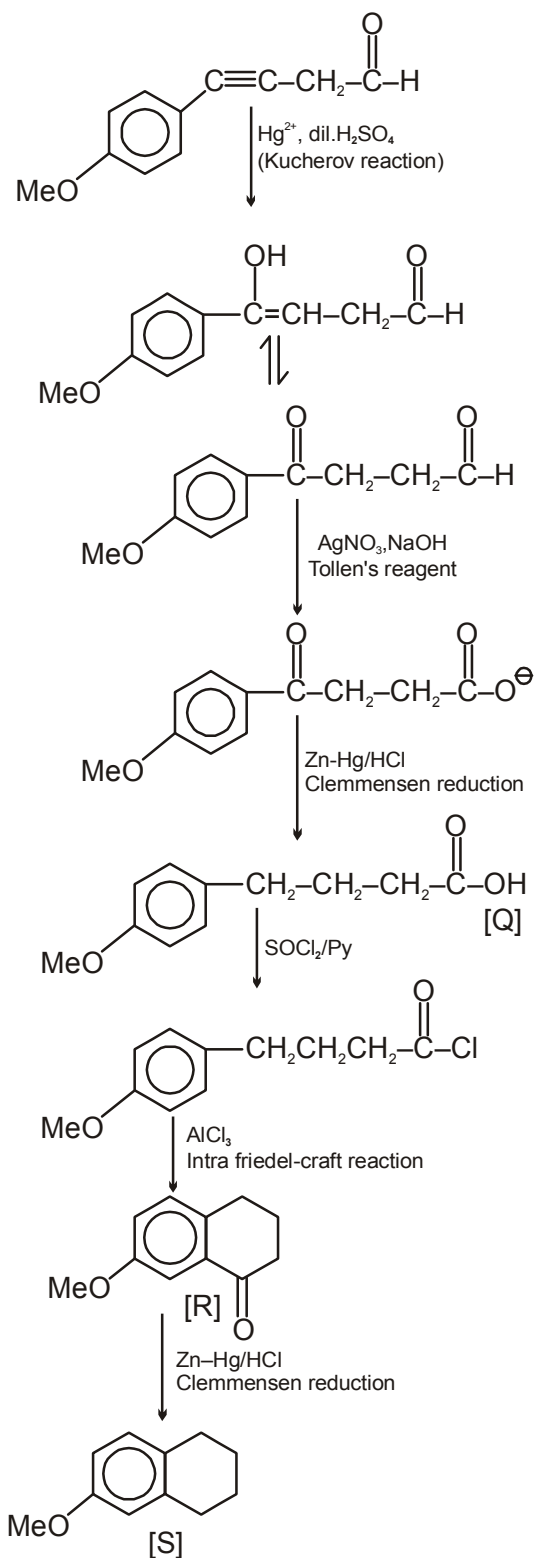


Consider Q, R and S as major products

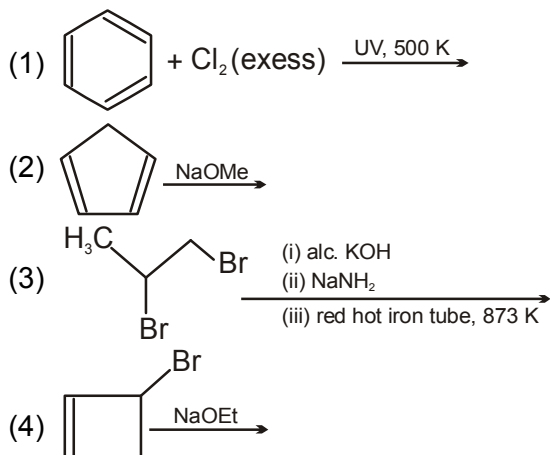
- (1) Q S
- (2) Q R
- (3) R S
- (4) R S

Ans. (2,3)

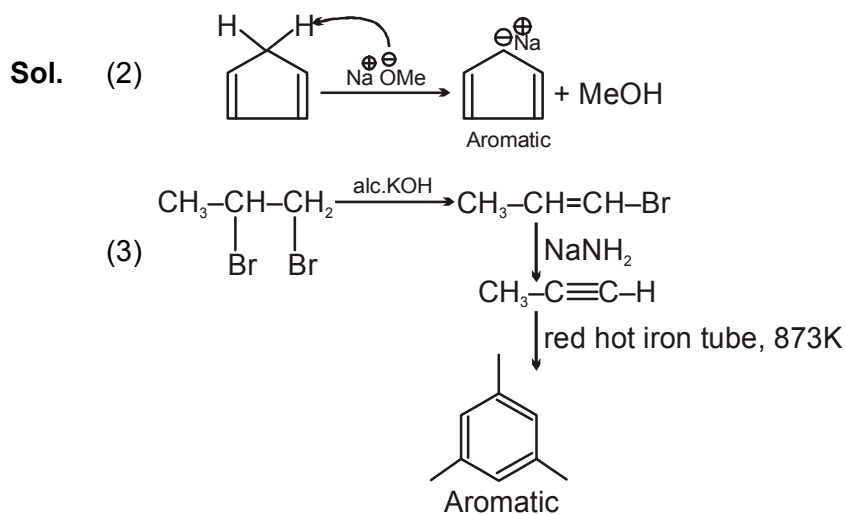
Sol.



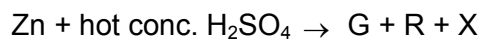
05. Choose the correct option(s) that gives(s) an aromatic compound as the major product



Ans. (2,3)



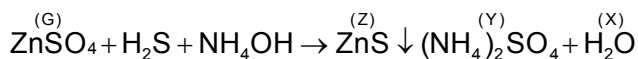
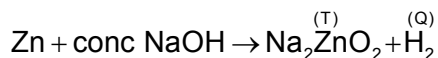
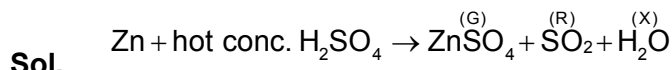
06. Consider the following reactions (unbalanced)



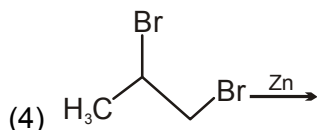
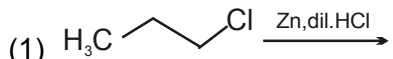
Choose the correct option(s)

- (1) The oxidation state of Zn in T is +1
- (2) R is a V-shaped molecule
- (3) Bond order of Q is 1 in its ground state
- (4) Z is dirty white in colour

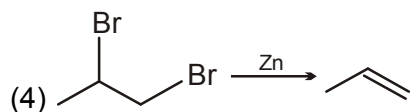
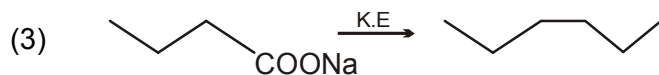
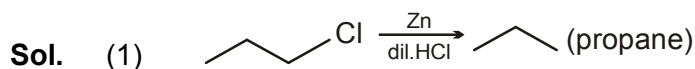
Ans. (2,3,4)



07. Which of the following reactions produce(s) propane as a major product?



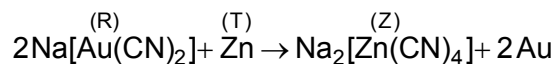
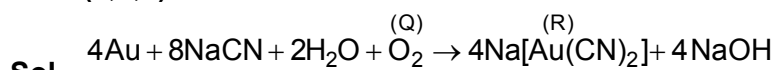
Ans. (1,2)



08. The cyanide process of gold extraction involves leaching out gold from its ore with  $\text{CN}^-$  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)

- (1) Z is  $[\text{Zn}(\text{CN})_4]^{2-}$       (2) T is Zn      (3) Q is  $\text{O}_2$       (4) R is  $[\text{Au}(\text{CN})_4]^-$

Ans. (1,2,3)



## SECTION 2 (Maximum Marks : 18)

- This section contains **SIX (06)** questions. The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer. If the numerical value has more than two decimal places, **truncate/round-off** the value of to **TWO** decimal places.
- Answer to each question will be evaluated according to the following marking scheme:  
**Full Marks : +3** If **ONLY** the correct numerical value is entered.  
**Zero Marks : 0** In all other cases.

**01.** 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  $1.2 \text{ g cm}^{-3}$ , the molarity of urea solution is \_\_\_\_\_  
 (Given data. Molar masses of urea and water are  $60 \text{ g mol}^{-1}$  and  $18 \text{ g mol}^{-1}$ , respectively)

**Ans. (2.98)**

**Sol.**  $x_{\text{urea}} = 0.05$ ;  $x_{\text{H}_2\text{O}} = 0.95$

$$n_{\text{H}_2\text{O}} = \frac{900}{18} = 50$$

$$\frac{x_{\text{urea}}}{x_{\text{H}_2\text{O}}} = \frac{n_{\text{urea}}}{n_{\text{H}_2\text{O}}}$$

$$\text{or, } \frac{0.05}{0.95} = \frac{n_{\text{urea}}}{n_{\text{H}_2\text{O}}} \quad \text{or, } n_{\text{urea}} = \frac{50}{19}$$

$$\text{mass of urea} = \frac{50}{19} \times 60 \text{ g} = \frac{3000}{19} \text{ g}$$

$$\text{mass of solution} = \left( 900 + \frac{3000}{19} \right) \text{ g} = \frac{20100}{19} \text{ g}$$

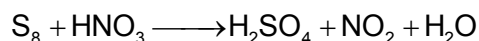
$$\text{Volume of solution} = \frac{m}{d} = \frac{20100}{19 \times 1.2} \text{ ml}$$

$$\text{Molarity of urea} = \frac{n}{v} = \frac{\frac{50}{19} \times 1000}{\frac{20100}{19 \times 1.2}} = 2.98$$

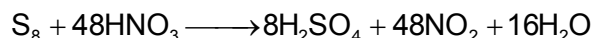
**02.** The amount of water produced (in g) in the oxidation of 1 mole of rhombic sulphur by conc.  $\text{HNO}_3$  to a compound with the highest oxidation state of sulphur is  
 (Given data : Molar mass of water =  $18 \text{ g mol}^{-1}$ )

**Ans. (288.00)**

**Sol.** Rhombic sulphur is  $\text{S}_8$



On balancing



$$\frac{\text{mole } S_8}{1} = \frac{\text{mole } H_2O}{16}$$

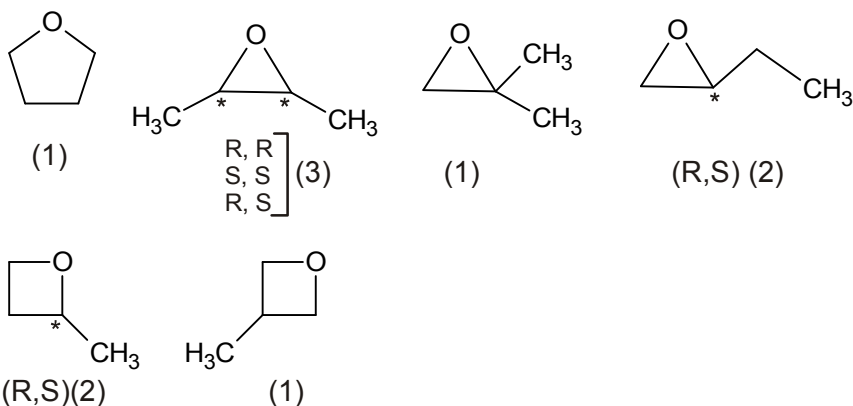
$$1 \times 16 = \frac{\text{Wt. } H_2O}{18}$$

$$\text{Wt. } H_2O = 16 \times 18 = 288 \text{ g.}$$

03. Total number of isomers, considering both structural and stereoisomers of cyclic ether with the molecular formula  $C_4H_8O$  is :

Ans. (10.00)

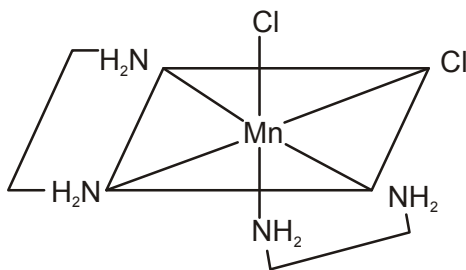
Sol.



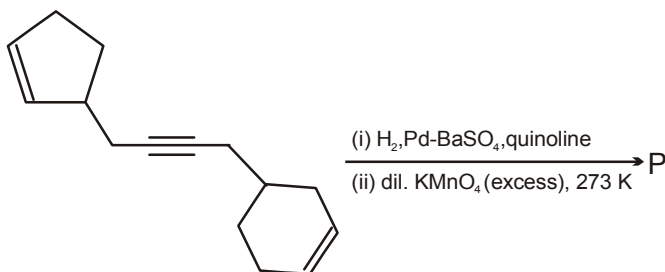
04. Total number of cis N-Mn-Cl bond angles (that is Mn-N and Mn-Cl bonds in cis positions) present in a molecule of cis- $[Mn(en)_2Cl_2]$  complex is \_\_\_\_\_ (en =  $NH_2CH_2CH_2NH_2$ )

Ans. (6.00)

Sol. Total number of cis N-Mn-Cl in cis- $[Mn(en)_2Cl_2]$  is



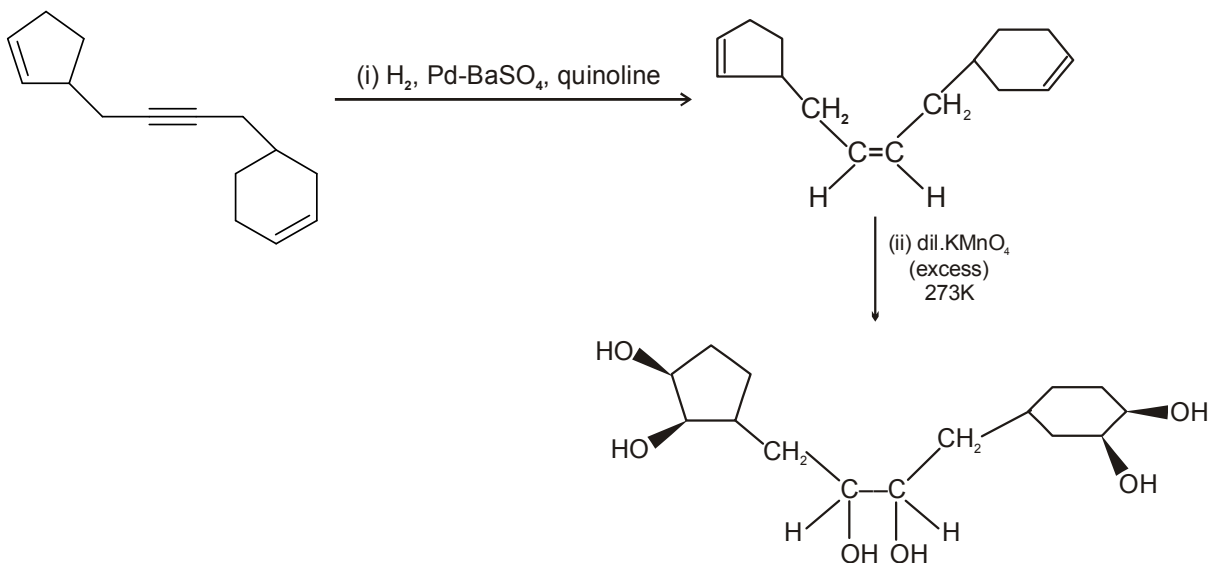
05. Total number of hydroxyl groups present in a molecule of the major product P is





Ans. (6.00)

Sol.



06. The decomposition reaction  $2\text{N}_2\text{O}_5(\text{g}) \xrightarrow{\Delta} 2\text{N}_2\text{O}_4(\text{g}) + \text{O}_2(\text{g})$  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  $5 \times 10^{-4} \text{ s}^{-1}$ , assuming ideal gas behavior, the value of Y is

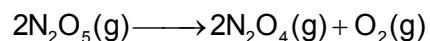
Ans. (2.30)

Sol. Reaction condition : constant V & T

$$t = 0, P = 1 \text{ atm}$$

$$t = Y \times 10^3 \text{ sec}, P = 1.45 \text{ atm}$$

$$K = 5 \times 10^{-4} \text{ s}^{-1}$$



$$\begin{array}{ccc} 1 & 0 & 0 \\ 1-X & X & X/2 \end{array}$$

$$A/q : 1 - X + X + \frac{X}{2} = 1.45$$

$$\frac{X}{2} = 0.45 \Rightarrow X = 0.90 \text{ atm}$$

$$2 \times K = \frac{2.303}{Y \times 10^3} \log \frac{1}{1-X}$$

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

$$Y = 2.303 \log 10$$

$$Y = 2.303 \text{ sec}$$

### SECTION 3 (Maximum Marks : 12)

- This section contains **TWO (02)** List-Match sets.
- 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-I** 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**

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  $n$ th orbit of the atom and List-II contains options showing how they depend on  $n$ .

**List-I**

- (I) Radius of the  $n$ th orbit
- (II) Angular momentum of the electron in the  $n$ th orbit
- (III) Kinetic energy of the electron in the  $n$ th orbit
- (IV) Potential energy of the electron in the  $n$ th orbit

**List-II**

- (P)  $\propto n^{-2}$
- (Q)  $\propto n^{-1}$
- (R)  $\propto n^0$
- (S)  $\propto n^1$
- (T)  $\propto n^2$
- (U)  $\propto n^{1/2}$

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

- (1) (II), (Q)
- (2) (I), (T)
- (3) (I), (P)
- (4) (II), (R)

**Ans. (2)**

**Sol.**  $R = \frac{n^2 h^2 \epsilon_0}{Z m \pi e^2}$ ;  $R \propto n^2$

Angular momentum =  $mvr = \frac{nh}{2\pi}$ ; Angular momentum  $\propto n$

(I) — (T) is correct.

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

- (1) (IV), (U)
- (2) (IV), (Q)
- (3) (III), (S)
- (4) (III), (P)

**Ans. (4)**

**Sol.**  $K.E. = \frac{Z^2 e^4 m}{8 n^2 h^2 \epsilon_0^2}$ ;  $K.E. \propto n^{-2}$

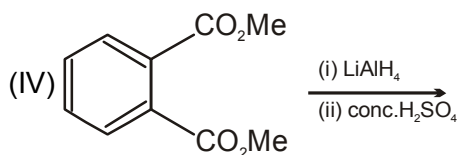
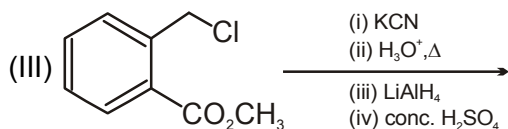
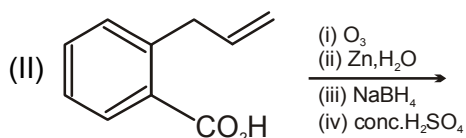
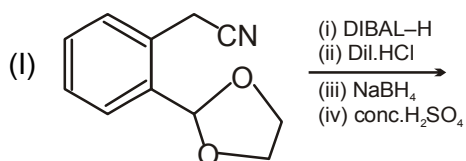
$$\text{P.E.} = \frac{-Z^2 e^4 m}{4n^2 h^2 \epsilon_0^2}; \text{P.E.} \propto n^{-2}$$

(III) — (P) is correct.

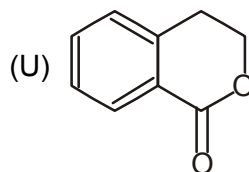
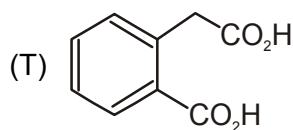
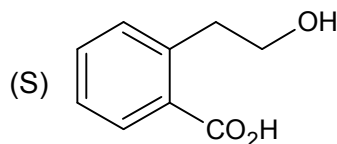
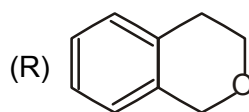
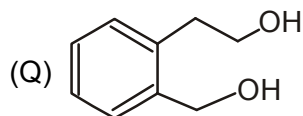
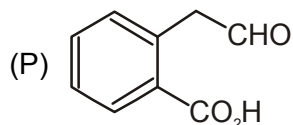
**Answer the following by appropriately matching the lists based on the information given in the paragraph**

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**



**List-II**

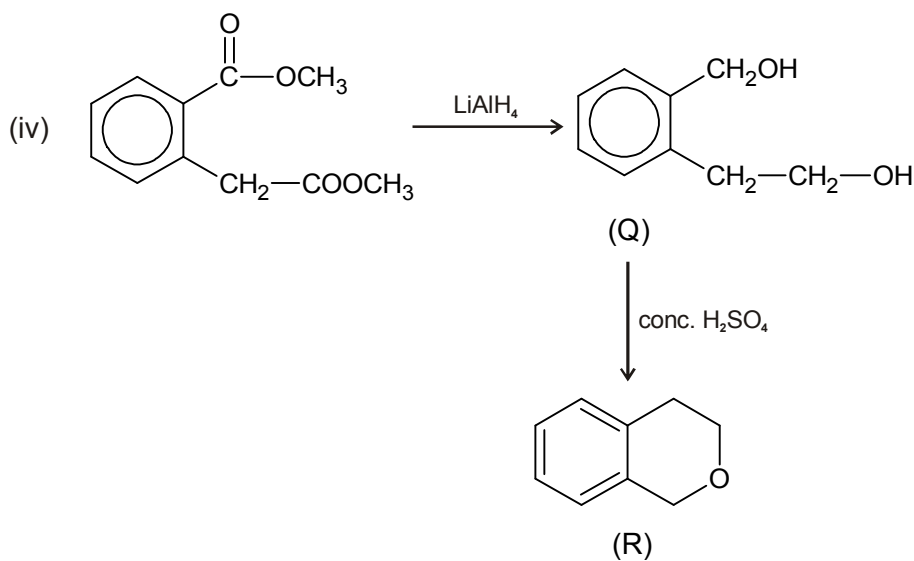
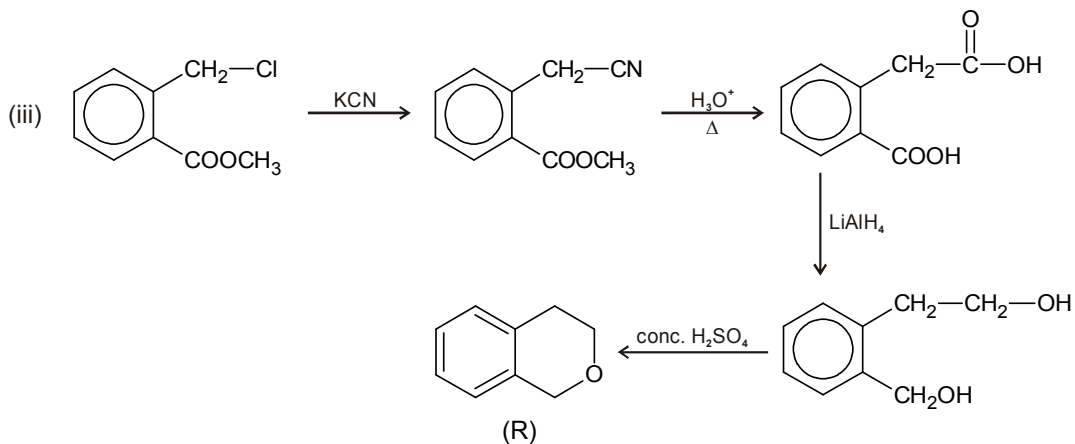


3. Which of the following options has correct combination considering List-I and List-II?

- (1) (III), (T), (U)      (2) (IV),(Q),(U)      (3) (IV),(Q),(R)      (4) (III),(S),(R)

Ans. (3)

Sol.



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

(1) (I), (S), (Q), (R)

(2) (II), (P), (S), (T)

(3) (I), (Q), (T), (U)

(4) (II), (P), (S), (U)

Ans. (4)

Sol.

