



JEE (Adv.) 2019

PAPER-II

Time: 3 Hours.

INSTRUCTIONS

1. The test is of 3 hours duration.
2. The Test Booklet consists of 90 questions. The maximum marks are 360.
3. There are three parts in the question paper A, B, C consisting of **Physics, Chemistry and Mathematics** having 30 questions in each part of equal weightage. Each question is allotted 4 (four) marks for correct response.
4. Candidates will be awarded marks as stated above in instruction No. 3 for correct response of each question. $\frac{1}{4}$ (one-fourth) marks of the total marks allotted to the question will be deducted for indicating incorrect response of each question. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.
5. There is only one correct response for each question. Filling up more than one response in any question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instruction 4 above.
6. On completion of the test, the candidate must hand over the Answer Sheet to the Invigilator on duty in the Room/Hall. However, the candidates are allowed to take away this Test Booklet with them.
7. Do not fold or make any stray mark on the Answer Sheet

USEFUL DATA

Atomic weights: Al = 27, Mg = 24, Cu = 63.5, Mn = 55, Cl = 35.5, O = 16, H = 1, P = 31, Ag = 108, N = 14, Li = 7, I = 127, Cr = 52, K = 39, S = 32, Na = 23, C = 12, Br = 80, Fe = 56, Ca = 40, Zn = 65.5, Ti = 48, Ba = 137, U = 238, Co = 59, B = 11, F = 19, He = 4, Ne = 20, Ar = 40, Mo = 96, Ni = 58.5, Sr = 87.5, Hg = 200.5, Tl = 204, Pb = 207 [Take : $\ln 2 = 0.69$, $\ln 3 = 1.09$, $e = 1.6 \times 10^{-19}$, $m_e = 9.1 \times 10^{-31}$ kg]
Take $g = 10 \text{ m/s}^2$ unless otherwise stated



JEE (ADVANCED) 2019 PAPER II

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 answer(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

Atomic structure

1. The ground state energy of hydrogen atom is -13.6 eV. Consider an electronic state Ψ of 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 Ψ ? Question ID : 337911184
- (1) It is a $4d$ state
 - (2) The nuclear charge experienced by the electron in this state is less than $2e$, where e is the magnitude of the electronic charge
 - (3) It has 3 radial nodes
 - (4) It has 2 angular nodes
- हाइड्रोजन परमाणु की निम्नतम अवस्था (ground state) की ऊर्जा -13.6 eV है। मान लीजिये कि He^+ की इलेक्ट्रॉनिक अवस्था Ψ की ऊर्जा, दिगंशी क्वांटम संख्या (azimuthal quantum number) तथा चुम्बकीय क्वांटम संख्या (magnetic quantum number) क्रमशः -3.4 eV, 2 और 0 हैं। दिये गये कथनों में से अवस्था Ψ के संदर्भ में सही कथन कौनसा/से है/हैं –
- (1) यह एक $4d$ अवस्था है
 - (2) इस अवस्था में इलेक्ट्रॉन $2e$ से कम नाभिकीय आवेश (nuclear charge) अनुभव करता है, जहाँ e इलेक्ट्रॉनिक आवेश (electronic charge) का परिमाण है।
 - (3) इसमें 3 त्रिज्य नोड (radial node) हैं

(4) इसमें 2 कोणीय नोड (angular node) हैं

Ans 1, 4

$$S. \quad -3.4 = -13.6 \times \frac{Z^2}{n^2}$$

$$-3.4 = -13.6 \times \frac{4}{n^2}$$

$$n = 4$$

$$\ell = 2$$

$$m = 1$$

So electronic state is 4d

→ Since only one electron is present,

nuclear charge is not shielded and nuclear charge experienced by the electron in this state will be 2e.

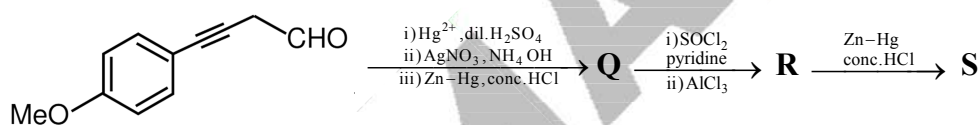
→ No of radial node = $n - \ell - 1$

$$= 4 - 2 - 1 = 1$$

no of angular node = $\ell = 2$

Carbonyl (aldehyde, ketone)

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

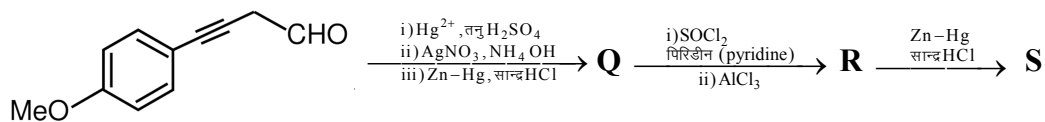


Consider **Q**, **R** and **S** are major products

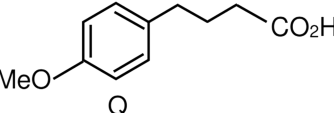
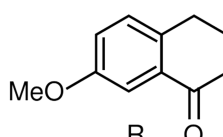
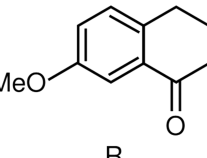
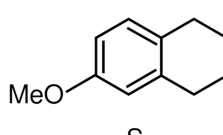
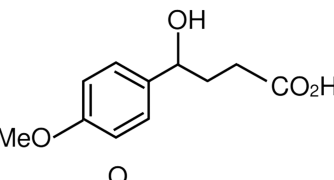
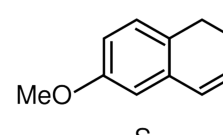
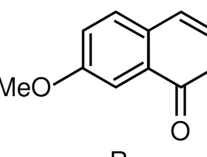
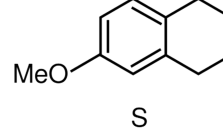
Question ID : 337911187

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

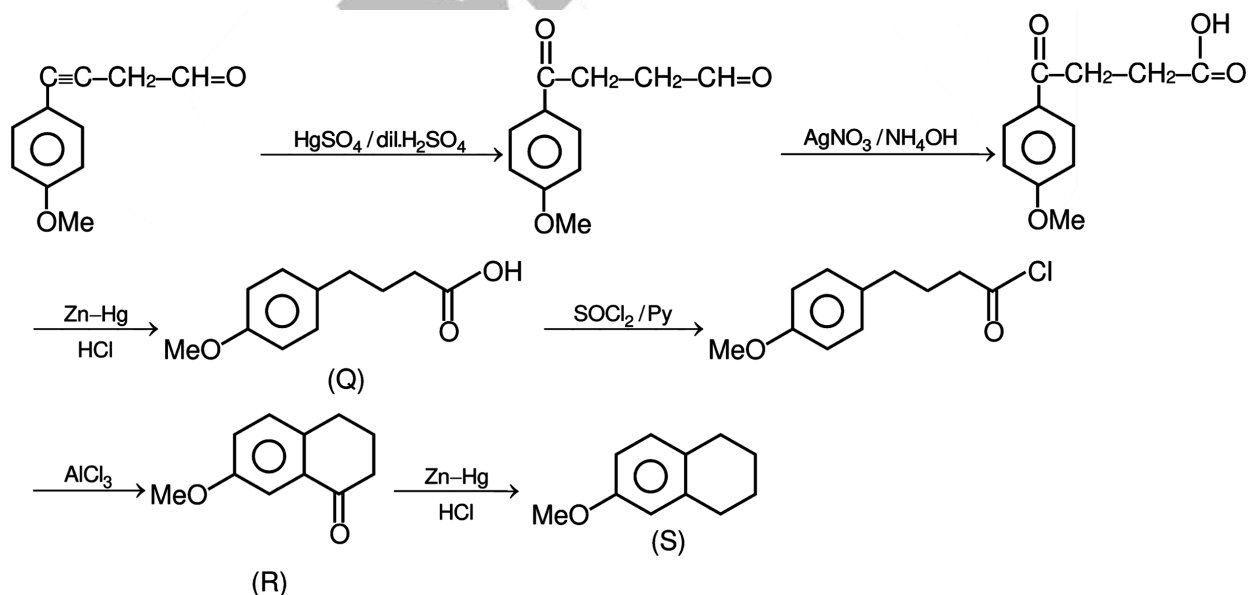
निम्न अभिक्रिया क्रम के लिए सही विकल्प/विकल्पों को चुनिये -



Q, R तथा S को मुख्य उत्पाद माने –

- (1)  
- (2)  
- (3)  
- (4)  

Ans 1, 2



Polymer

3. Choose the correct option(s) from the following

Question ID : 337911188

- (1) Natural rubber is polyisoprene containing *trans* alkene units
 (2) Nylon-6 has amide linkages
 (3) Cellulose has only α -D-glucose units that are joined by glycosidic linkages
 (4) Teflon is prepared by heating tetrafluoroethene in presence of a persulphate catalyst at high pressure
- निम्न में से सही विकल्प/विकल्पों को चुनिये –

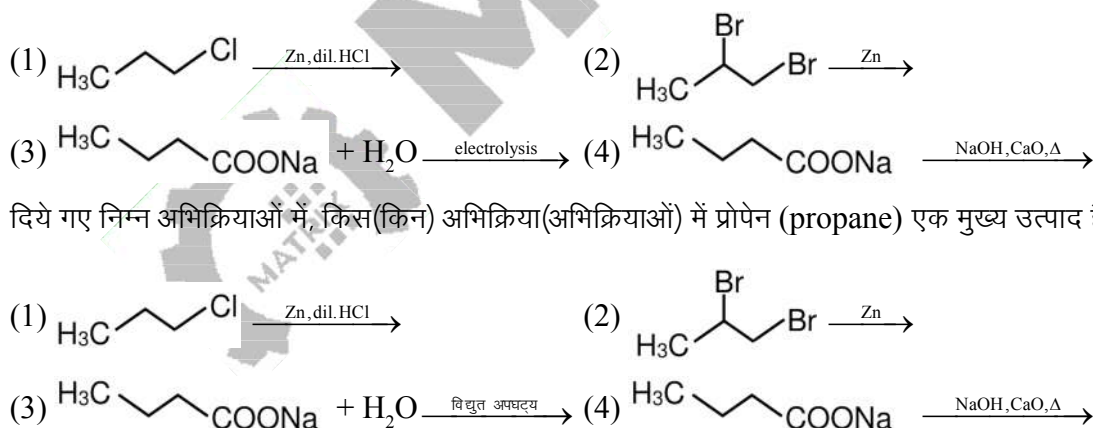
- (1) प्राकृतिक रबर पॉलिआइसोप्रीन (polyisoprene) है जिसमें विपक्ष (*trans*) एल्कीन एकांक होते हैं
 (2) नाइलॉन-6 (nylon-6) में ऐमाइड बंध है।
 (3) सेलुलोज (cellulose) में केवल α -D-ग्लूकोस एकांक हैं जो ग्लाइकोसाइडी बंधनों (glycosidic linkages) द्वारा जुड़े हैं
 (4) टेफलॉन (teflon) को, टेट्राफ्लुओरोएथीन (tetrafluoroethene) को गरम करके, परसल्फेट (persulphate) उत्प्रेरक की उपस्थिति में उच्च दाब पर बनाया जाता है।

Ans 2, 4

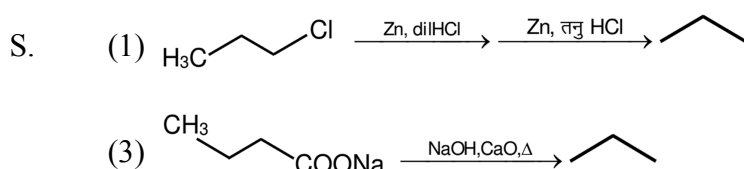
- S. (1) Natural rubber is polyisoprene containing *cis* alkene units.
 (2) Nylon-6 has amide linkages. It is fact.
 (3) Cellulose has only β -D-glucose units that are joined by glycosidic linkages
 (4) Teflon is prepared by heating tetrafluoroethene in presence of a persulphate catalyst at high pressure via radical addition mechanism.

Alkyl halide, alcohol, ether

4. Which of the following reactions produce(s) propane as a major product? **Question ID : 337911185**



Ans 1, 4



p-block

5. With reference to *aqua regia*, choose the correct option(s) **Question ID : 337911182**

- (1) The yellow colour of *aqua regia* is due to the presence of NOCl and Cl_2 .
 (2) *Aqua regia* is prepared by mixing conc. HCl and conc. HNO_3 in 3 : 1 (v/v) ratio.

(3) Reaction of gold with *aqua regia* produces an anion having Au in +3 oxidation state.

(4) Reaction of gold with *aqua regia* produces NO_2 in the absence of air

एक्वारेजिया (*aqua regia*) के संदर्भ में सही विकल्प/विकल्पों का चयन कीजिए –

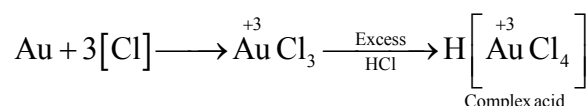
(1) एक्वारेजिया का पीला रंग NOCl और Cl_2 की उपस्थिति के कारण है।

(2) एक्वारेजिया को सांद्रित HCl और सांद्रित HNO_3 के 3 : 1 आयतनिक मात्र (v/v) के मिश्रण से बनाया जाता है।

(3) एक्वारेजिया की सोने के साथ अभिक्रिया पर एक ऋणायन (anion) उत्पादित होता है जिसमें Au की ऑक्सीकरण अवस्था +3 है।

(4) सोने की एक्वारेजिया के साथ हवा की अनुपस्थिति में अभिक्रिया कराने पर NO_2 उत्पादित होता है।

Ans 1, 2, 3



(1) The yellow/organe colour of A.R. is due to dissolved Cl_2 (Chlorine) and NOCl (Nitrosyl Chloride)

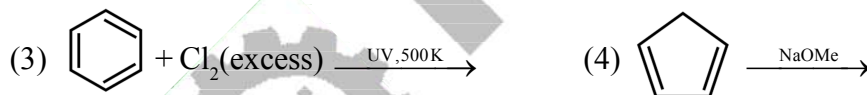
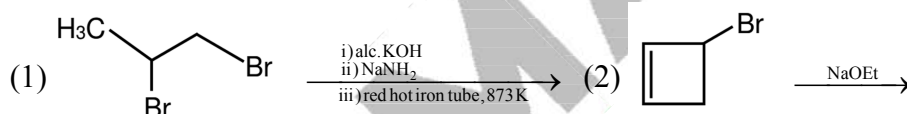
(2) Aqua regia is prepared by mixing Conc. HCl and Conc. HNO_3 in 3 : 1 (v/v) ratio.

(3) In AuCl_3 (or) $\text{H}[\text{AuCl}_4]$, gold has +3 oxidation state.

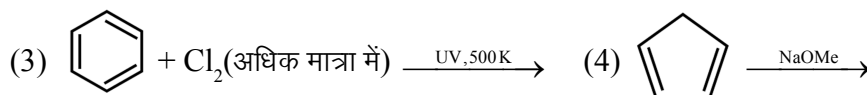
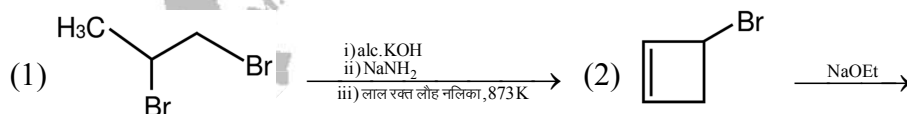
Alkyl halide, alcohol, ether

6. Choose the correct option(s) that give(s) an aromatic compound as the major product

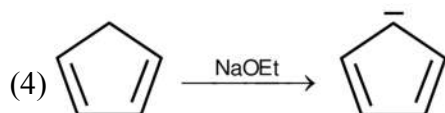
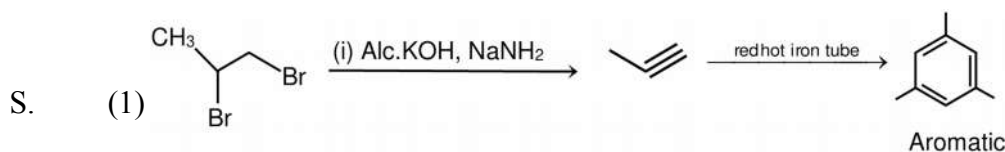
Question ID : 337911186



सही विकल्प/विकल्पों को चुनिये जिसमें/जिनमें ऐरोमैटिक उत्पाद मुख्य है/हैं –



Ans 1, 4



7. 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)

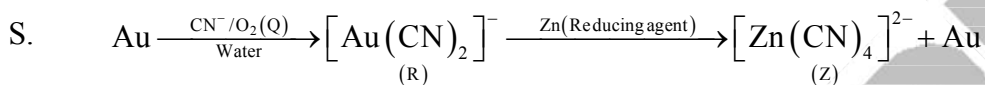
Question ID : 337911181

- (1) **Z** is $[\text{Zn}(\text{CN})_4]^{2-}$ (2) **R** is $[\text{Au}(\text{CN})_4]^-$ (3) **Q** is O_2 (4) **T** is **Zn**

सायनाइड प्रक्रम (cyanide process) से सोने के निष्कर्षण (extraction) में उसके अयस्क से CN^- द्वारा पानी में **Q** की उपस्थिति में निक्षालन (leaching) पर **R** बनता है। इसके पश्चात्, **R** का **T** से विवेचन पर, **Au** और **Z** प्राप्त होते हैं। निम्न में से सही विकल्प/विकल्पों को चुनिये –

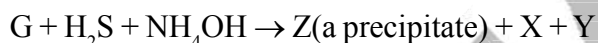
- (1) **Z** है $[\text{Zn}(\text{CN})_4]^{2-}$ (2) **R** है $[\text{Au}(\text{CN})_4]^-$ (3) **Q** है O_2 (4) **T** है **Zn**

Ans 1, 3, 4



Type of reactions

8. Consider the following reaction (unbalanced)



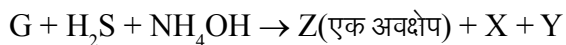
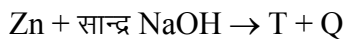
Choose the correct option(s)

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

निम्न अभिक्रियाओं (असंतुलित) पर विचार करें।



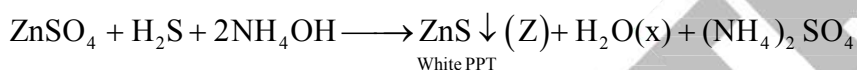
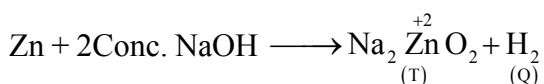
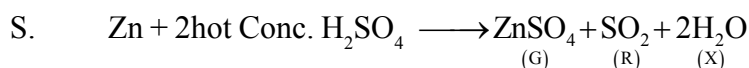
Question ID : 337911183



सही विकल्प/विकल्पों को चुनिये –

- (1) Z का रंग अस्वच्छ श्वेत (dirty white) है।
- (2) R एक V-आकार का अणु है।
- (3) अपनी निम्नतम अवस्था (ground state) में Q का आबन्ध क्रम (bond order) एक है।
- (4) T में Zn की ऑक्सीकरण अवस्था (oxidation state) +1 है।

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 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.

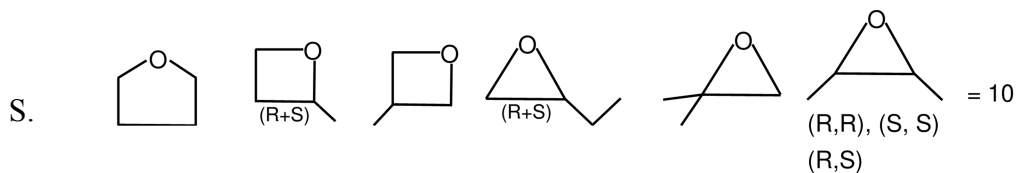
Isomerism

1. Total number of isomers, considering both structural and stereoisomers, of cyclic ethers with the molecular formula $\text{C}_4\text{H}_8\text{O}$ is _____

Question ID : 337911194

संरचनात्मक (structural) और त्रिविम (stereo) समावयवी (isomers) दोनों को मान कर, आण्विक सूत्र $\text{C}_4\text{H}_8\text{O}$ से बने चक्रिय ईथरों (cyclic ethers) के समावयवीयों की कुल संख्या है _____

Ans 10



Mole concept-2

2. 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 _____

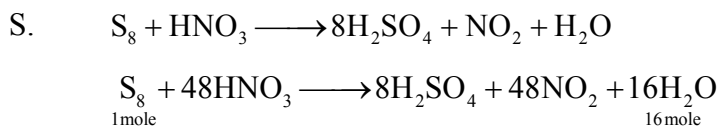
(Given data : Molar mass of water = 18 g mol^{-1})

Question ID : 337911189

1 मोल विषमलंबाक्ष सल्फर (rhombic sulphur) की सान्द्र HNO_3 द्वारा ऑक्सीकरण पर पानी और एक यौगिक, जिसमें सल्फर की ऑक्सीकरण अवस्था उच्चतम है, उत्पादित होता है। उत्पादित पानी की मात्रा (g में) _____ है।

(दिया गया : पानी का मोलर द्रव्यमान 18 g mol^{-1})

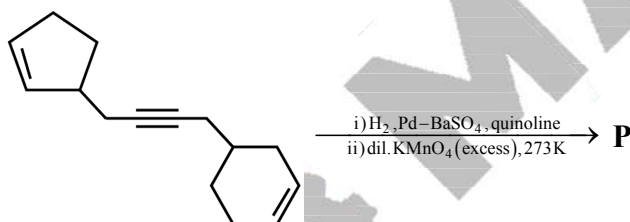
Ans 288 gm



Mass of $\text{H}_2\text{O} = 16 \times 18 = 288 \text{ gm}$

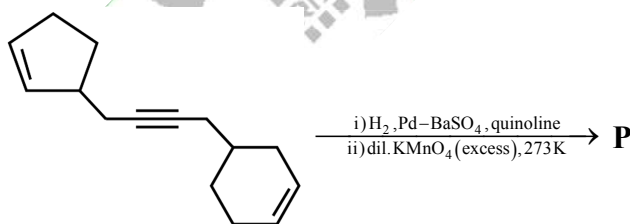
Hydrocarbon(alkane,alkene, alkyne)

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



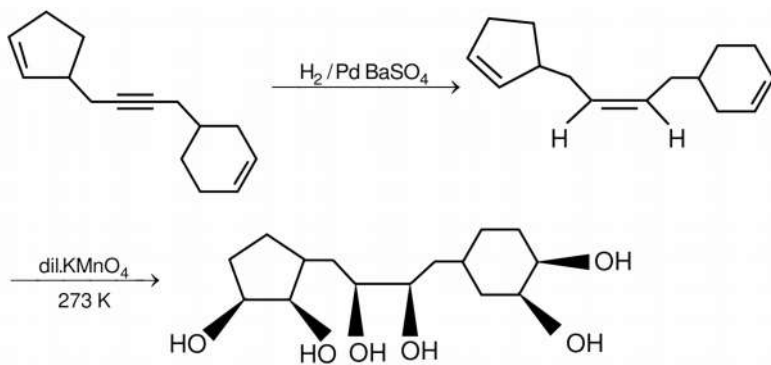
Question ID : 337911193

मुख्य उत्पाद P के एक अणु में हाईड्रोक्सिल समूहों की कुल संख्या _____ है।



Ans 06

S.



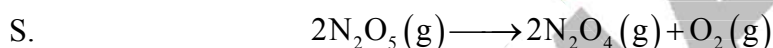
Chemical kinetics

4. 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 _____

Question ID : 337911191

1 atm शुरुआती दबाव पर अपघटन अभिक्रिया $2\text{N}_2\text{O}_5(\text{g}) \xrightarrow{\Delta} 2\text{N}_2\text{O}_4(\text{g}) + \text{O}_2(\text{g})$ को एक बन्द सिलिन्डर में समतापी (isothermal) समआयतनिक (isochoric) अवस्था में शुरू किया गया। $Y \times 10^3$ s के पश्चात्, सिलिन्डर के अन्दर का दबाव 1.45 atm पाया गया। आदर्श गैस व्यवहार मानकर, अगर इस अभिक्रिया का वेग स्थिरांक (rate constant) $5 \times 10^{-4} \text{ s}^{-1}$ है, तब Y का मान है _____

Ans 2.303 sec JEE ANS. 2.3



$$\begin{array}{lcl} t = 0 & 1 & \\ t = Y \times 10^3 \text{ s} & 1 - x & x \quad \frac{x}{2} \end{array}$$

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

$$\frac{x}{2} = 0.45$$

$$x = 0.9$$

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

$$2 \times 5 \times 10^{-1} \times Y = \ln 10$$

$$Y = \frac{2.303}{0.5 \times 2}$$

$$= 2.303 \text{ sec}$$

Mole concept-1

5. 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)

Question ID : 337911192

यूरिया के एक जलीय विलयन में, जिसमें 900 g पानी है, यूरिया का मोल-अंश (mole fraction) 0.05 है। अगर इस विलयन का घनत्व 1.2 g cm^{-3} है, तब इस यूरिया विलयन की मोलरता _____ है।

(दिया गया : यूरिया और पानी के मोलर द्रव्यमान क्रमशः 60 g mol^{-1} और 18 g mol^{-1} हैं।)

Ans 2.985 JEE ANS. 2.98 (2.80 - 3.05)*

S. Let total moles of solution = 1

Moles of Urea = 0.05

Moles of Water = 0.95

Mass of solution = $0.05 \times 60 + 0.95 \times 18$

$$= 3 + 17.1$$

$$= 20.1$$

$$\text{Volume of solution} = \frac{20.1}{1.2} \text{ mL}$$

$$\text{Molarity} = \frac{0.05}{\frac{20.1}{12}} \times 1000 = \frac{50 \times 12}{201} = 2.985$$

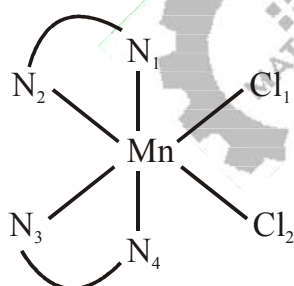
Coordination compound

6. 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*– $[\text{Mn}(\text{en})_2\text{Cl}_2]$ complex is _____ (*en* = $\text{NH}_2\text{CH}_2\text{CH}_2\text{NH}_2$) **Question ID : 337911190**

समपक्ष *cis*– $[\text{Mn}(\text{en})_2\text{Cl}_2]$ कॉम्प्लेक्स (complex) के एक अणु में समपक्षी N–Mn–Cl आबंध कोणों (अर्थात् Mn–N तथा Mn–Cl आबंध समपक्षीय (*cis*) हों) की कुल संख्या है _____ (*en* = $\text{NH}_2\text{CH}_2\text{CH}_2\text{NH}_2$)

Ans 6

S.



Consider, Mn–N and Mn–Cl bonds in *cis* position.



SECTION III (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) 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) $\propto n^{1/2}$

Atomic structure

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

Question ID : 337911196

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

Atomic structure

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

Question ID : 337911195

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

अनुच्छेद में दी गई जानकारी के आधार पर सूचियों का उचित मिलान करके प्रश्न का उत्तर दें।

एक-इलेक्ट्रॉन परमाणु के बोर के मॉडल का विचार कीजिए, जहाँ इलेक्ट्रॉन एक नाभिक के चारों ओर घूम रहा है। निम्न में सूची-I में n^{th} कक्षक के कुछ परिमाण दिये गए हैं तथा सूची-II में उनकी n पर निर्भरता दी गयी है।

List-I

- (I) n^{th} कक्षक की त्रिज्या
(II) n^{th} कक्षक में इलेक्ट्रॉन का कोणीय संवेग
(III) n^{th} कक्षक में इलेक्ट्रॉन की गतिज ऊर्जा
(IV) n^{th} कक्षक के इलेक्ट्रॉन की स्थितिज ऊर्जा

List-II

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

सूची-I और सूची-II का विचार करते हुए निम्न में से किस विकल्प में सही मेल दिया गया है?

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

Ans 1

सूची-I और सूची-II का विचार करते हुए निम्न में से किस विकल्प में सही मेल दिया गया है?

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

Ans 1

S. Radius = $r = 0.529 \frac{n^2}{Z} \text{Å}$

$r \propto n^2$

Angular momentum = $n \frac{h}{2\pi}$
 $\propto n$

K.E. = -T.E.

K.E. = $13.6 \frac{Z^2}{n^2} \text{eV}$

K.E. $\propto n^{-2}$

P.E. = 2T.E.

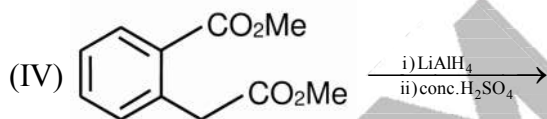
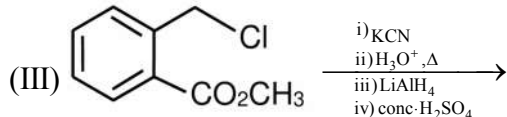
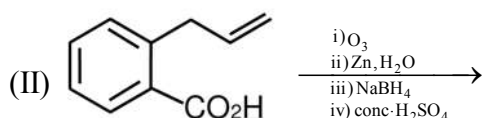
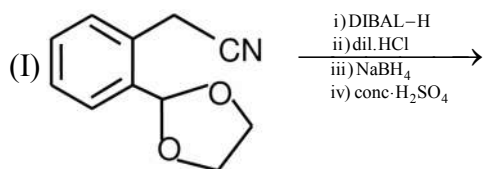
= $-2 \times 13.6 \frac{Z^2}{n^2}$

$$P.E. \propto n^{-2}$$

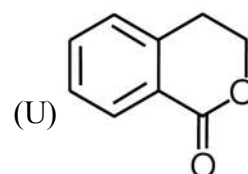
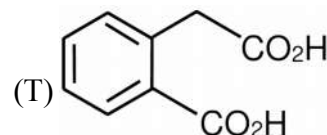
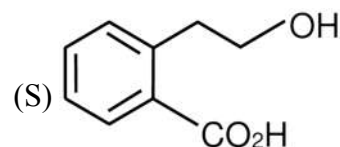
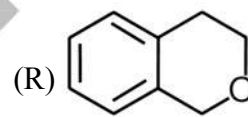
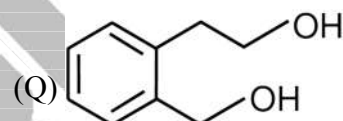
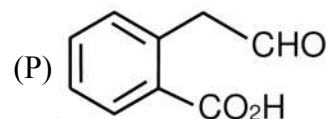
Answer the following by appropriately matching the lists based on the information given in the paragraph.

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



Carbonyl (aldehyde, ketone)

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

Question ID : 337911197

(1) (II), (P), (S), (T)

(2) (II), (P), (S), (U)

(3) (I), (S), (Q), (R)

(4) (I), (Q), (T), (U)

Carbonyl (aldehyde, ketone)

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

Question ID : 337911198

(1) (IV), (Q), (R)

(2) (IV), (Q), (U)

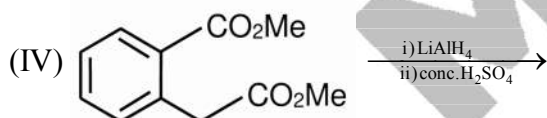
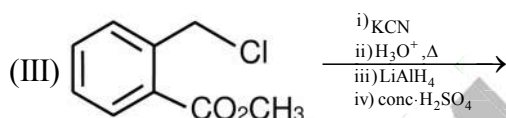
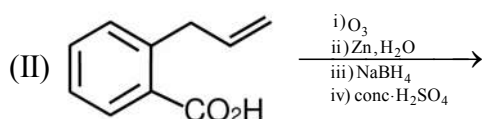
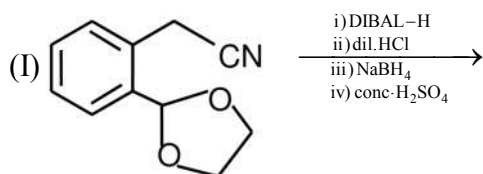
(3) (III), (S), (R)

(4) (III), (T), (U)

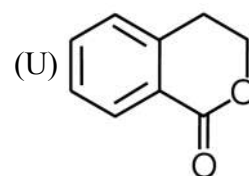
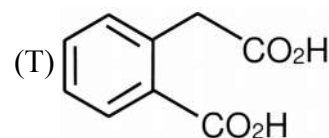
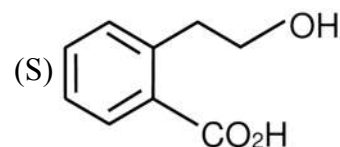
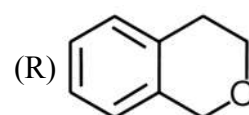
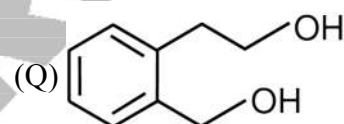
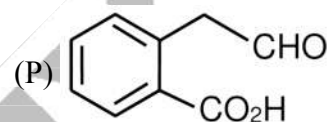
अनुच्छेद में दी गई जानकारी के आधार पर सूचियों का उचित मिलान करके प्रश्न का उत्तर दें।

सूची-I में कुछ चुनिंदा रासायनिक अभिक्रियाओं के प्रारम्भिक पदार्थ तथा अभिकर्मक दिये गए हैं। सूची-II में कुछ यौगिकों की संरचना दी गयी है जो सूची-I की अभिक्रियाओं से मध्यवर्ती उत्पाद एवं/या अंतिम उत्पाद के रूप में निर्मित हो सकते हैं।

List-I



List-II



सूची-I और सूची-II का विचार करते हुए निम्न में से किस विकल्प में सही मेल दिया गया है?

(1) (II), (P), (S), (T)

(2) (II), (P), (S), (U)

(3) (I), (S), (Q), (R)

(4) (I), (Q), (T), (U)

Ans 2

सूची-I और सूची-II का विचार करते हुए निम्न में से किस विकल्प में सही मेल दिया गया है?

(1) (IV), (Q), (R)

(2) (IV), (Q), (U)

(3) (III), (S), (R)

(4) (III), (T), (U)

Ans 1

