

JEE ADVANCED ANSWER KEY

2021

CHEMISTRY
PAPER - 1

QUESTION WITH SOLUTION



32700+ SELECTIONS
SINCE 2007

Motion®

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Online + Offline Mode

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6th October 2021

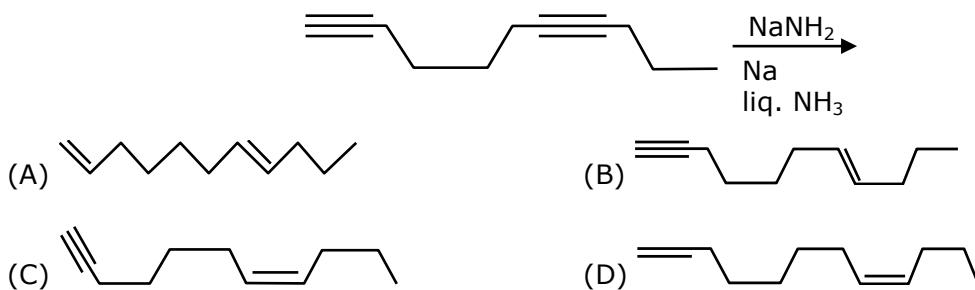
SECTION – 1

- This section contains **FOUR (04)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme:
 Full Marks : +3 If ONLY the correct option 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.

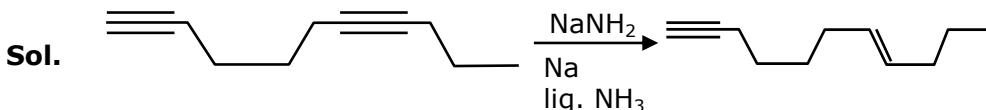
QID: 521094

Alkynes

- Q.1** The major product formed in the following reaction is
 निम्न अभिक्रिया में निर्मित सुख्य उत्पाद है



Ans. B

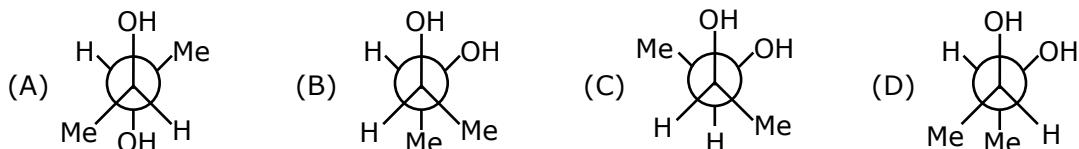


It is Birch reduction reaction, in which alkyne reduces into trans-Alkene.

QID: 521097

Isomerism

- Q.2** Among the following, the conformation that corresponds to the most stable conformation of meso-butane-2,3-diol is
 निम्नलिखित में से संरूपण जो मेसो-ब्यूटेन-2,3-डाई ऑल के सर्वाधिक स्थायी संरूपण से सम्बन्धित है वह है



Ans. B



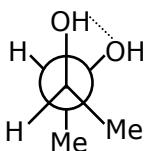
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Sol.



meso-Butane-2,3-diol

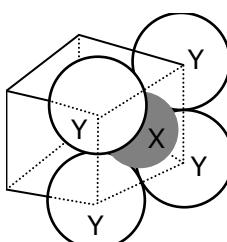
It is stable by intramolecular H-bonding.

QID: 521102

Solid State

- Q.3** For the given close packed structure of a salt made of cation X and anion Y shown below (ions of only one face are shown for clarity), the packing fraction is approximately (packing fraction = $\frac{\text{packing efficiency}}{100}$)

नीचे दर्शाए गए (स्पष्टता के लिए केवल एक फलक के आयन दर्शाए गए हैं) धनायन X तथा ऋणायन Y से बने एक लवण की दी गयी निविड़, संकुलित संरचना के लिए संकुलन प्रभाज लगभग है (संकुलन प्रभाज = $\frac{\text{संकुलन दक्षता}}{100}$)



(A) 0.74

(B) 0.63

(C) 0.52

(D) 0.48

Ans. B

Sol. edge length $a = 2ry$

$$a\sqrt{2} = 2(r_x + r_y)$$

$$\text{P.E.} = \frac{\left[\frac{4}{3} \times \pi r_y^3 + 3 \times \frac{4}{3} \pi r_x^3 \right] \times 100}{a^3}$$

$$\text{P.E.} \geq 52\% \quad \text{P.E.} < 74\% \Rightarrow \text{P.E.} \approx 63\%$$

$$\text{p.F} = 0.63$$

QID: 521106

Coordination

- Q.4** The calculated spin only magnetic moments of $[\text{Cr}(\text{NH}_3)_6]^{3+}$ and $[\text{CuF}_6]^{3-}$ in BM, respectively, are (Atomic numbers of Cr and Cu are 24 and 29, respectively)

(A) 3.87 and 2.84 (B) 4.90 and 1.73 (C) 3.87 and 1.73 (D) 4.90 and 2.84

$[\text{Cr}(\text{NH}_3)_6]^{3+}$ तथा $[\text{CuF}_6]^{3-}$ के चक्रण मात्रा चुम्बकीय आघूर्ण की गणना क्रमशः (BM में) कीजिए (Cr तथा Cu के परमाणु क्रमांक क्रमशः 24 तथा 29 हैं)

(A) 3.87 तथा 2.84 (B) 4.90 तथा 1.73 (C) 3.87 तथा 1.73 (D) 4.90 तथा 2.84

Ans. A



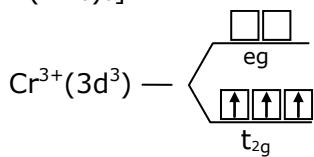
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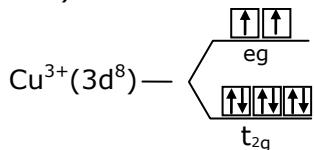


Sol. $[\text{Cr}(\text{NH}_3)_6]^{3+}$



$$n = 3, \mu = \sqrt{15} = 3.87 \text{ BM}$$

$(\text{CuF}_6)^{3-}$



$$n = 2, \mu = \sqrt{8} = 2.84 \text{ BM}$$

Section – 2

- This section contains **THREE (03)** question stems.
- There are **TWO (02)** questions corresponding to each question stem.
- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value corresponding to the answer in the designated place using the mouse and the on-screen virtual numeric keypad.
- 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:

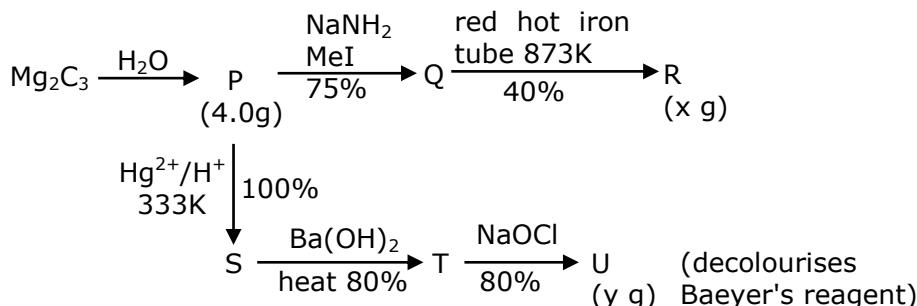
Full Marks : +2 If ONLY the correct numerical value is entered at the designated place;

Zero Marks : 0 In all other cases.

Question Stem for Question Nos. 5 and 6

Question Stem

For the following reaction scheme, percentage yields are given along the arrow:



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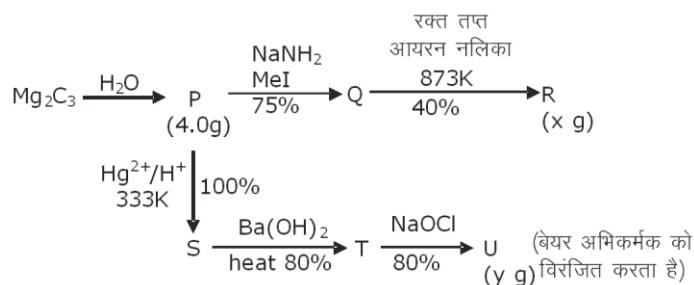
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x g and y g are mass of R and U, respectively.

(Use: Molar mass (in g mol⁻¹) of H, C and O as 1, 12 and 16, respectively)

निम्नलिखित अभिक्रिया आरेख के लिए, तीर के अनुदिश प्रतिशत लक्ष्य दी गयी हैं:



x g तथा y g क्रमशः R तथा U के द्रव्यमान हैं;

(H, C तथा O के लिए मोलर द्रव्यमान (g mol⁻¹ में) क्रमशः 1, 12, 16 हैं)

QID: 521110

Alkynes

Q.5 The value of x is ____.

x का मान ____ है

Ans. 1.62

QID: 521111

Alkynes

Q.6 The value of y is ____.

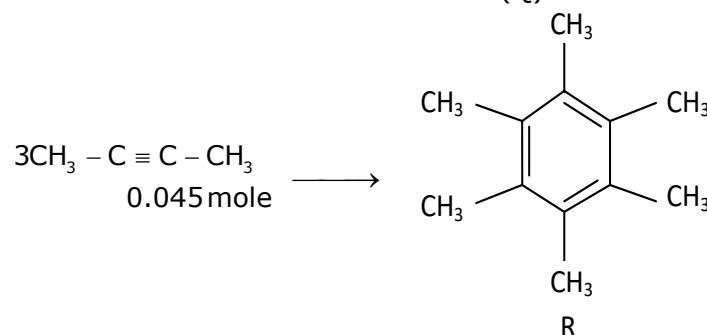
y का मान ____ है

Ans. 3.9

Sol. moles of propyne = $\frac{4}{40} = 0.1$

moles of 2-butyne = $0.1 \times 0.75 = 0.075$

(Q)



$$\frac{0.075}{3} \times 0.4 = 0.01 \text{ mol.}$$

$$\text{wt of R} = 0.01 \times 162 = 1.62 \text{ gm}$$

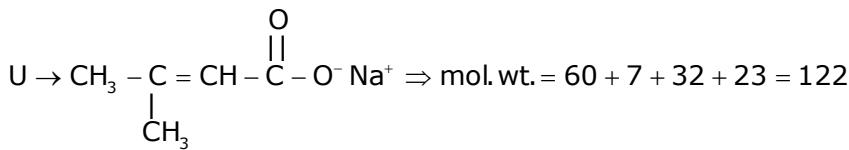
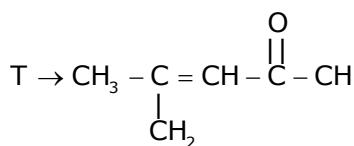


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$$\text{moles of } T = \frac{0.1}{2} \times 0.8 = 0.04$$

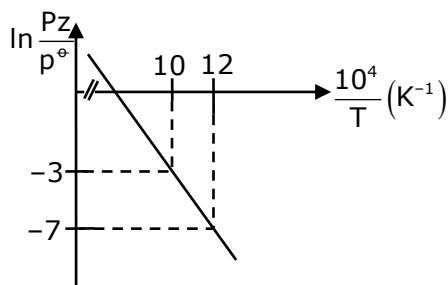
$$\text{moles of } U = 0.04 \times 0.8 = 0.032$$

$$\text{wt of } U = 0.032 \times 122 = 3.9 \text{ gm}$$

Question Stem for Question Nos. 7 and 8

Question Stem

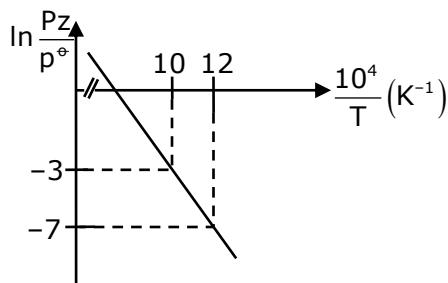
For the reaction, $X(s) \rightleftharpoons Y(s) + Z(g)$, the plot of $\ln \frac{p_z}{p^\ominus}$ versus $\frac{10^4}{T} (\text{K}^{-1})$ is given below (in solid line), where p_z is the pressure (in bar) of the gas Z at temperature T and $p^\ominus = 1 \text{ bar}$.



(Given, $\frac{d(\ln K)}{d\left(\frac{1}{T}\right)} = -\frac{\Delta H^\ominus}{R}$, where the equilibrium constant, $K = \frac{p_z}{p^\ominus}$ and the gas constant, $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$)

अभिक्रिया $X(s) \rightleftharpoons Y(s) + Z(g)$ के लिए, \ln व $\frac{p_z}{p^\ominus}$ के $\frac{10^4}{T}$ मध्य आरेख नीचे दिया गया है (ठोस रेखा में),

जहाँ p_z ताप T पर गैस Z का दाब (बार में) तथा $p^\ominus = 1$ बार है



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(दिया है, $\frac{d(\ln K)}{d\left(\frac{1}{T}\right)} = -\frac{\Delta H^\circ}{R}$, जहाँ साम्य नियतांक, $K = \frac{P_z}{P^\circ}$ तथा गैस नियतांक, $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$)

QID: 521115

Thermochemistry

Q.7 The value of standard enthalpy, ΔH° (in kJ mol^{-1}) for the given reaction is ____.

दी गयी अभिक्रिया के लिए मानक एन्थेली ΔH° (kJ mol^{-1} में) का मान ____ है।

Ans. 166.28

$$\ln k = \frac{-\Delta H}{RT} + \frac{\Delta S^\circ}{R}$$

$$\ln k = \frac{-\Delta H}{RT} \times \frac{10^4}{10^4} + \frac{\Delta S^\circ}{R}$$

$$\text{Slope} = \frac{-\Delta H}{R \times 10^4} = -\frac{4}{2} \Rightarrow \Delta H^\circ = 2R \times 10^4$$

$$\Delta H^\circ = 2 \times 8.314 \times 10 \text{ kJ / mole} = 166.28 \text{ kJ / mol}$$

QID: 521116

Thermochemistry

Q.8 The value of ΔS° (in $\text{J K}^{-1} \text{ mol}^{-1}$) for the given reaction, at 1000 K is ____.

100 K पर दी गयी अभिक्रिया के लिए ΔS° ($\text{J K}^{-1} \text{ mol}^{-1}$ में) का मान ____ है।

Ans. 141.34

Sol. Put the value of $\ln k$ & ΔH°

$$-3 = \frac{-\Delta H^\circ}{R \times 10^4} \times 10 + \frac{\Delta S^\circ}{R}$$

$$= -2 \times 10 + \frac{\Delta S^\circ}{R}$$

$$\frac{\Delta S^\circ}{R} = 17 \Rightarrow \Delta S^\circ = 17 \times R$$

$$= 17 \times 8.314$$

$$= 141.338 \text{ J / mol}$$

$$= 141.34 \text{ J / mol}$$

Question Stem for Question Nos. 9 and 10

Question Stem

The boiling point of water in a 0.1 molal silver nitrate solution (solution A) is $x^\circ\text{C}$. To this solution A, an equal volume of 0.1 molal aqueous barium chloride solution is added to make a new solution B. The difference in the boiling points of water in the two solutions A and B is $y \times 10^{-2} \text{ }^\circ\text{C}$.

(Assume: Densities of the solutions A and B are the same as that of water and the soluble salts dissociate completely.)

Use: Molal elevation constant (Ebullioscopic Constant), $K_b = 0.5 \text{ K kg mol}^{-1}$; Boiling point of pure water as 100°C)



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मोलल सिल्वर नाइट्रोजन का विलयन (विलयन A) में जल का क्वथनांक $x^{\circ}\text{C}$ है। इस विलयन A में 0.1 मोलल जलीय बैनियम क्लोराइड विलयन का तुल्य आयतन मिलाकर एक नया विलयन B बनाया जाता है। दार्ते विलयन A तथा B में जल के क्वथनांक में अन्तर $y \times 10^{-2} ^{\circ}\text{C}$ है।

(माना: विलयन A तथा B के घनत्व जल के घनत्व के समान हैं तथा विलेयशील लवण पूर्ण वियोजित होता है sss मोलल उन्नयन स्थिरांक (क्वथनांकमितीय नियतांक), $K_b = 0.5 \text{ K kg mol}^{-1}$; शुद्ध जल का क्वथनांक 100°C)

QID: 521120

Solution and Colligative Properties

Q.9 The value of x is ____.

x का मान ____ है।

Ans. 100.1

Sol. For solution A (AgNO_3), $i = 2$

$$\Delta T_b = i k_b \times m = 2 \times 0.5 \times 0.1 = 0.1$$

$$\text{the B.P. of solution A is } 100 + \Delta T_b \\ = 100.1^{\circ}\text{C}$$

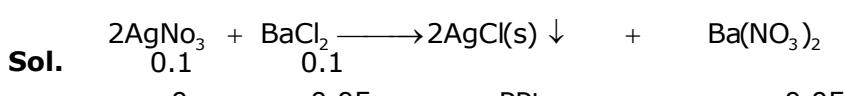
QID: 521122

Solution and Colligative Properties

Q.10 The value of $|y|$ is ____.

$|y|$ का मान ____ है।

Ans. 2.5



$$\text{total moles} = 0.05 \times 3 + 0.05 \times 3 = 0.3 \text{ moles}$$

$$\text{molality} = \frac{0.3}{2} = 0.15$$

$$\Delta T_b = 0.15 \times 0.5 = 0.075$$

$$\text{B.P. of solution B} = 100.075$$

$$\begin{aligned} \text{Difference in B.P. of solution A & solution B} &= 100.1 - 100.075 \\ &= 0.025 \\ &= 2.5 \times 10^{-2} \\ Y &= 2.5 \end{aligned}$$

Section – 3

- This section contains SIX (06) questions.
- Each question has FOUR options (A), (B), (C) and (D). 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;



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Partial Marks : +2 If three or more options are correct but ONLY two options are chosen, 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 unanswered;

Negative Marks : -2 In all other cases.

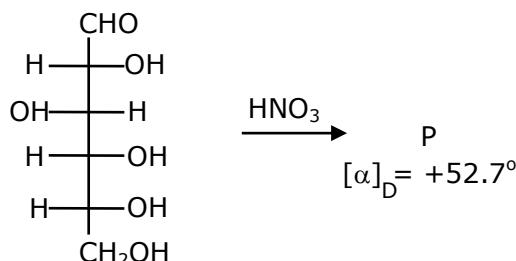
- For example, in a question, if (A), (B) and (D) are the ONLY three options corresponding to correct answers, then
 - choosing ONLY (A), (B) and (D) will get +4 marks;
 - choosing ONLY (A) and (B) will get +2 marks;
 - choosing ONLY (A) and (D) will get +2 marks;
 - choosing ONLY (B) and (D) will get +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(s) (i.e. the question is unanswered) will get 0 marks and choosing any other option(s) will get -2 marks.

QID: 521124

Biomolecules

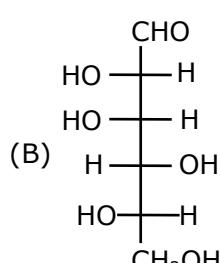
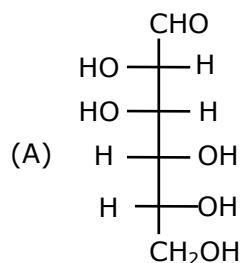
Q.11 Given :

दिया गया है :



The compound(S), which on reaction with HNO_3 will give the product having degree of rotation $[\alpha]_D = -52.7^\circ$ is(are)

यौगिक जो HNO_3 के साथ अभिक्रिया पर घूर्णन कोटि $[\alpha]_D = -52.7^\circ$ वाला उत्पाद देते हैं, वे हैं/हैं

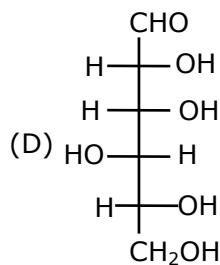
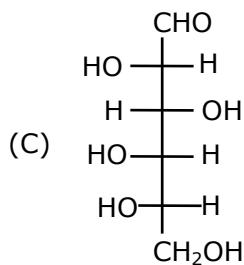


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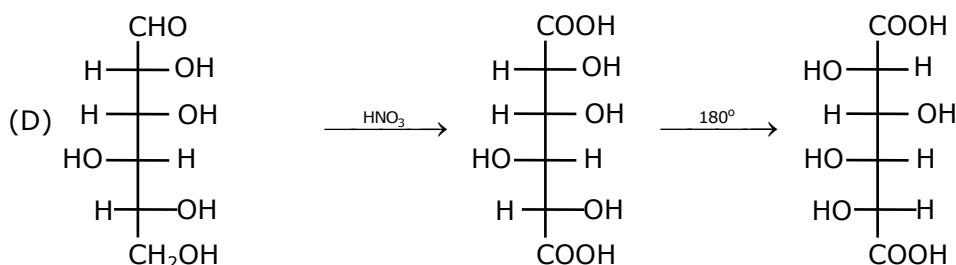
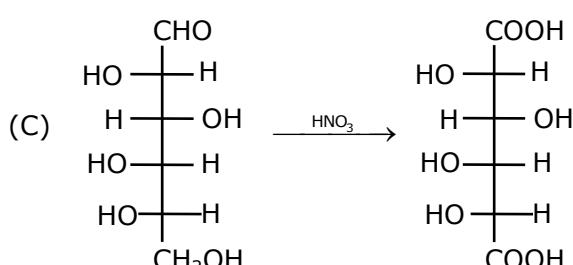
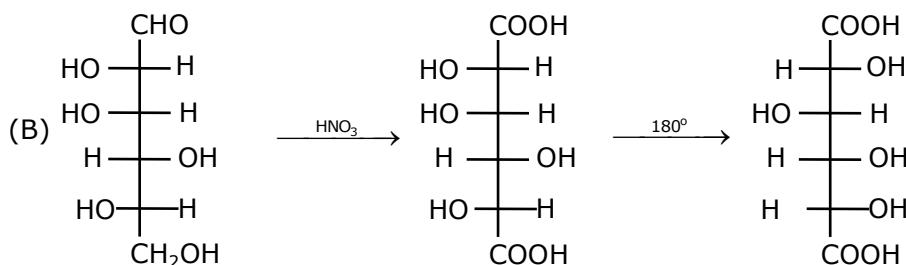
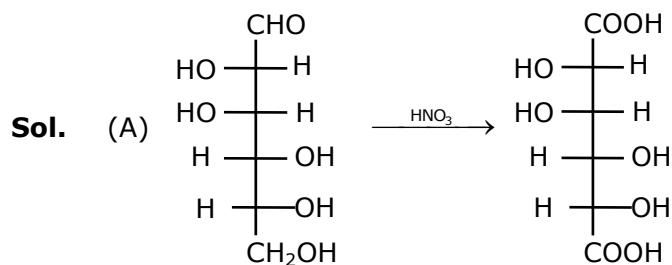
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Ans. CD



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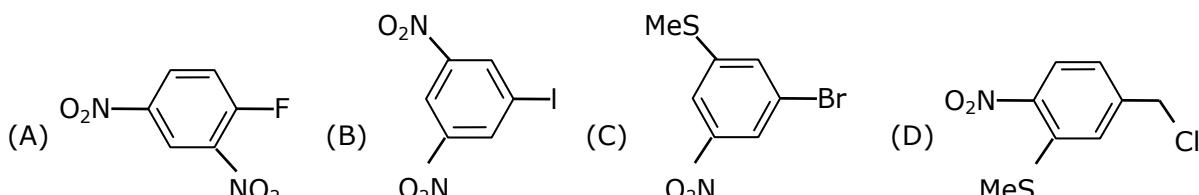
QID: 521129

Aromatic

Q.12 The reaction of **Q** with PhSNa yields an organic compound (major product) that gives positive Carius test on treatment with Na_2O_2 followed by addition of BaCl_2 .

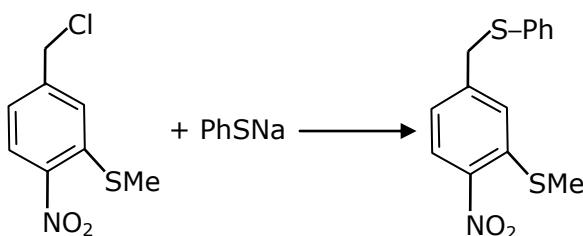
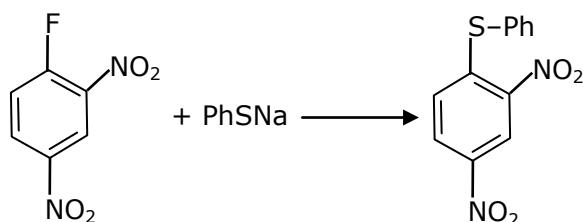
The correct option(s) for **Q** is(are)

Q की PhSNa के साथ अभिक्रिया पर एक कार्बनिक यौगिक (मुख्य उत्पाद) प्राप्त होता है जो Na_2O_2 के साथ उपचार व बाद में BaCl_2 मिलाने पर धनात्मक कर्टियस परीक्षण देता है। **Q** के लिए सही विकल्प हैं/हैं



Ans. AD

Sol.



QID: 521131

Surface Chemistry

Q.13 The correct statement(s) related to colloids is (are)

(A) The process of precipitating colloidal sol by an electrolyte is called peptization.

(B) Colloidal solution freezes at higher temperature than true solution at the same concentration.

(C) Surfactants form micelle above critical micelle concentration (CMC). CMC depends on temperature.

(D) Micelles are macromolecular colloids.

कोलॉयड से सम्बन्धित सही कथन हैं/हैं

(A) विद्युतअपघट्य द्वारा कोलॉयडी सॉल को अवक्षेपित करने का प्रक्रम पेप्टीकरण कहलाता है

(B) समान सांदर्भ वाले कोलॉयडी विलयन वास्तविक विलयन की अपेक्षा ऊच्च ताप पर जमता है



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- (C) पृष्ठ संक्रियक क्रांतिक मिसेल सांदरण (CMC) के ऊपर मिसेल बनाते हैं। CMC ताप पर निर्भर करती है
(D) मिसेल वृहदआणविक कोलॉयड होते हैं

Ans. C

Sol. (A) False

Peptization is a method for the formation of Colloided solution By peptization precipitates are converted into colloidal solution.

(B) False

Concentration is same hence ΔT_f is also same hence freezing point is also same.

(C) True

CMC depend on temperature on ↑ temperature it will first decreases, micelles are formed only at above concentration called CMC

(D) False

Smaller particles aggregate to form micelles hence it is multimolecular.

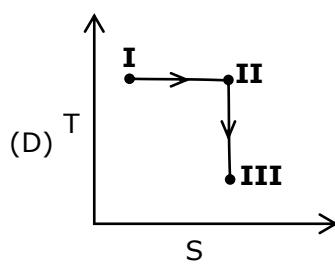
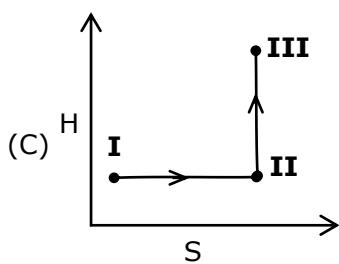
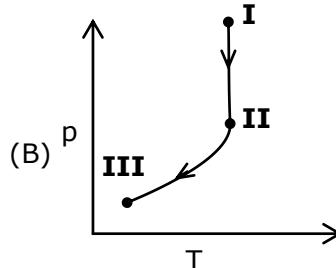
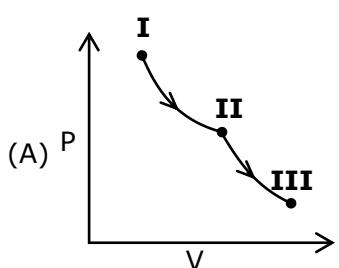
QID: 521132

Thermochemistry

Q.14 An ideal gas undergoes a reversible isothermal expansion from state **I** to state **II** followed by a reversible adiabatic expansion from state **II** to state **III**. The correct plot(s) representing the changes from state **I** to state **III** is(are) (p: pressure, V: volume, T: temperature, H: enthalpy, S: entropy)

एक आदर्श गैस अवस्था **I** से **II** में एक उत्क्रमणीय समतापीय प्रसार से गुजरती है इसके पाचात अवस्था **II** से **III** में एक उत्क्रमणीय रुद्धोष्म प्रसार से गुजरती है। अवस्था **I** से **III** में परिवर्तन को दर्शाने वाला सही वक्र है/हैं—

(p: दाब, V: आयतन, T: ताप, H: एन्थैल्पी, S: एन्ट्रॉपी)



Ans. ABD

Sol. $I \rightarrow II \rightarrow$ reversible, isothermal expansion,

$T \rightarrow$ constant, $\Delta V \rightarrow +ve$, $\Delta S \rightarrow +ve$ $\Delta H \Rightarrow 0$

$II \rightarrow III \rightarrow$ Reversible, adiabatic expansion



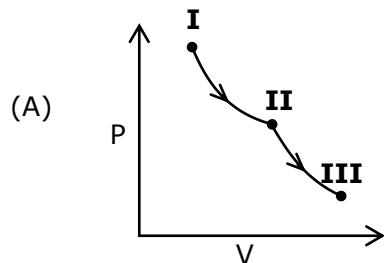
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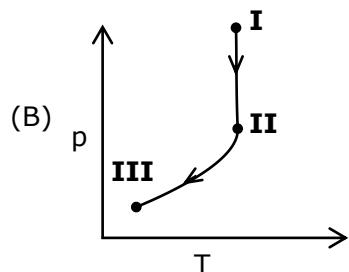
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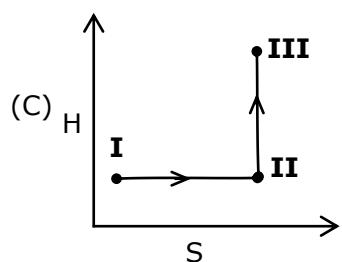
$$Q = 0, \Delta V \rightarrow +ve, \Delta S \rightarrow 0$$



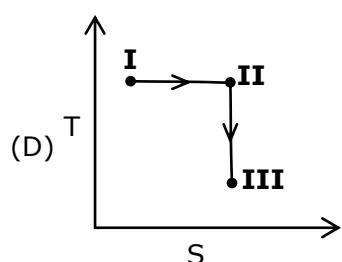
-ve slope – isothermal <adiabatic
I \rightarrow II \rightarrow Isothermal
II \rightarrow III \rightarrow Adiabatic



I \rightarrow II \rightarrow T constant
II \rightarrow III \rightarrow Adiabatic



I \rightarrow II \rightarrow $\Delta S > 0, \Delta H = 0$
II \rightarrow III \rightarrow $\Delta S > 0, \Delta H < 0$



I \rightarrow II \rightarrow $\Delta S > 0, \Delta T = 0$
II \rightarrow III \rightarrow $\Delta S > 0$

QID: 521138

Metallurgy

Q.15 The correct statement(s) related to the metal extraction processes is(are)

- (A) A mixture of PbS and PbO undergoes self-reduction to produce Pb and SO₂.
- (B) In the extraction process of copper from copper pyrites, silica is added to produce copper silicate.
- (C) Partial oxidation of sulphide ore of copper by roasting, followed by self-reduction produces blister copper.
- (D) In cyanide process, zinc powder is utilized to precipitate gold from Na[Au(CN)₂].



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धातु निष्कर्षण प्रक्रम से सम्बन्धित सही कथन है/हैं

- (A) PbS तथा PbO के मिश्रण के स्वतः अपचयन पर Pb तथा SO₂ प्राप्त होता है
- (B) कॉपर पार्इराइट से कॉपर के निष्कर्षण प्रक्रम में, कॉपर सिलिकेट बनाने के लिए सिलिका मिलाया जाता है
- (C) कॉपर के सल्फाइड अयस्क के भर्जन द्वारा आंशिक ऑक्सीकरण व बाद में स्वतः अपचयन पर फफोलेदार (ब्लिस्टर) कॉपर प्राप्त होता है
- (D) सायनाइड प्रक्रम में, Na[Au(CN)₂] से गोल्ड को अवक्षेपित करने के लिए जिंक चूर्ण मिलाया जाता है

Ans. ACD

Sol.

- (A) PbS + 2PbO → 3Pb + SO₂ (Self reduction)
- (B) FeO + SiO₂ → FeSiO₃
Imp. Flux Slag
- (C) CuFeS₂ → Cu₂S + FeS (Roasting)
Cu₂S + O₂ → Cu₂O + SO₂
Cu₂S + 2Cu₂O → 6Cu + SO₂ (Self reduction)
Blister copper
- (D) 2Na[Au(CN)₂] + Zn → Na₂[Zn(CN)₄] + 2Au

QID: 521143

Salt Analysis

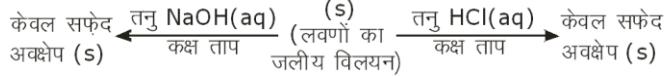
Q.16 A mixture of two salts is used to prepare a solution S, which gives the following results:



The correct option(s) for the salt mixture is(are)

- (A) Pb(NO₃)₂ and Zn(NO₃)₂
- (B) Pb(NO₃)₂ and Bi(NO₃)₃
- (C) AgNO₃ and Bi(NO₃)₃
- (D) Pb(NO₃)₂ and Hg(NO₃)₂

दो लवणों के मिश्रण के उपयोग से विलयन S बनाया जाता है जो निम्नलिखित परिणाम देता है:



लवण मिश्रण के लिए सही विकल्प है/हैं

- (A) Pb(NO₃)₂ तथा Zn(NO₃)₂
- (B) Pb(NO₃)₂ तथा Bi(NO₃)₃
- (C) AgNO₃ तथा Bi(NO₃)₃
- (D) Pb(NO₃)₂ तथा Hg(NO₃)₂

Ans. AB

Sol.

Pb(NO ₃) ₂	$\xrightarrow{\text{dil.NaOH}}$ Pb(OH) ₂ (white ppt) $\xrightarrow{\text{dil.HCl}}$ PbCl ₂ (white ppt)
Zn(NO ₃) ₂	$\xrightarrow{\text{dil.NaOH}}$ Zn(OH) ₂ (white ppt) $\xrightarrow{\text{dil.HCl}}$ ZnCl ₂ soluble
Bi(NO ₃) ₂	$\xrightarrow{\text{dil.NaOH}}$ Bi(OH) ₃ (yellowish white) $\xrightarrow{\text{H}_2\text{O}}$ BiOCl (white ppt)

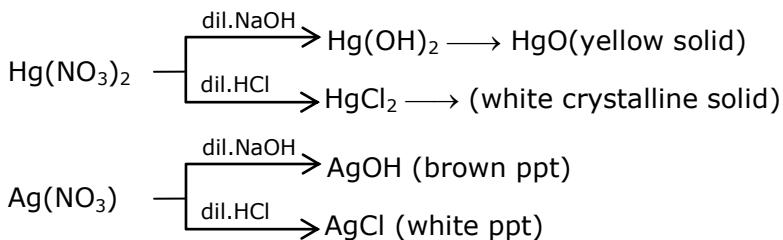


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SECTION 4

- This section contains **THREE (03)** questions.
- The answer to each question is a **NON-NEGATIVE INTEGER**.
- For each question, enter the correct integer corresponding to the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme:
 Full Marks : +4 If ONLY the correct integer is entered;
 Zero Marks : 0 In all other cases.

QID: 521145

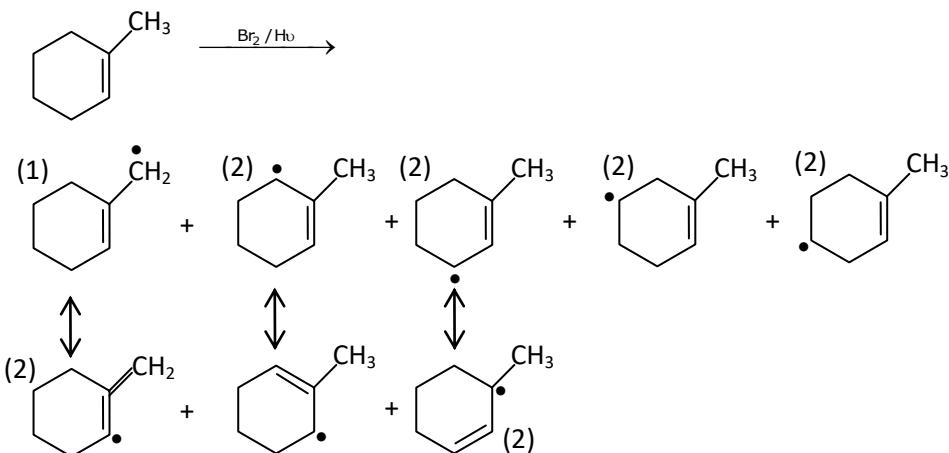
Alkane

- Q.17** The maximum number of possible isomers (including stereoisomers) which may be formed on mono-bromination of 1-methylcyclohex-1-ene using Br_2 and UV light is _____.

Br_2 तथा UV प्रकाश का उपयोग करके 1-मेथिलसाइक्लोहैक्स-1-इन के एकल ब्रोमिनीकरण पर बनने वाले संभव समावयवियों की अधिकतम संख्या है। (त्रिविम समावयवी सहित)

Ans. 13

Sol.



QID: 521147

Alkane

- Q.18** In the reaction given below, the total number of atoms having sp^2 hybridization in the major product P is ____.

नीचे दि गयी अभिक्रिया में मुख्य उत्पाद P में sp^2 संकरण वाले परमाणुओं की कुल संख्या है—

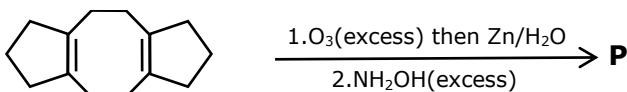


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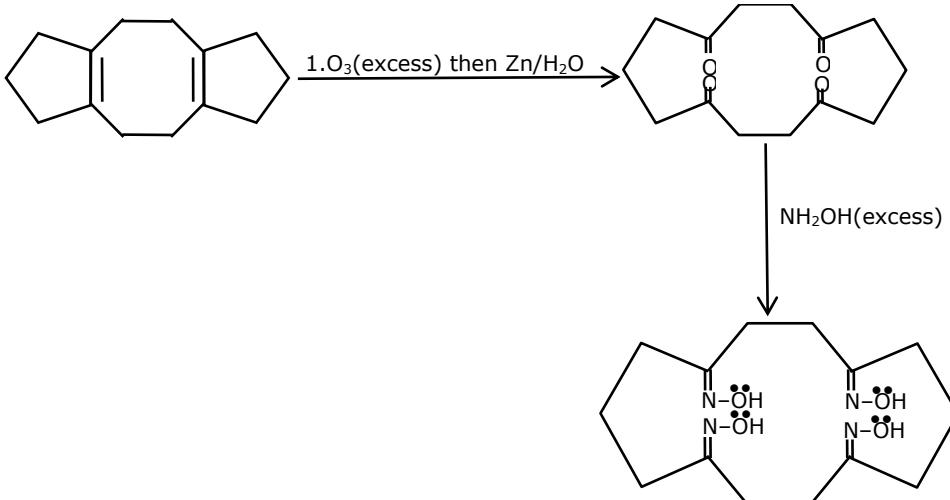
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SS

Ans. 12



Sol.

QID: 521148

Coordination Chemistry

Q.19 The total number of possible isomers for $[\text{Pt}(\text{NH}_3)_4\text{Cl}_2]\text{Br}_2$ is ____.
 $[\text{Pt}(\text{NH}_3)_4\text{Cl}_2]\text{Br}_2$ के लिए संभव समावयवियों की कुल संख्या है ____.

Ans. 6

Sol. $[\text{Pt}(\text{NH}_3)_4\text{Cl}_2]\text{Br}_2 = 2$ (cis and trans)
 $[\text{Pt}(\text{NH}_3)_4\text{ClBr}]\text{ClBr} = 2$ (cis and trans)
 $[\text{Pt}(\text{NH}_3)_4\text{Br}_2]\text{Cl}_2 = 2$ (cis and trans)



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