JEE ADVANCED

ANSWER KEY

2021

CHEMISTRY

PAPER - 1

QUESTION WITH SOLUTION

32700+ SELECTIONS SINCE 2007

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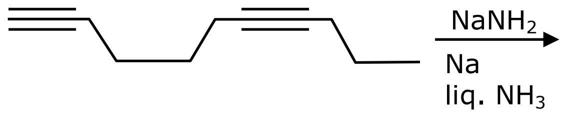
SECTION – 1

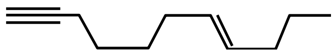
- This section contains **FOUR (04)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated according to the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

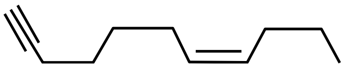
Full Marks : +3 If ONLY the correct option is chosen;
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : −1 In all other cases.

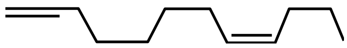
Q.1 The major product formed in the following reaction is



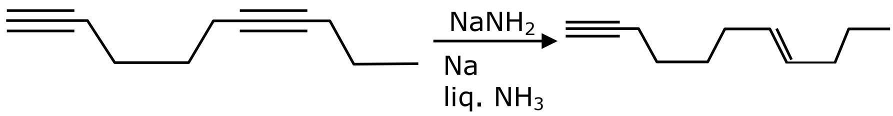
(A) 

(B) 

(C) 

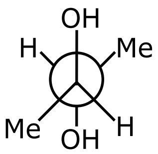
(D) 

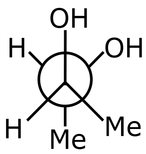
Ans. **B**

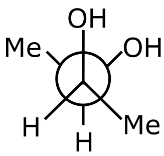
Sol. 

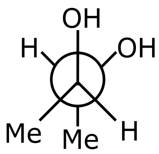
It is Birch reduction reactiobn,in which alkyne reduces into trans-Alkene.

Q.2 Among the following, the conformation that corresponds to the most stable conformation of meso-butane-2,3-diol is

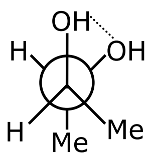
(A) 

(B) 

(C) 

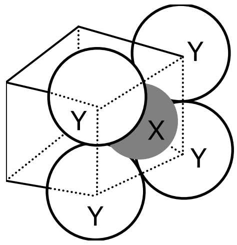
(D) 

Ans. **B**

Sol. 

meso-Butane-2,3-diol
It is stable by instramoleculer H-bonding.

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 = $\frac{\text{packing efficiency}}{100}$)



(A) 0.74 (B) 0.63 (C) 0.52 (D) 0.48

Ans. **B**

Sol. edge length a = $2r_y$

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

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

P.E. $\geq 52\%$ P.E. < 74% $\Rightarrow$ P.E. $\simeq 63\%$

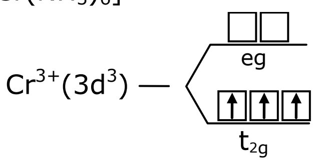
p.F = 0.63

Q.4 The calculated spin only magnetic moments of $[Cr(NH_3)_6]^{3+}$ and $[CuF_6]^{3-}$ 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

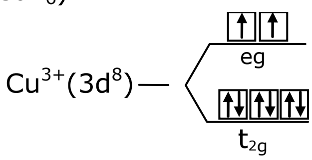
Ans. **A**

Sol. $[Cr(NH_3)_6]^{3+}$



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

$(CuF_6)^{3-}$



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

$$Mg_2C_3 \xrightarrow{H_2O} \underset{(4.0g)}{P} \xrightarrow[75\%]{NaNH_2,\ MeI} Q \xrightarrow[40\%]{\text{red hot iron tube } 873K} \underset{(x\ g)}{R}$$

$$P \xrightarrow[100\%]{Hg^{2+}/H^+,\ 333K} S \xrightarrow[\text{heat } 80\%]{Ba(OH)_2} T \xrightarrow[80\%]{NaOCl} \underset{(y\ g)}{U} \quad \text{(decolourises Baeyer's reagent)}$$

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)

Q.5 The value of x is ___.

Ans. 1.62

Q.6 The value of y is ___.

Ans. 3.9

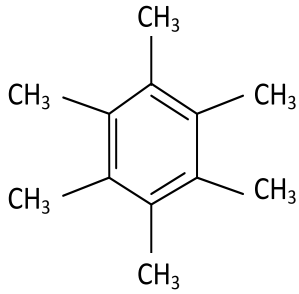
Sol. moles of propyne = $\frac{4}{40} = 0.1$

moles of 2-butyne = 0.1 × 0.75 = 0.075

(Q)

$3CH_3 - C \equiv C - CH_3 \longrightarrow$

0.045 mole



R

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

wt of R = 0.01 × 162 = 1.62 gm

$$T \rightarrow CH_3 - \underset{\underset{CH_2}{|}}{C} = CH - \overset{\overset{O}{||}}{C} - CH$$

$$U \rightarrow CH_3 - \underset{\underset{CH_3}{|}}{C} = CH - \overset{\overset{O}{||}}{C} - O^- Na^+ \Rightarrow \text{mol. wt.} = 60 + 7 + 32 + 23 = 122$$

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

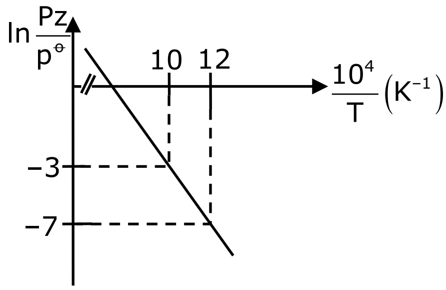
moles of U = 0.04 ×0.8 = 0.032

wt of U = 0.032 × 122 = 3.9 gm

Question Stem for Question Nos. 7 and 8

Question Stem

For the reaction, $\mathbf{X}(s) \rightleftharpoons Y(s) + Z(g)$, the plot of $\ln\frac{p_Z}{p^\ominus}$ versus $\frac{10^4}{T}$ 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 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 J K^{-1} mol^{-1})

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

Ans. **166.28**

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

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

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

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

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

Ans. **141.34**

Sol. Put the value of $\ln k$ & ΔH°

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

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

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

$= 17 \times 8.314$

$= 141.338 \text{ J / mol}$

$= 141.34 \text{ J / mol}$

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°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 × 10^{-2} °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 K kg mol^{-1}; Boiling point of pure water as 100°C)

Q.9 The value of x is ____.

Ans. **100.1**

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

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

the B.P of solution A is 100 + ΔT_b

= 100.1 °C

Q.10 The value of |y| is ___.

Ans. **2.5**

Sol.
$$\underset{\substack{0.1\\0}}{2AgNo_3} + \underset{\substack{0.1\\0.05}}{BaCl_2} \longrightarrow \underset{PPt}{2AgCl(s)\downarrow} + \underset{0.05}{Ba(NO_3)_2}$$

total moles = $0.05 \times 3 + 0.05 \times 3 = 0.3$ moles

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

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

B.P. of solution B = 100.075

Difference in B.P. of solution A & solution B = 100.1 – 100.075

= 0.025

= 2.5×10^{-2}

Y = 2.5

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;

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 +2marks;

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

choosing ONLY (A) will get +1 mark;

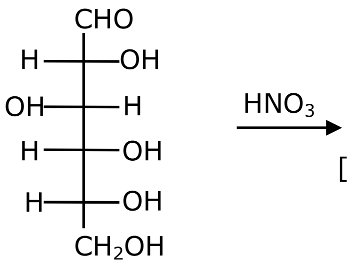
choosing ONLY (B) will get +1 mark;

choosing ONLY (D) will get +1 mark;

choosing no option(s) (i.e. the question is unanswered) will get 0 marks and

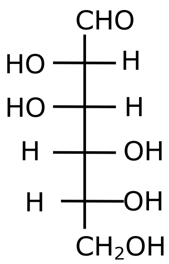
choosing any other option(s) will get −2 marks.

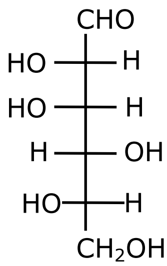
Q.11 Given :

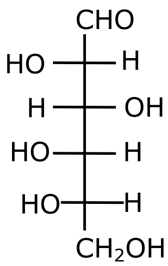


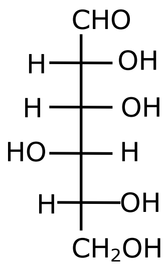
P
$[\alpha]_D = +52.7^\circ$

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

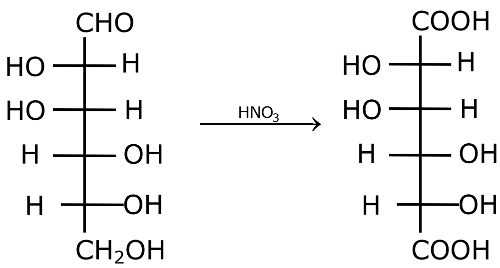
(A) 

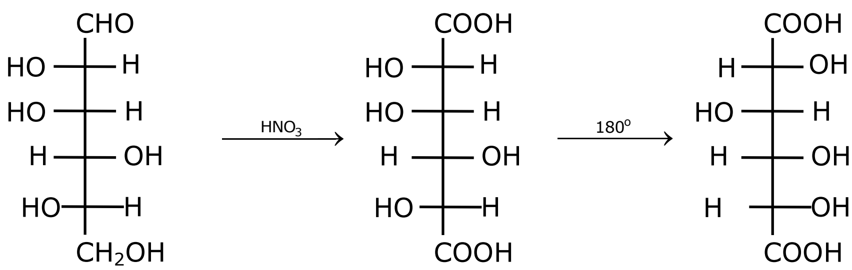
(B) 

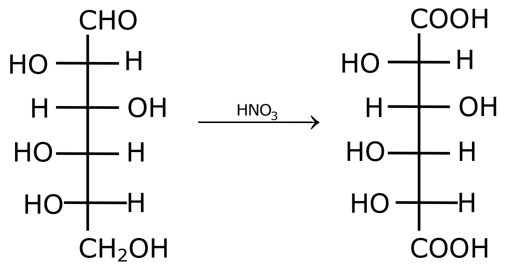
(C) 

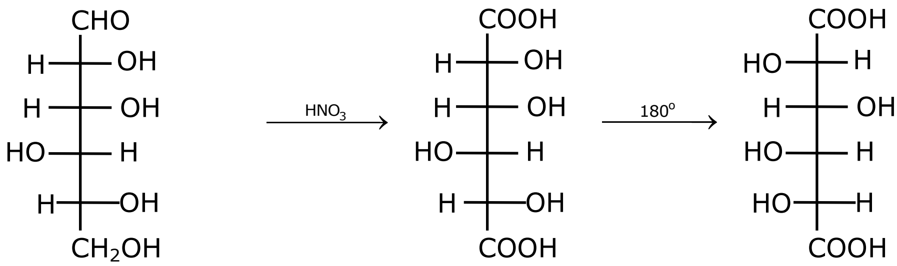
(D) 

Ans. **CD**

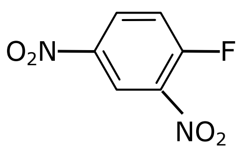
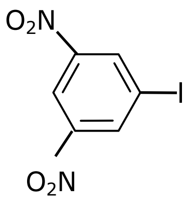
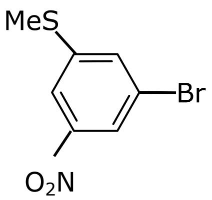
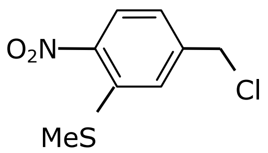
Sol. (A) 

(B) 

(C) 

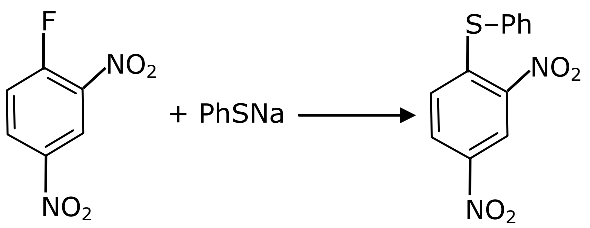
(D) 

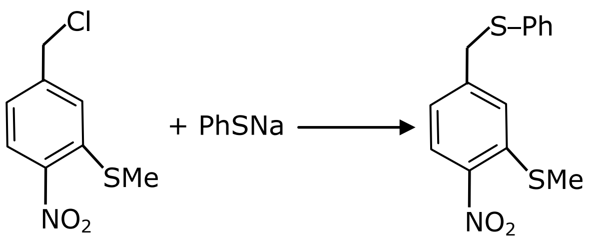
Q.12 The rection of **Q** with PhSNa yields an organic compound (major product) that gives positive Carius test test on treatment with Na_2O_2 followed by addition of $BaCl_2$.
The correct option(s) for **Q** is(are)

(A)  (B)  (C)  (D) 

Ans. AD

Sol.





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.

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.

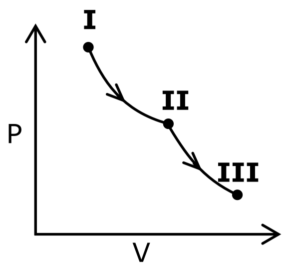
(C) Ture

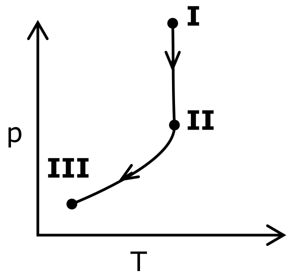
CMC depend on temperature on $\uparrow$ temperature it will first decreases, micelles are formed only at above concentration called CMC

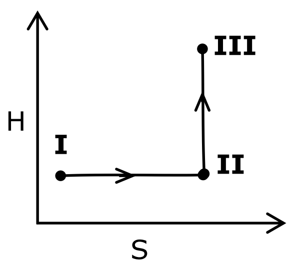
(D) False

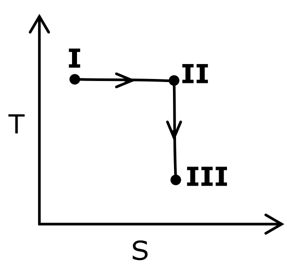
Smaller particles aggregate to form micelles hence it is multimolecular.

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)

(A) 

(B) 

(C) 

(D) 

Ans. **ABD**

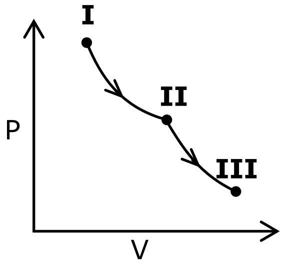
Sol. $I \rightarrow II \rightarrow$ reversible, isothermal expansion,

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

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

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

(A)

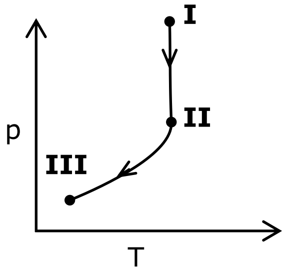


–ve slope – isothemal <adiabatic

$I \rightarrow II \rightarrow$ Isothermal

$II \rightarrow III \rightarrow$ Asdiab atic

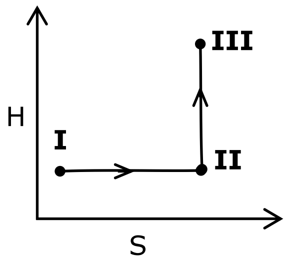
(B)



$I \rightarrow II \rightarrow T$ constant

$II \rightarrow III \rightarrow$ Adiab atic

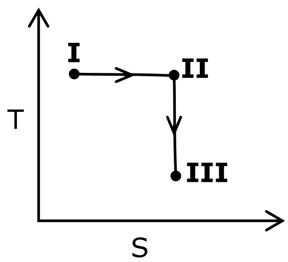
(C)



$I \rightarrow II \rightarrow \Delta S \rightarrow +ve$, $\Delta H \Rightarrow 0$

$II \rightarrow III \rightarrow \Delta S \rightarrow 0$, $\Delta H \rightarrow -ve$

(D)



$I \rightarrow II \rightarrow \Delta S \rightarrow +ve, \Delta T=0$

$II \rightarrow III \rightarrow \Delta S \rightarrow 0$

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 SO_2.

(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 $Na[Au(CN)_2]$.

Ans. **ACD**

Sol. (A) $PbS + 2PbO \longrightarrow 3Pb + SO_2$ (Self reduction)

(B) $\underset{\text{Imp.}}{FeO} + \underset{\text{Flux}}{SiO_2} \longrightarrow \underset{\text{Slag}}{FeSiO_3}$

(C) $CuFeS_2 \longrightarrow Cu_2S + Fes$ (Roasting)

$Cu_2S + O_2 \longrightarrow Cu_2O + SO_2$

$Cu_2S + 2Cu_2O \longrightarrow \underset{\text{Blister copper}}{6Cu} + SO_2$ (Self reduction)

(D) $2Na[Au(CN)_2] + Zn \longrightarrow Na_2\,(Zn(CN)_4) + 2Au$

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

$$\text{White precipitate(s) only} \xleftarrow[\text{Room temperature}]{\text{Dilute NaOH(aq)}} \underset{\text{(aq solution of the salts)}}{S} \xrightarrow[\text{Room temperature}]{\text{Dilute HCl(aq)}} \text{White precipitate(s) only}$$

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

(A) $Pb(NO_3)_2$ and $Zn(NO_3)_2$

(B) $Pb(NO_3)_2$ and $Bi(NO_3)_3$

(C) $AgNO_3$ and $Bi(NO_3)_3$

(D) $Pb(NO_3)_2$ and $Hg(NO_3)_2$

Ans. **AB**

Sol.

$Pb(NO_3)_2 \xrightarrow{\text{dil.NaOH}} Pb(OH)_2$ (white ppt)

$Pb(NO_3)_2 \xrightarrow{\text{dil.HCl}} PbCl_2$ (white ppt)

$Zn(NO_3)_2 \xrightarrow{\text{dil.NaOH}} Zn(OH)_2$ (white ppt)

$Zn(NO_3)_2 \xrightarrow{\text{dil.HCl}} ZnCl_2$ soluble

$Bi(NO_3)_2 \xrightarrow{\text{dil.NaOH}} Bi(OH)_3$ (yellowish white)

$Bi(NO_3)_2 \longrightarrow BiCl_3 \xrightarrow{H_2O} BiOCl$ (white ppt)

$Hg(NO_3)_2 \xrightarrow{\text{dil.NaOH}} Hg(OH)_2 \longrightarrow HgO$(yellow solid)

$Hg(NO_3)_2 \xrightarrow{\text{dil.HCl}} HgCl_2 \longrightarrow$ (white crystalline solid)

$Ag(NO_3) \xrightarrow{\text{dil.NaOH}} AgOH$ (brown ppt)

$Ag(NO_3) \xrightarrow{\text{dil.HCl}} AgCl$ (white ppt)

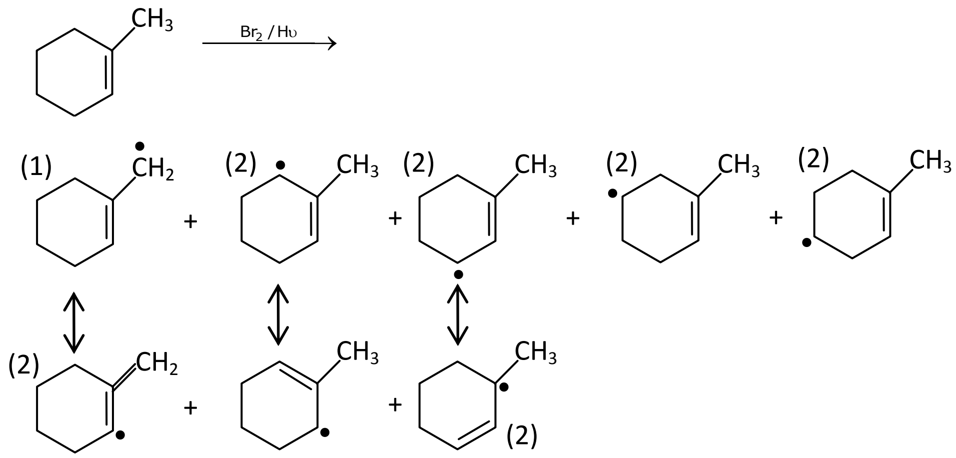
SECTION 4

- 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.

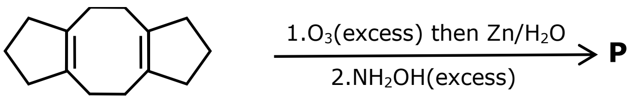
Q.17 The maximum number of possible isomers (including stereoisomers) which may be formed on mono-bromination of 1-methylcyclohex-1-ene using Br_2 and UV light is ______.

Ans. 13

Sol.

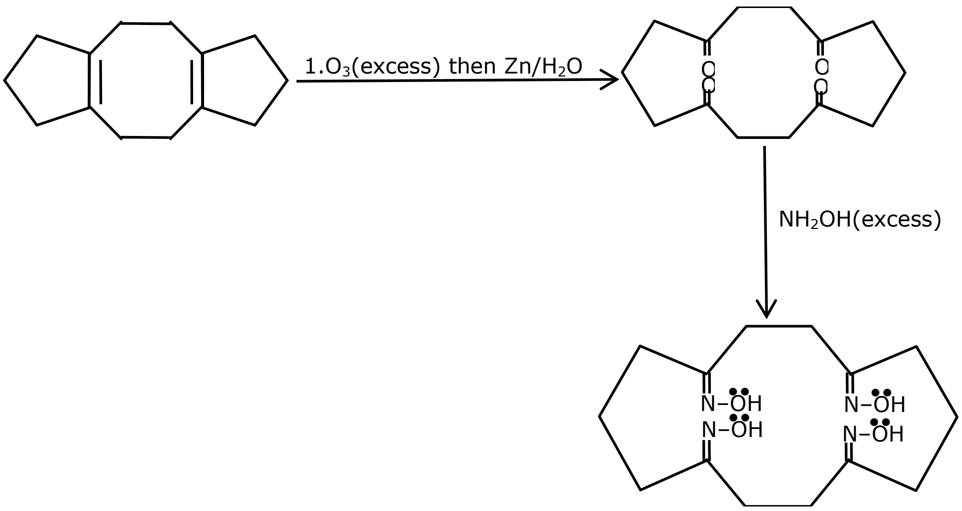


Q.18 In the reaction given below, the total number of atoms having sp^2 hybridization in the major product P is ___.



Ans. **12**

Sol.



Q.19 T he total number of possible isomers for $[Pt(NH_3)_4Cl_2]Br_2$ is ____.

Ans. **6**

Sol. $[Pt(NH_3)_4Cl_2]$ Br_2 = 2 (cis and trans)

$[Pt(NH_3)_4ClBr]$ ClBr = 2 (cis and trans)

$[Pt(NH_3)_4Br_2]$ Cl_2 = 2 (cis and trans)

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