FINAL JEE(Advanced) EXAMINATION - 2021

(Held On Sunday 03rd OCTOBER, 2021)

PAPER-1 | **TEST PAPER WITH SOLUTION**

PART-2 : CHEMISTRY

SECTION-1 : (Maximum Marks : 12)

- 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.

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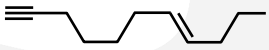
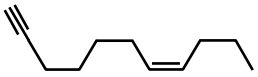
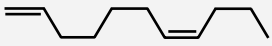
1. The major product formed in the following reaction is

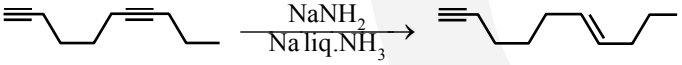
(A) 

(B) 

(C) 

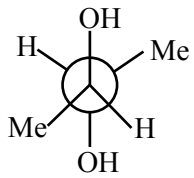
(D) 

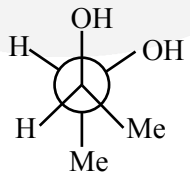
Ans. (B)

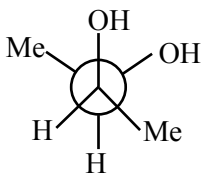
Sol. 

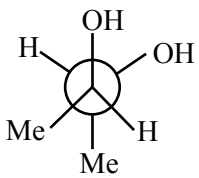
(B) is answer

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

(A) 

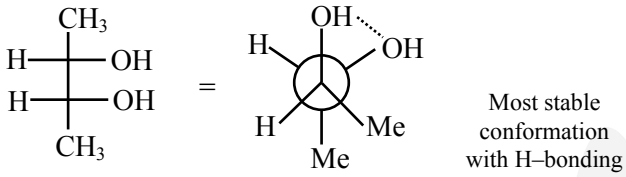
(B) 

(C) 

(D) 

Ans. (B)

Sol.



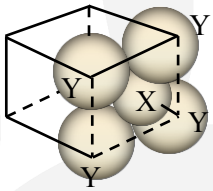
Most stable conformation with H–bonding

Meso butane –2,3,–diol

(B) is the answer

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. Packing fraction (P.F.) $= \frac{1\times\frac{4}{3}\pi r_-^3 + 3\times\frac{4}{3}\pi r_+^3}{a^3}$

$\frac{r_+}{r_-} = 0.414$ (square planar void), $a = 2r_-$

We get,

$$\text{P.F.} = \frac{\frac{4}{3}\pi\left(r_-^3 + 3r_+^3\right)}{8r_-^3}$$

$$= \left[\frac{\pi}{6}\left(1+3\left(0.414\right)^3\right)\right]$$

$$= 0.63$$

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

$Cr^{3+} \Rightarrow [Ar]3d^3$

In presence of NH_3 ligand $\square\square$ e_g

$\boxed{1}\boxed{1}\boxed{1}$ t_{2g}

Number of unpaired electrons = 3

$\mu = \sqrt{n(n+2)}$ B.M.

$\mu = \sqrt{3(3+2)}$ B.M.

$\mu = \sqrt{15}$ B.M.

$\Rightarrow$ 3.87 B.M.

$[CuF_6]^{3-}$

$Cu^{3+} \Rightarrow [Ar]3d^8$

In presence of F^- Ligand

$Cu^{3+} \Rightarrow$ $\boxed{1}\boxed{1}$ e_g

$\boxed{1\downarrow}\boxed{1\downarrow}\boxed{1\downarrow}$ t_{2g}

Number of unpaired electrons = 2

$\mu = \sqrt{n(n+2)}$ B.M.

$\mu = \sqrt{2(2+2)} \Rightarrow \sqrt{8}$ B.M.

$\Rightarrow$ 2.84 B.M

SECTION-2 : (Maximum Marks : 12)

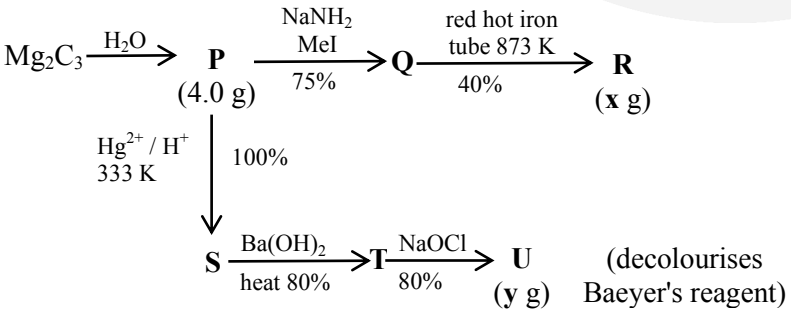
- This section contains **THREE (03)** question stems.
- There are **TWO (02)** questions corresponding to each question stem.
- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value corresponding to the answer in the designated place using the mouse 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 the following reaction scheme, percentage yields are given along the arrow :



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)

5. The value of **x** is_____.

Ans. (1.62)

Sol. $Mg_2C_3 + 4H_2O \rightarrow 2Mg(OH)_2 + CH_3C \equiv CH$

$$CH_3C \equiv CH \xrightarrow{NaMe_2} CH_3 - C \equiv C^-Na^+ \xrightarrow{MeI} CH_3{-}C{\equiv}C{-}CH_3 (0.075\,mmol)$$
(Q)

$$3CH_3 - C \equiv C - CH_3 \xrightarrow[\text{iron tube}\ 873K]{\text{red hot}} \text{benzene}$$
0.75 mole

$(0.075 \times 0.4) \times$

$= 0.01$ mole

The value of x = $162 \times 0.01 = 1.62$ gm

6. The value of **y** is_____.

Ans. (3.2)

Sol. (P) (0.1) mole $\xrightarrow[333K,\ 100\%\ \text{Kucherov reaction.}]{Hg^{2+}/H^+}$ $CH_3{-}\overset{O}{\overset{\|}{C}}{-}CH_3$ (0.01) mole $\xrightarrow{Ba(OH)_2/\Delta}$

$$(H_3C)_2C = CH - \overset{O}{\overset{\|}{C}} - CH_3 \quad \left(0.1 \times \frac{82}{100} \times \frac{1}{2}\right)$$
0.04 mole

$$(H_3C)_2C = CH - \overset{O}{\overset{\|}{C}} - OH + CHCl_3$$

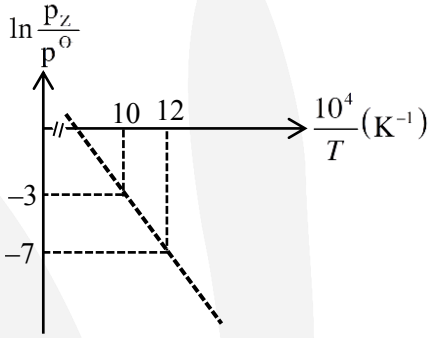
$\left(0.04 \times \frac{80}{100}\right) = 0.032$mole

$60 + 32 + 8 = 100$

The value of Y $= 0.032 \times 100 = 3.2$

Question Stem for Question Nos. 7 and 8

For the reaction $\mathbf{X}(s) \rightleftharpoons \mathbf{Y}(s) + \mathbf{Z}(g)$, 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})

7. The value of standard enthalpy, $\Delta H^\ominus$ (in kJ mol^{-1}) for the reaction is_____ .

Ans. (166.28)

Sol. $\Delta G^\circ = -RT \ln\left(\frac{P}{1}\right) = \Delta H^\circ - T\Delta S^\circ$

$$\ln\left(\frac{P}{1}\right) = -\frac{\Delta H^\circ}{RT} + \frac{\Delta S^\circ}{R}$$

$$\text{Slope} = -\frac{\Delta H^\circ}{R} = 10^4 \times \left(-\frac{4}{2}\right)$$

$\Rightarrow \Delta H^\circ = 2 \times 10^4 \times R$

$= 166.28$ kJ/mole

8. The value of $\Delta S^\ominus$ (in J K^{-1} mol^{-1}) for the given reaction, at 1000 K is_____ .

Ans. (141.33 or 141.34)

Sol. From the plot when, $\frac{10^4}{T} = 10 \Rightarrow T = 1000$ K

$$\ln\left(\frac{P_2}{1}\right) = -3$$

Substituting in equation :

$$\ln\left(\frac{P_2}{1}\right) = -\frac{\Delta H^\circ}{RT} + \frac{\Delta S^\circ}{R}$$

We get,

$$-3 = -\frac{2\times10^4 \times R}{R\times1000} + \frac{\Delta S^\circ}{R}$$

$\Rightarrow \Delta S^\circ = 17R$

$\Rightarrow \Delta S^\circ = 17 \times 8.314$ J/K-mol

$\Rightarrow \Delta S^\circ = 141.34$ J/K-mol

Question Stem for Question Nos. 9 and 10

The boiling point of water in a 0.1 molal silver nitrate solution (solution **A**) is **x** ºC. 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** $\times 10^{-2}$ ºC.

(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 100ºC.)

9. The value of **x** is _____.

Ans. **(100.10)**

Sol. $AgNO_3(aq) \longrightarrow Ag^+(aq) + NO_3^-(aq)$

0.1 m 0.1 m

$\Delta T_b = 0.2 \times 0.5$

$= 0.1°C = 0.1$ K

Boiling point of solution = 100.1°C

= X

10. The value of |**y**| is _____ .

Ans. **(2.50)**

Sol. $AgNO_3(aq) \longrightarrow Ag^+(aq) + NO_3^-(aq)$

0.05 m 0.05 m 0.05 m

$BaCl_2(aq) \longrightarrow Ba^{2+}(aq) + 2Cl^-(aq)$

0.05 m 0.05 m 0.1 m

Ag^+ and Cl^- combine to form AgCl precipitate

	$Ag^+(aq)$	+	$Cl^-(aq)$	$\longrightarrow$	AgCl(s)
t = 0	0.05 m		0.1 m		
t = ∞	0		0.05 m		

In final solution total concentration of all ions :

$[Cl^-]+[NO_3^-]+[Ba^{2+}] = 0.05+0.05+0.05$

= 0.15 m

$\Delta T_b = 0.5 \times 0.15$

= 0.075 °C

B.P. of solution 'B' = 100.075°C

B.P. of solution 'A' = 100.1°C

|y| = 100.1 – 100.075

$= 0.025 = 2.5 \times 10^{-2}$

SECTION-3 : (Maximum Marks : 24)

- 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 <u>according to the following marking scheme</u>:

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 +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.

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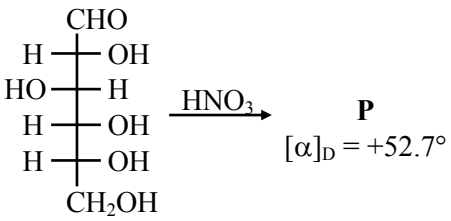
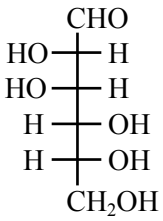
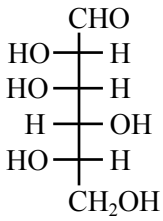
11. Given

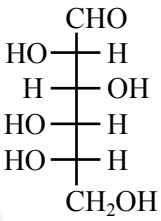


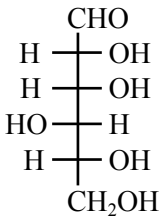
D-Glucose

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

(A) 

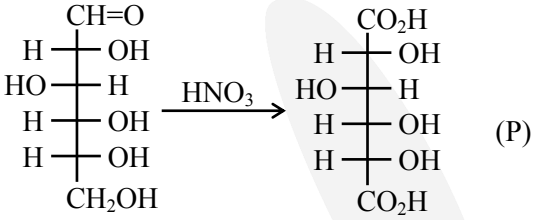
(B) 

(C) 

(D) 

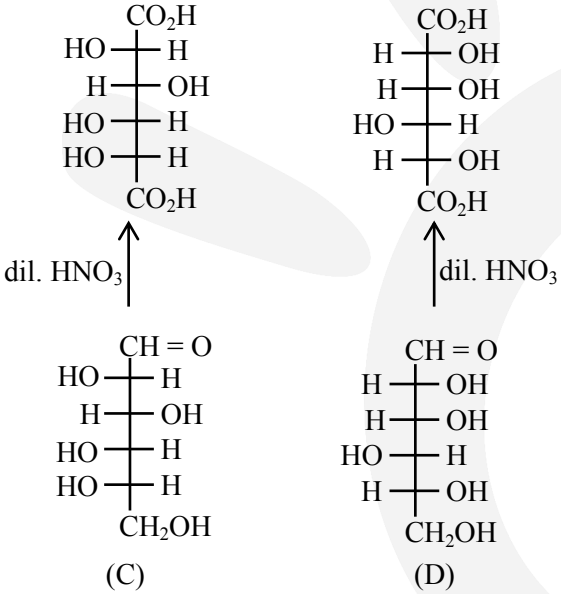
Ans. (C,D)

Sol.

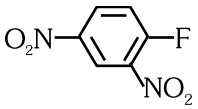


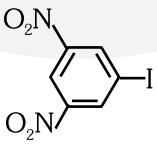
$[\alpha]_D = 52.7°$

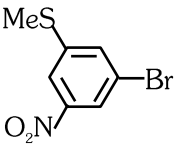
The enantiomer of P has rotation –52.7° is as follows

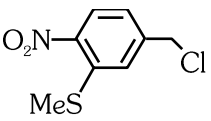


12. The reaction of **Q** with PhSNa yields an organic compound (major product) that gives positive Carius test on treatment with Na_2O_2 followed by addition of $BaCl_2$. The correct option(s) for **Q** is (are).

(A) 

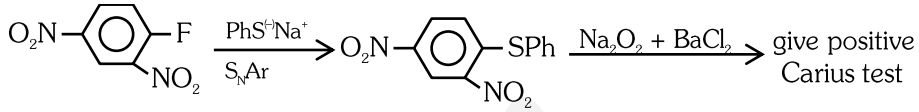
(B) 

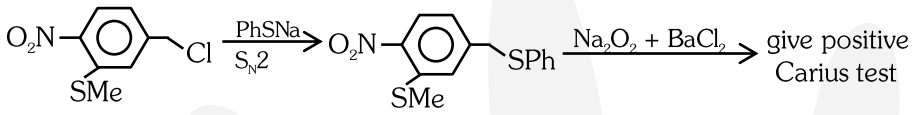
(C) 

(D) 

Ans. (A,D)

Sol.

(A) 

(D) 

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 the 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. (B,C)

Sol. (A) Process of precipitating colloidal solution is called coagulation. Hence false.

(B) For colloidal solutions concentration is very small due to very large molar mass and hence their colligative properties are very small as compared to true solutions

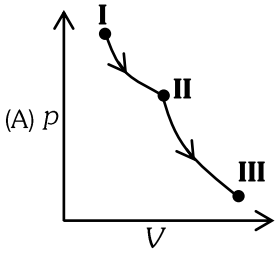
$\therefore \Delta T_f$ is lesser for colloidal solution. Hence true.

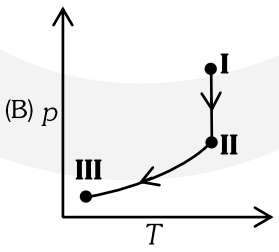
(C) At CMC surfactant form micelles. Hence true

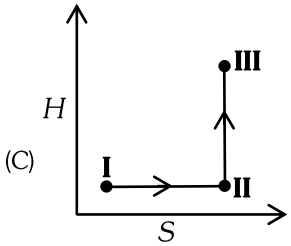
(D) Micelles and macromolecular colloids are two different types of colloids. Hence false.

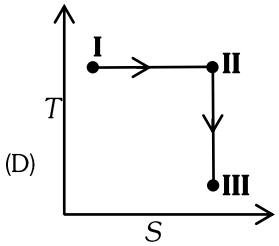
14. An ideal gas undergoes a reversible isothermal expansion from state **I** to state **II** followed by a reversible adiabatic expansion from state **II** to state **III**. The correct plot(s) representing the changes from state **I** to state **III** is(are)

(p : pressure, V : volume, T : temperature, H : enthalpy, S : entropy)









Ans. (A,B,D)

Sol. From state I to II (Reversible isothermal expansion)

$\Rightarrow$ P decreases, V increases, T constant

H constant & S increases.

From state II to III (Reversible adiabatic expansion)

$\Rightarrow$ P decreases, V increases, T decreases

H decreases, S constant

$\therefore$ Plots (A), (B), (D) are correct while (C) is wrong as from II to III, H is decreasing.

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. (A,C,D)

Sol. (A) $PbS + 2PbO \rightarrow 3Pb + SO_2$ (self reduction)

(B) Silica is added to remove impurity of Fe in the form of slag $FeSiO_3$

(C) $CuFeS_2$ ore is partially oxidized first by roasting and then self reduction of Cu takes place to produce blister copper.

(D) $4\,Na\overset{+1}{[Au}\,(CN)_2] + \underset{\text{Reducing Agent}}{2\,Zn} \longrightarrow 2\,Na_2\overset{+2}{[Zn}(CN)_4] + 4\,\overset{0}{Au}$

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

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

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. (A,B)

Sol. $Pb(NO_3)_2 \xrightarrow{dil.HCl} \underset{\text{White PPt.}}{PbCl_2}\downarrow$

$Bi(NO_3)_3 \xrightarrow{dil.HCl} \underset{\text{Water Soluble}}{BiCl_3}$

$Hg(NO_3)_2 \xrightarrow{dil.HCl} \underset{\text{Water Soluble}}{HgCl_2}$

$AgNO_3 \xrightarrow{dil.HCl} \underset{\text{White PPt.}}{AgCl}\downarrow$

$Zn(NO_3)_2 \xrightarrow{dil.HCl} \underset{\text{Water Soluble}}{ZnCl_2}$

$Pb(NO_3)_2 \xrightarrow{NaOH(dil.)} \underset{\text{White PPt.}}{Pb(OH)_2}\downarrow$

$Zn(NO_3)_2 \xrightarrow{NaOH(dil.)} \underset{\text{White PPt.}}{Zn(OH)_2}\downarrow$

$Bi(NO_3)_3 \xrightarrow{NaOH(dil.)} \underset{\text{White PPt.}}{Bi(OH)_3}\downarrow$

$AgNO_3 \xrightarrow{NaOH(dil.)} \underset{\text{Brown PPt.}}{Ag_2O}$

$Hg(NO_3)_2 \xrightarrow{NaOH(dil.)} \underset{\text{Yellow PPt.}}{HgO}\downarrow$

SECTION-4 : (Maximum Marks : 12)

- 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.

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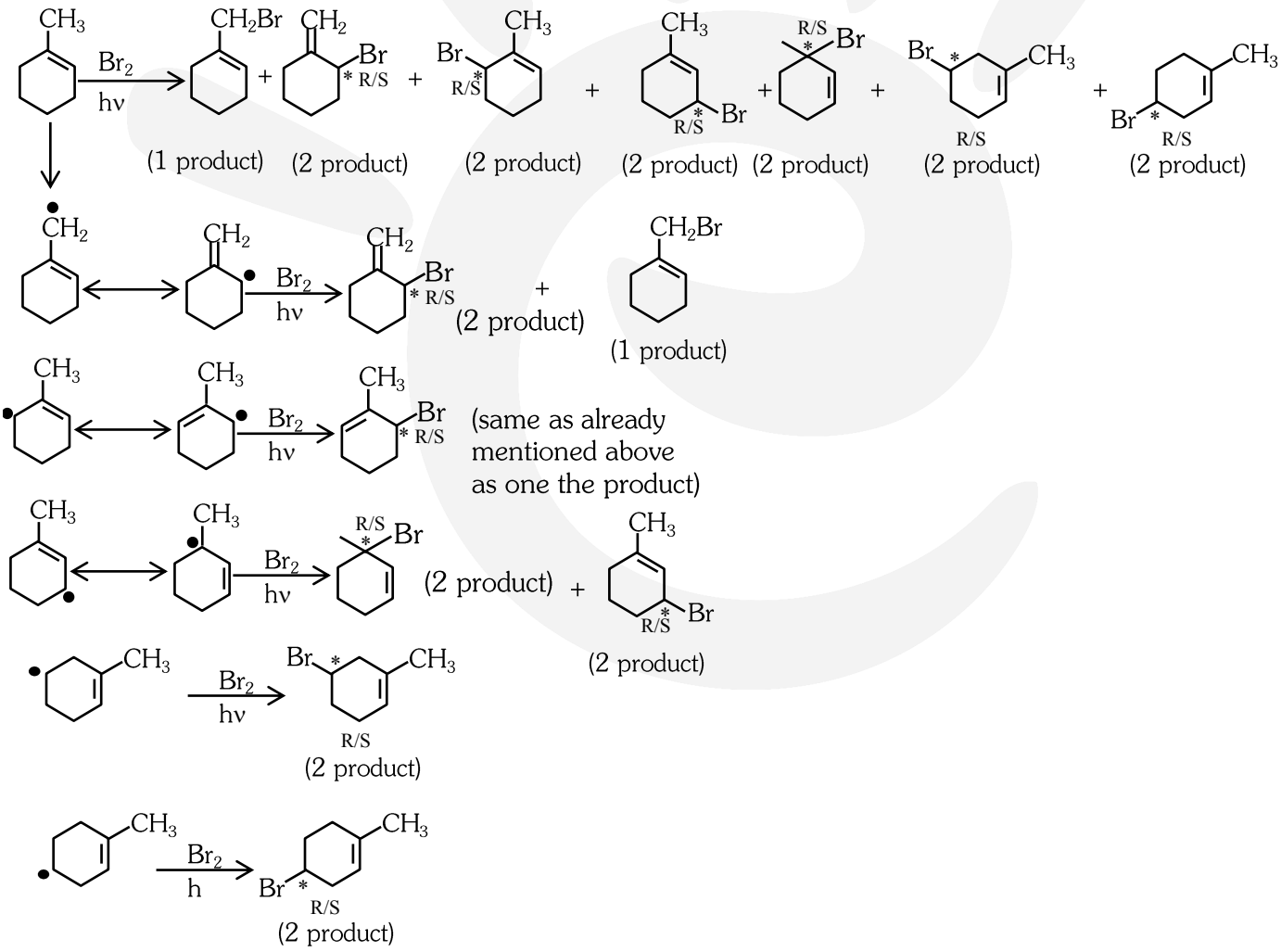
17. The maximum number of possible isomers (including stereoisomers) which may be formed on *mono*-bromination of 1-methylcyclohex-1-ene using Br_2 and UV light is ____

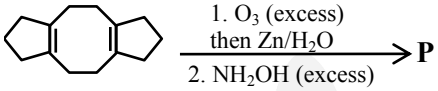
Ans. (13)

Sol.



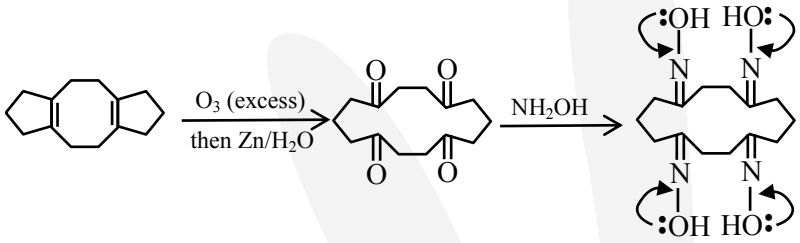
Total 13 product

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



Ans. (12)

Sol.



Total 12 atoms are sp^2 hybridised

19. The total number of possible isomers for $[Pt(NH_3)_4Cl_2]Br_2$ is _____

Ans. (6)

Sol. Isomers

(I) $[Pt(NH_3)_4Cl_2]Br_2 \Rightarrow$ G.I. = 2

(II) $[Pt(NH_3)_4Br_2]Cl_2 \Rightarrow$ G.I. = 2

(III) $[Pt(NH_3)_4BrCl]Br.Cl \Rightarrow$ G.I. = 2

I, II, III are ionisation isomers of each other, each having 2 geometrical isomers.

Total possible isomers will be 6