

QUESTIONS & ANSWER KEYS FOR JEE (ADVANCED)-2021(PAPER 1)

[CHEMISTRY]

SECTION 1

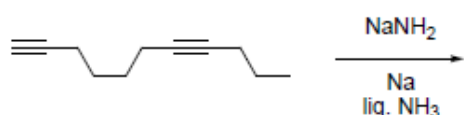
- This section contains **SIX** (04) questions
- Each question **FOUR** option (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following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

Full Marks : +3 If ONLY the correct options 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



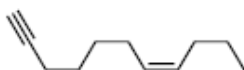
(A)



(B)



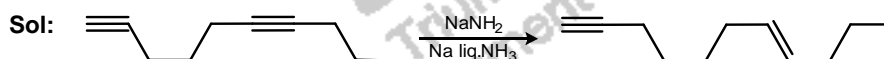
(C)



(D)

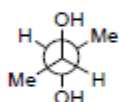


Answer Key (B)

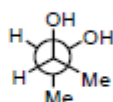


Q.2 Among the following, the conformation that corresponds to the most stable conformation of *meso*-butane-2,3-diol is

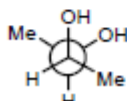
(A)



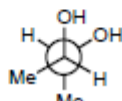
(B)



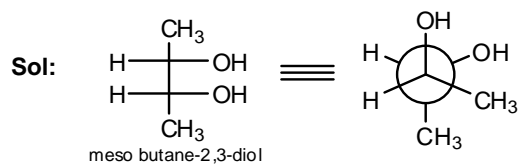
(C)



(D)

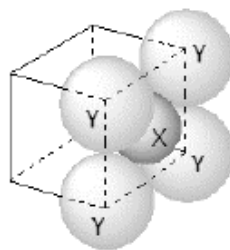


Answer Key (B)



The above conformer is stable due to intramolecular hydrogen 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

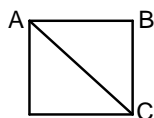
(B) 0.63

(C) 0.52

(D) 0.48

Answer Key (B)

Sol: Number of 'Y' per unit cell = 1
 Number of 'X' per unit cell = 3
 Consider a face of the unit cell



here AB (edge length) = $2r_y$
 and AC (face diagonal) = $2(r_x + r_y)$

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

$$\frac{r_x}{r_y} = (\sqrt{2} - 1) = 0.414$$

$$\text{Packing fraction} = \frac{1 \times \frac{4}{3} \pi (r_y)^3 + 3 \times \frac{4}{3} \pi (r_x)^3}{a^3}$$

$$= \frac{\frac{4}{3} \pi [(r_y)^3 + 3(r_x)^3]}{8(r_y)^3} = \frac{\pi}{6} [1 + 3 \times (0.414)^3] = 0.63$$

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

Answer Key (A)

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

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

there are 3 unpaired electrons

$$\therefore \mu = \sqrt{n(n+2)} = \sqrt{3 \times 5} = 3.87 \text{ BM}$$

$[\text{CuF}_6]^{3-}$

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

F^- is a weak ligand therefore pairing will not take place

there are 2 unpaired electrons

$$\therefore \mu = \sqrt{2 \times 4} = 2.84 \text{ BM}$$

SECTION 2

- This section contains **THREE** (03) questions 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.

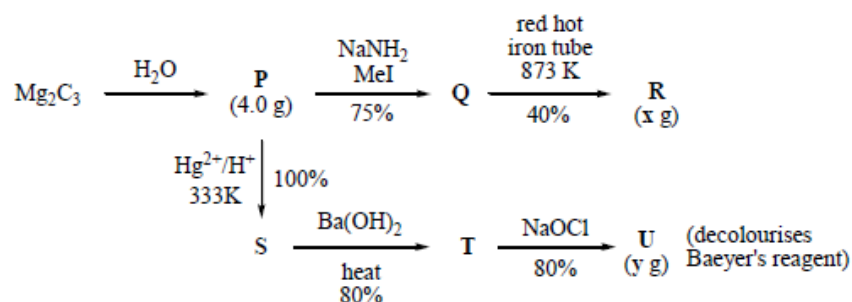
Full Marks : +2 If ONLY the correct numerical value is entered at the designated place;

Zero Marks : 0 In all other cases.

Question Stem for Question No. 5 and 6

Question Stem

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

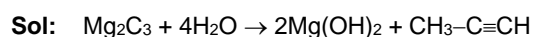


x g and y g are mass of **R** and **U**, respectively.

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

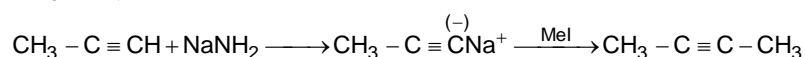
Q.5 The value of x is ____.

Answer Key (1.62)



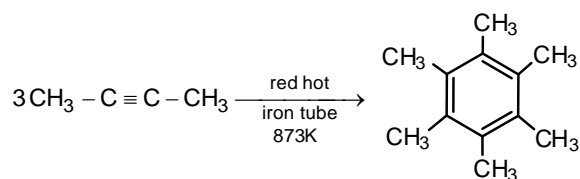
'P' is propyne

4.0 g propyne is 0.1 mole



'Q' is but-2-yne

Since reaction is only 75% complete number of moles of but-2-yne formed is 0.075

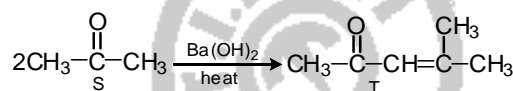
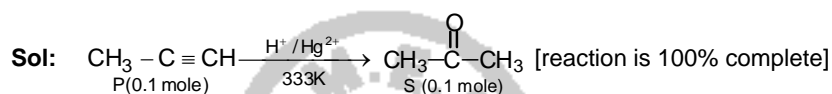


$$\text{Number of moles of R formed} = 0.075 \times \frac{40}{100} \times \frac{1}{3} = 0.01$$

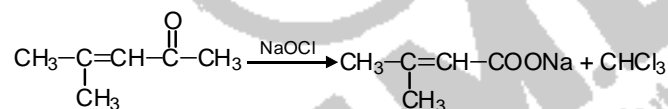
$$\therefore \text{The value of X} = 0.01 \times 162 = 1.62$$

Q.6 The value of y is ____.

Answer Key (3.20)



$$\text{Number of moles of T formed} = 0.1 \times \frac{80}{100} \times \frac{1}{2} = 0.04 \text{ moles}$$



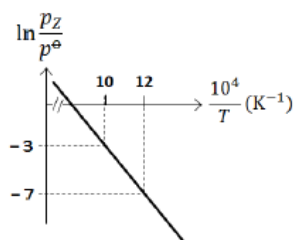
$$\text{Number of moles of U formed} = 0.04 \times \frac{80}{100} = 0.032 \text{ moles}$$

$$\text{The value of Y} = 0.032 \times 100 = 3.2$$

Question Stem for Question No. 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 $\frac{10^4}{T}$ 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, $\frac{d(\ln K)}{d(\frac{1}{T})} = -\frac{\Delta H^\ominus}{R}$, where the equilibrium constant, $K = \frac{p_Z}{p^\ominus}$ and the gas constant, $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$)

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

Answer Key (166.28)

Sol: $\Delta G^\circ = -RT \ln K = -RT \ln \left(\frac{p_z}{p^\circ} \right)$

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$

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

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

$$\Delta H^\circ = 2 \times 10^4 \times 8.314 = 166.28 \text{ kJ mol}^{-1}$$

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

Answer Key (141.34)

Sol: When $T = 1000 \text{ K} \Rightarrow \frac{10^4}{T} = 10$

$$\therefore \frac{-\Delta H^\circ}{RT} + \frac{\Delta S^\circ}{R} = -3$$

$$\frac{-2 \times 10^4 \times R}{R \times 1000} + \frac{\Delta S^\circ}{R} = -3$$

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

$$\Delta S^\circ = 141.34 \text{ J K}^{-1} \text{mol}^{-1}$$

Question Stem for Question No. 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 $y \times 10^{-2}$ °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), $K_b = 0.5 \text{ K kg mol}^{-1}$; Boiling point of pure water as 100 °C.)

Q.9 The value of x is ____.

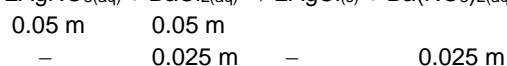
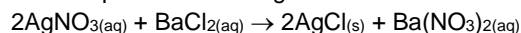
Answer Key (100.10)

Sol: $\Delta T_b = i \times K_b \times m$
 $= 2 \times 0.5 \times 0.1 = 0.1 \text{ K}$
 $\therefore x = 100.10^\circ\text{C}$

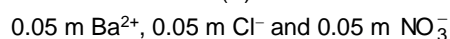
Q.10 The value of $|y|$ is ____.

Answer Key (2.50)

Sol: When equal volume of AgNO_3 solution and BaCl_2 solution are mixed the concentration become half



\therefore The final solution (B) contain



total concentration = 0.15 m

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

Boiling point of solution B = 100.075

$$y = 100.10 - 100.075 = 0.025 = 2.5 \times 10^{-2}$$

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).
- 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) chose,

Partial Marks: +3 If all the four options are correct but ONLY three options are chosen;

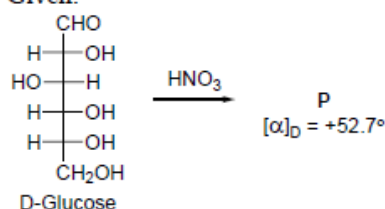
Partial Marks: +2 If three or more options are correct but ONLY two options are chosen, both of which are correct.

Partial Marks: +1 If two or more options are correct but ONLY one option is chosen and it is a correction option;

Zero Marks 0 If unanswered;

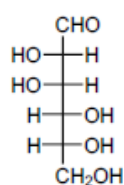
Negative Marks -2 In all other cases.
- For example, in a question, if (A), (B) and (D) are the ONLY three options corresponding to correct answers, then
 - Choosing ONLY (A), (B) and (D) will get +4 marks;
 - Choosing ONLY (A) and (B) will get +2 marks;
 - Choosing ONLY (A) and (D) will get +2 marks;
 - 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 mark and
 - Choosing any other option(s) will get -2 marks.

Q.11 Given:

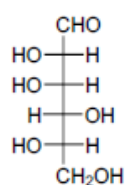


The compound(s), which on reaction with HNO_3 will give the product having degree of rotation, $[\alpha]_D = -52.7^\circ$ is(are)

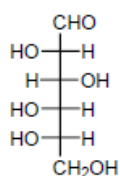
(A)



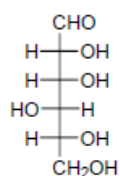
(B)



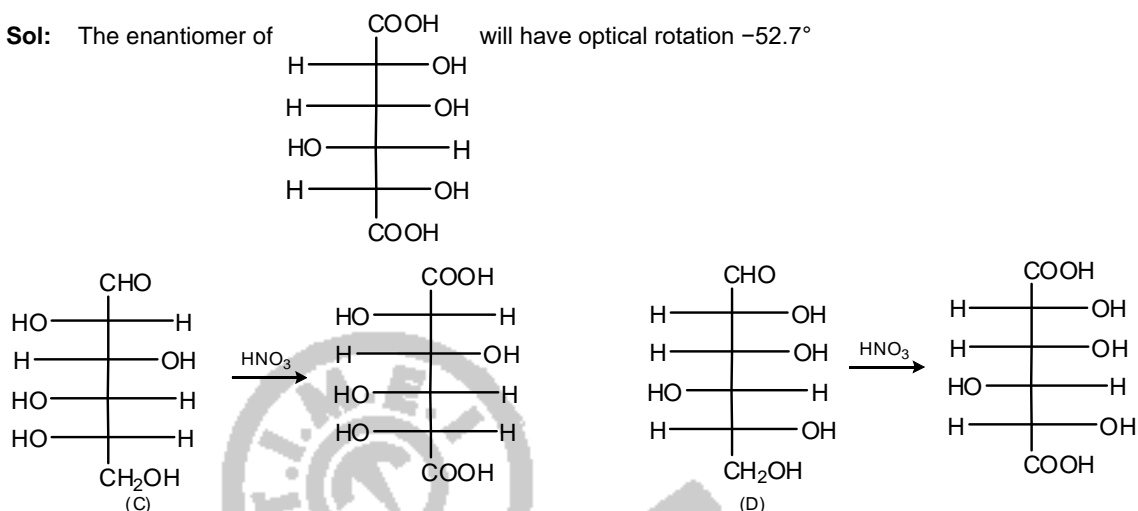
(C)



(D)

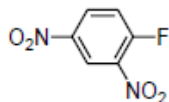
**Answer Key (C, D)**

Sol: The enantiomer of  will have optical rotation -52.7°

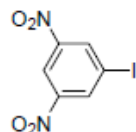


Q.12 The reaction of **Q** with PhSNa yields an organic compound (major product) that gives positive Carius test on treatment with Na_2O_2 followed by addition of BaCl_2 . The correct option(s) for **Q** is(are)

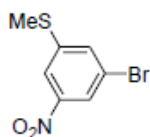
(A)



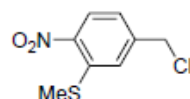
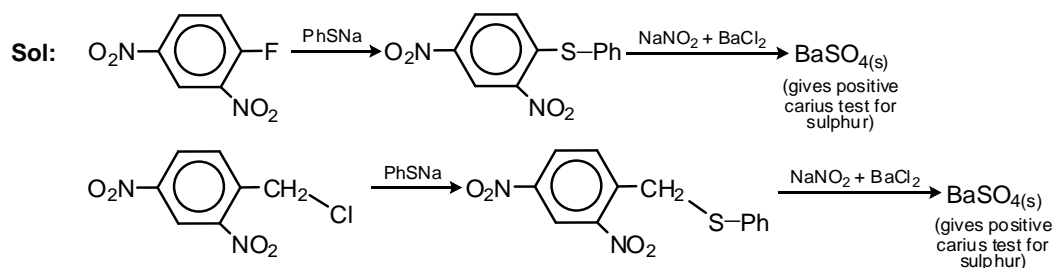
(B)



(C)



(D)

**Answer Key (A, D)**

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

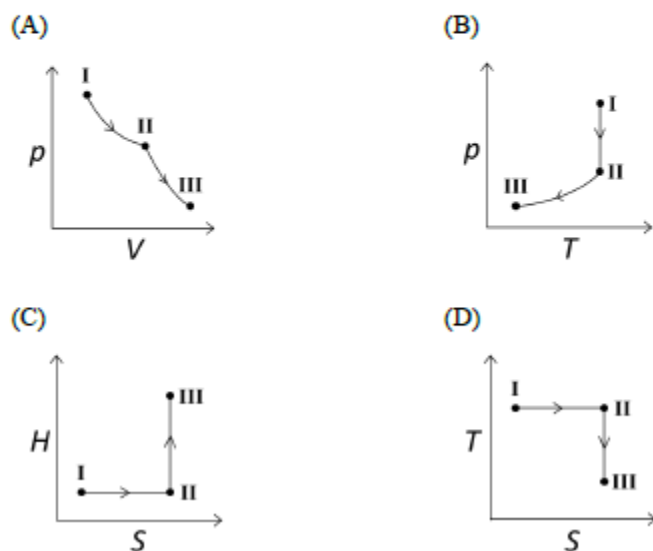
- (A) The process of precipitating colloidal sol by an electrolyte is called peptization.
- (B) Colloidal solution freezes at higher temperature than the true solution at the same concentration.
- (C) Surfactants form micelle above critical micelle concentration (CMC). CMC depends on temperature.
- (D) Micelles are macromolecular colloids.

Answer Key (B, C)

Sol: The process of precipitating colloids by adding an electrolyte is called coagulation
Micelles are associated colloids

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)



Answer Key (A, B, D)

Sol: For state I \rightarrow State II (Reversible isothermal expansion)
 $\Delta V = +ve$ $\Delta P = -ve$ and $\Delta T = 0$
 $\therefore \Delta H = 0$ and $\Delta S = +ve$
 For state II \rightarrow state III (Reversible adiabatic expansion)
 $\Delta V = +ve$ $\Delta P = -ve$ and $\Delta T = -ve$
 $\therefore \Delta H = -ve$ and $\Delta S = 0$

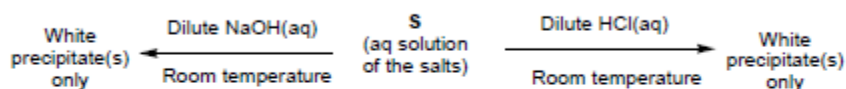
Q.15 The correct statement(s) related to the metal extraction processes is(are)

- (A) A mixture of PbS and PbO undergoes self-reduction to produce Pb and 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].

Answer Key (A, C, D)

Sol: (B) In the extraction of copper from copper pyrites, silica is added as a flux to remove FeO

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

Answer Key (A, B)

Sol: Among the given cations, only Pb²⁺ and Ag⁺ forms White precipitate with dil.HCl
All these cations from precipitate with NaOH
Pb(OH)₂, Zn(OH)₂ and Bi(OH)₃ are white precipitate
Ag⁺ forms brown coloured Ag₂O while Hg²⁺ forms yellow coloured HgO

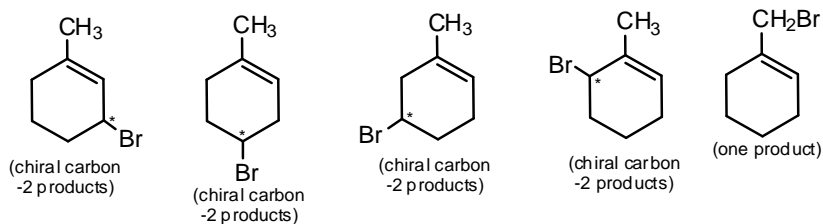
SECTION 4

- 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.

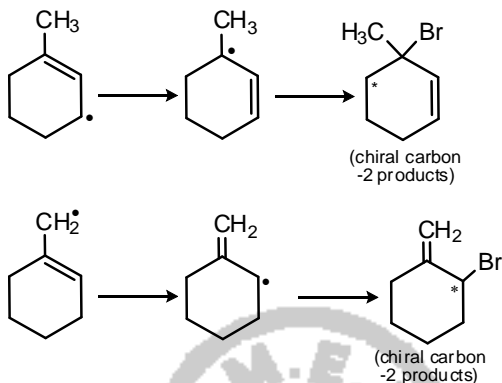
Q.17 The maximum number of possible isomers (including stereoisomers) which may be formed on *mono*-bromination of 1-methylcyclohex-1-ene using Br₂ and UV light is ____.

Answer Key (13)

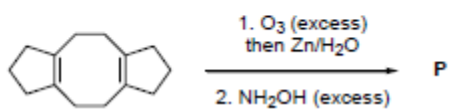
Sol: Bromination in presence of uv light is free radical substitution reaction.
The direct product possible are



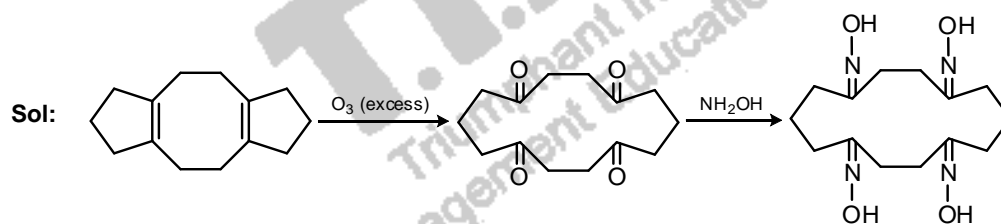
The products formed after rearrangement of free radical



Q.18 In the reaction given below, the total number of atoms having sp^3 hybridization in the major product P is ____.



Answer Key (12)



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

Answer Key (6)

Sol: The compound has the ionisation isomers
 $[Pt(NH_3)_4Cl_2]Br_2$
 $[Pt(NH_3)_4Br_2]Cl_2$
 $[Pt(NH_3)_4BrCl]Br.Cl$
 All three has two geometrical isomers