JEE Advanced (2024)

PAPER 2

General Instructions:

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.

1. According to Bohr's model, the highest kinetic energy is associated with the electron in the

(A) first orbit of H atom **(B)** first orbit of He^+

(C) second orbit of He^+ **(D)** second orbit of Li^{2+}

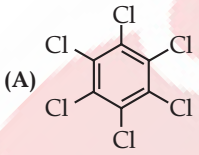
2. In a metal deficient oxide sample, $M_XY_2O_4$ (M and Y are metals), M is present in both +2 and +3 oxidation states and Y is in +3 oxidation state. If the fraction of M^{2+} ions present in M is $\frac{1}{3}$, the value of X is ..... .

(A) 0.25 **(B)** 0.33 **(C)** 0.67 **(D)** 0.75

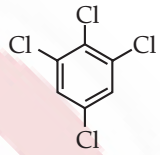
3. In the following reaction sequence, the major product Q is

L-Glucose $\xrightarrow[\text{(ii) } Cr_2O_3\text{, 775K, 10-20 atm}]{\text{(i) HI, }\Delta}$ P $\xrightarrow[\text{UV}]{Cl_2\text{ (excess)}}$ Q

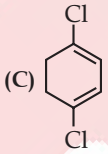
(A)



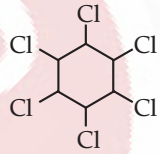
(B)



(C)



(D)



4. The species formed on fluorination of phosphorus pentachloride in a polar organic solvent are

(A) $[PF_4]^+[PF_6]^-$ and $[PCl_4]^+[PF_6]^-$

(B) $[PCl_4]^+[PCl_4F_2]^-$ and $[PCl_4]^+[PF_6]^-$

(C) PF_3 and PCl_3

(D) PF_5 and PCl_3

General Instructions:

SECTION 2 (Maximum Marks: 12)

- This section contains **THREE (03)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY OR MORE THAN ONE** of these four options is the correct answer.
- 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 **ONLY** if (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 none of the options is chosen (i.e., the question is 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 combination of options will get –2 marks.

5. An aqueous solution of hydrazine (N_2H_4) is electrochemically oxidised by O_2, thereby releasing chemical energy in the form of electrical energy. One of the products generated from the electrochemical reaction is $N_2(g)$.

Choose the correct statement(s) about the above process

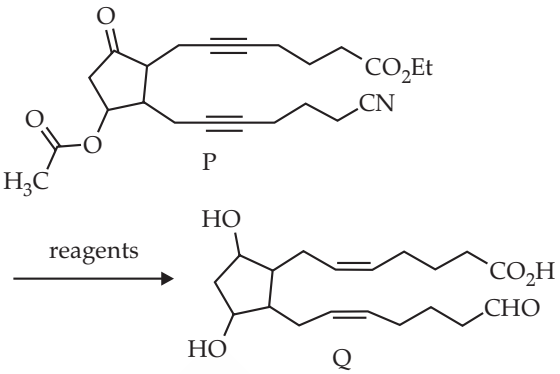
(A) OH^- ions react with N_2H_4 at the anode to form $N_2(g)$ and water, releasing 4 electrons to the anode.

(B) At the cathode, N_2H_4 breaks to $N_2(g)$ and nascent hydrogen released at the electrode reacts with oxygen to form water.

(C) At the cathode, molecular oxygen gets converted to OH^-.

(D) Oxides of nitrogen are major by-products of the electrochemical process.

6. The option(s) with correct sequence of reagents for the conversion of P to Q is(are)



(A) i) Lindlar's catalyst, H_2; ii) $SnCl_2$/HCl; iii) $NaBH_4$; iv) H_3O^+

(B) i) Lindlar's catalyst, H_2; ii) H_3O^+; iii) $SnCl_2$/HCl; iv) $NaBH_4$

(C) i) $NaBH_4$; ii) $SnCl_2$/HCl; iii) H_3O^+; iv) Lindlar's catalyst, H_2

(D) i) Lindlar's catalyst, H_2; ii) $NaBH_4$; iii) $SnCl_2$/HCl; iv) H_3O^+

7. The compound(s) having peroxide linkage is(are)

(A) $H_2S_2O_7$ **(B)** $H_2S_2O_8$ **(C)** $H_2S_2O_5$ **(D)** H_2SO_5

General Instructions:

SECTION 3 (Maximum Marks: 24)

- This section contains **SIX (06)** 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 option is chosen;

Zero Marks : 0 in all other cases.

8. To form a complete monolayer of acetic acid on 1g of charcoal, 100 mL of 0.5 M acetic acid was used. Some of the acetic acid remained unadsorbed. To neutralise the unadsorbed acetic acid, 40 mL of 1 M NaOH solution was required. If each molecule of acetic acid occupies $P \times 10^{-23}$ m^2 surface area on charcoal, the value of P is ..... .

[Use given data: Surface area of charcoal = 1.5×10^2 m^2g^{-1}; Avogadro's number (N_A) = 6.0×10^{23} mol^{-1}]

9. Vessel-1 contains w_2 g of a non-volatile solute X dissolved in w_1 g of water. Vessel-2 contains w_2 g of another non-volatile solute Y dissolved in w_1 g of water. Both the vessels are at the same temperature and pressure. The molar mass of X is 80% of that of Y. The van't Hoff factor for X is 1.2 times of that of Y for their respective concentrations.

The elevation of boiling point for solution in Vessel-1 is ..... % of the solution in Vessel-2.

10. For a double strand DNA, one strand is given below:

5' A G T C A C G T A A G T C 3'

The amount of energy required to split the double strand DNA into two single strands is ..... kcal mol^{-1}.

[Given: Average energy per H-bond for A-T base pair = 1.0 kcal mol^{-1}, G–C base pair = 1.5 kcal mol^{-1} and A-U base pair = 1.25 kcal mol^{-1}. Ignore electrostatic repulsion between the phosphate groups.]

11. A sample initially contains only U-238 isotope of uranium. With time, some of the U-238 radioactively decays into Pb-206 while the rest of it remains undisintegrated. When the age of the sample is $P \times 10^8$ years, the ratio of mass of Pb-206 to that of U-238 in the sample is found to be 7. The value of P is ..... .

[Given: Half-life of U-238 is 4.5×10^9 years; $\log_e 2 = 0.693$]

12. Among $[Co(CN)_4]^{4-}$, $[Co(CO)_3(NO)]$, XeF_4, $[PCl_4]^+$, $[PdCl_4]^{2-}$, $[ICl_4]^-$, $[Cu(CN)_4]^{3-}$ and P_4 the total number of species with tetrahedral geometry is ..... .

13. An organic compound P having molecular formula $C_6H_6O_3$ gives ferric chloride test and does not have intramolecular hydrogen bond. The compound P reacts with 3 equivalents of NH_2OH to produce oxime Q. Treatment of P with excess methyl iodide in the presence of KOH produces compound R as the major product. Reaction of R with excess iso-butylmagnesium bromide followed by treatment with H_3O^+ gives compound S as the major product.

The total number of methyl ($-CH_3$) group(s) in compound S is ..... .

***General Instructions*:**

SECTION 4 (Maximum Marks : 12)

- This section contains **TWO (02)** paragraphs.
- Based on each paragraph, there are **TWO (02)** questions.
- The answer to each question is a **NUMERICAL VALUE**
- For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.
- Answer to each question will be evaluated **according to the following marking scheme:**

Full Marks : +3 If ONLY the correct numerical value is entered in the designated place;
Zero Marks : 0 in all other cases.

PARAGRAPH I

An organic compound P with molecular formula $C_9H_{18}O_2$ decolourises bromine water and also shows positive iodoform test. P on ozonolysis followed by treatment with H_2O_2 gives Q and R. While compound Q shows positive iodoform test, compound R does not give positive iodoform test. Q and R on oxidation with pyridinium chlorochromate (PCC) followed by heating give S and T, respectively. Both S and T show positive iodoform test. Complete copolymerisation of 500 moles of Q and 500 moles of R gives one mole of a single acyclic copolymer U.

[Given, atomic mass: H = 1, C = 12, O = 16]

14. Sum of number of oxygen atoms in S and T is ..... .

15. The molecular weight of U is ..... .

PARAGRAPH II

When potassium iodide is added to an aqueous solution of potassium ferricyanide, a reversible reaction is observed in which a complex P is formed. In a strong acidic medium, the equilibrium shifts completely towards P. Addition of zinc chloride to P in a slightly acidic medium results in a sparingly soluble complex Q.

16. The number of moles of potassium iodide required to produce two moles of P is ..... .

17. The number of zinc ions present in the molecular formula of Q is ..... .

ANSWER KEY

Q.No.	Answer key	Topic's name	Chapter's name
1	B	Bohr Model of Atom	Atomic Structure
2	D	Oxidation State	Redox Reaction
3	D	Carbohydrates	Biomolecules
4	A or B	Group 15 Elements	p Blocks Elements (Group 14 to 18)
5	A, C	Cell Reaction	Electrochemistry
6	C, D	Alkene	Hydrocarbon
7	B, D	Group 16 Elements	p Blocks Elements (Group 14 to 18)
8	[2500]	Mole Concept	Some Basic Concepts of Chemistry
9	[150]	Colligative Properties	Solutions
10	[41]	DNA Strands	Biomolecules
11	[143]	Radioactivity	Chemical Kinetics
12	[5]	CFT	Coordination Compounds
13	[12 or 6]	Ketone	Aldehyde, Ketone and Carboxylic Acid
14	[2]	Alcohol	Alcohols, Phenols and Ether
15	[93018]	Polymer	Polymer
16	[2]	Reaction of Coordination Compounds	Coordination Compounds
17	[3 or 2]	Reaction of Coordination Compounds	Coordination Compounds

ANSWERS WITH EXPLANATIONS

1. Correct option is (B).

Kinetic energy of election in n^{th} Bohr's orbit,

$$K.E = 13.6\frac{z^2}{n^2} \text{ ev/atom}$$

For, $n = 1$ (H atom) $\rightarrow K.E. \propto \frac{1^2}{1^2} = 1$

$n = 1(He^+ \text{ ion}) \rightarrow K.E. \propto \frac{2^2}{1^2} = 4$

$n = 2(He^+ \text{ ion}) \rightarrow K.E. \propto \frac{2^2}{2^2} = 1$

$n = (Li^{2+} \text{ ion}) \rightarrow K.E. \propto \frac{3^2}{2^2} = \frac{9}{4}$

So, kinetic energy will be highest for $n = 1$ of He^+ ion.

2. Correct option is (D).

$M_XY_2O_4$

$$M^{+2} = \frac{x}{3}, M^{+3} = \frac{2x}{3}$$

So, total of O.N. of all atoms

$$\frac{2X}{3} + 3\left(\frac{2X}{3}\right) + 2(+3) + 4(-2) = 0$$

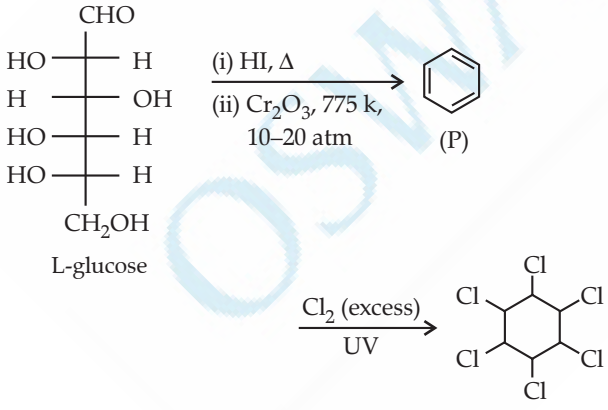
$$\frac{2X}{3} + 2X + 6 - 8 = 0$$

$$\frac{8X}{3} = 2$$

$$X = \frac{6}{8} = \frac{3}{4} = 0.75$$

So, value of X is 0.75

3. Correct option is (D).



4. Correct option is (B) or (A).

On fluorination of PCl_5 in polar organic solvent ionic isomers are formed, i.e.

$[PCl_4]^+[PCl_4F_2]^- \rightarrow$ (Colourless crystal)

$[PCl_4]^+[PF_6] \rightarrow$ (White crystal)

5. Correct options are (A and C).

At anode $N_2H_4 + 4OH^- \longrightarrow N_2 + 4H_2O + 4e^-$

At cathode $O_2 + 2H_2O + 4e^- \longrightarrow 4OH^-$

Overall reaction $N_2H_4 + O_2 \longrightarrow N_2 + 2H_2O$

$N_2H_4 + 2O_2 \longrightarrow 2NO + 2H_2O$

$N_2H_4 + 3O_2 \longrightarrow 2NO_2 + 2H_2O$

6. Correct options are (C and D).

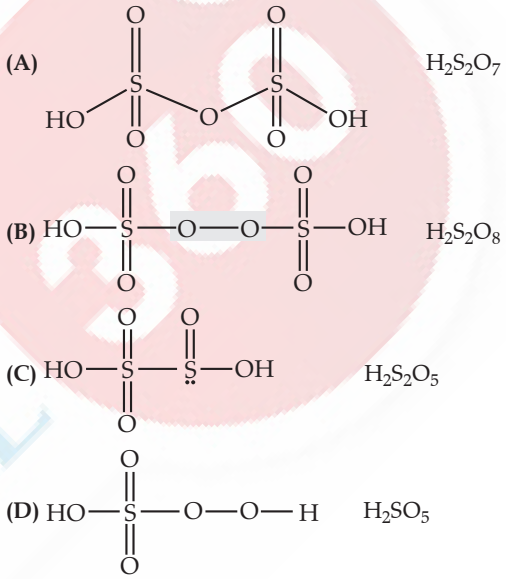
Reagent

(C) (i) $NaBH_4$; (ii) $SnCl_2$/HCl; (iii) H_3O^+; (iv) Lindlar's catalyst, H_2;

(D) (i) Lindlar's catalyst, H_2; (ii) $NaBH_4$; (iii) $SnCl_2$/HCl; (iv) H_3O^+

7. Correct options are (B and D).

(—O—O—) linkage is called peroxy linkage.



8. Correct answer is [2500].

Number of moles of NaOH $= 40 \times 1 \times 10^{-3}$
$= 4 \times 10^{-2}$

Number of moles of acetic acid $= 100 \times 0.5 \times 10^{-3}$
$= 5 \times 10^{-2}$

$\therefore$ Number of moles of acetic acid adsorbed on charcoal
$= 5 \times 10^{-2} - 4 \times 10^{-2}$
$= 1 \times 10^{-2}$

$\therefore$ Number of molecules of acetic acid absorbed
$= 1 \times 10^{-2} \times N_A$
$= 6 \times 10^{21}$

Total surface area absorbed by one molecule of acetic acid $= \frac{1.5 \times 10^2}{6 \times 10^{21}}$

$= 2500 \times 10^{-23}$

$\therefore$ $P = 2500$

9. Correct answer is [150].

Elevation in boiling point $(\Delta T_b) = i_x k_f \times$ molality

$$(\Delta T_b)_1 = i_1 k_f \times \frac{W_2}{\frac{M_X}{\left(\frac{W_1}{1000}\right)}}$$

$$(\Delta T_b)_2 = i_2 k_f \times \frac{W_2}{\frac{M_Y}{\left(\frac{W_1}{1000}\right)}}$$

$$\frac{(\Delta T_b)_1}{(\Delta T_b)_2} = \frac{i_1}{i_2} \times \frac{M_y}{M_x}$$

$$= 1.2 \times \frac{1}{0.8}$$

$$(\Delta T_b)_1 = 1.5(\Delta T_b)_2$$

$$= 150$$

10. Correct answer is [41].

A G T C A C G T A A G T C
‖ ||| ‖ ||| ‖ ||| ||| ‖ ‖ ‖ ||| ‖ |||
T C A C T G C A T T C A G

Total energy = [B.E. H-Bond for (A – T) × No. of (A – T) pair × 2] + [B.E. H-Bond for (G – C) × No. of (G – C) pair × 3]

As there are seven pair of (A – T) and six pair of (G – C)

total energy = [1 × 7 × 2] + [1.5 × 6 × 3]

= 14 + 27

= 41 kcal

11. Correct answer is [143].

Mass = Number of moles × Molar mass

$$\frac{(\text{Mass})_{Pb}}{(\text{Mass})_U} = \frac{n_{Pb} \times 206}{n_U \times 238} = \frac{7}{1}$$

$$\frac{n_{Pb}}{n_U} = \frac{238 \times 7}{206}$$

$$\ell n\left(1 + \frac{n_{Pb}}{n_U}\right) = \lambda t$$

$$\ell n\left(1 + \frac{238 \times 7}{206}\right) = \frac{\ell n 2}{t_{\frac{1}{2}}} \times t$$

$$\ell n\left(\frac{206 + 1666}{206}\right) = \frac{\ell n 2}{t_{\frac{1}{2}}} \times t$$

$$\ell n(9) = \frac{\ell n 2}{t_{\frac{1}{2}}} \times t$$

$$t = \frac{\ell n 9}{\ell n 2} \times t_{\frac{1}{2}}$$

$$t = \frac{2 \times 0.4771}{0.3010} \times 4.5 \times 10^9$$

$$t = 14.265 \times 10^9$$

$$= 142.65 \times 10^8 \text{ years}$$

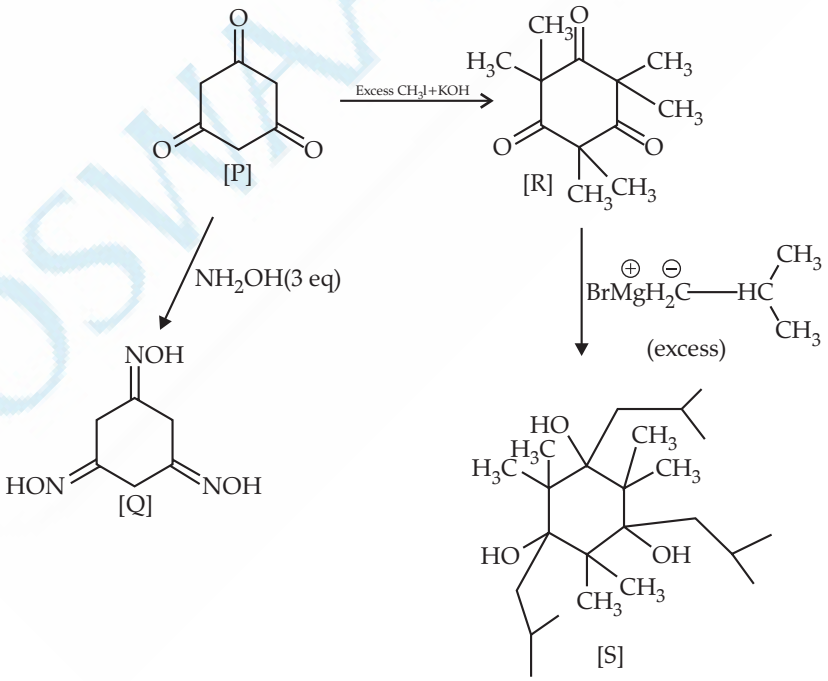
$$P = 142.65 = 143$$

12. Correct answer is [5].

$[Co(CN)_4]^{4-} \longrightarrow$ Tetrahedral
$[Co(CO)_3(NO)] \longrightarrow$ Tetrahedral
$XeF_4 \longrightarrow$ Square planar
$[PCl_4]^+ \longrightarrow$ Tetrahedral
$[PdCl_4]^{2-} \longrightarrow$ Square planar
$[ICl_4]^- \longrightarrow$ Square planar
$[Cu(CN)_4]^{3-} \longrightarrow$ Tetrahedral
$P_4 \longrightarrow$ Tetrahedral

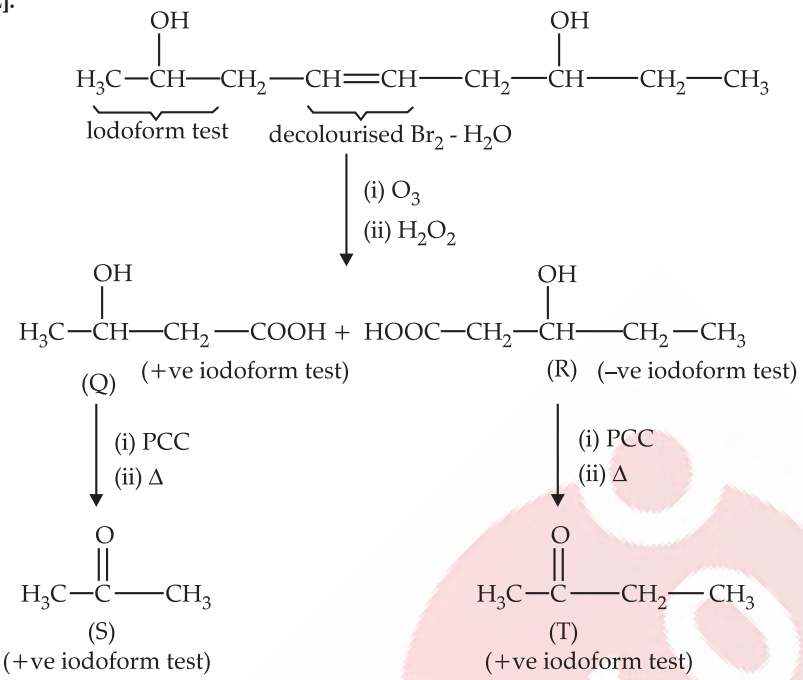
So, there are 5 compounds with tetrahedral geometry.

13. Correct answer is [12] or [6].



Note: If we consider the methyl group given by methyl iodide only then number of methyl group in the product will be 6 but it we consider the methyl group of isobutyl group also then the number of methyl group in the product will be 12.

14. Correct answer is [2].



Sum of oxygen atom in S and T = 1 + 1 = 2

15. Correct answer is [93018].

$$Q + R \longrightarrow \text{Polymer (U)}$$

Since moles of U = 1

$$\text{Moles} = \frac{\text{Weight}}{\text{Molar mass}}$$

Weight of 'U' = Weight of (Q + R) – Weight of water
Weight of 'Q' = 500 × 104 = 52,000 g
Weight of 'R' = 500 × 118 = 59,000 g
Weight of 'H_2O' = 999 × 18 = 17982 g
Weight of polymer = 52000 + 59000 – 17982
= 93018 g/mol

16. Correct answer is [2].

$2KI + 2K_3[Fe(CN)_6] \longrightarrow 2K_4[Fe(CN)_6] + I_2$
(P) (3 mole of KI is needed)

17. Correct answer is [3] or [2].

$3ZnCl_2 + 2K_4[Fe(CN)_6] \longrightarrow K_2Zn_3[Fe(CN)_6]_2 + 6KCl$
White ppt. (Q)

3 zinc ions are present in (Q) compound.

OR

$2ZnCl_2 + K_4[Fe(CN)_6] \longrightarrow Zn_2[Fe(CN)_6]$

2 zinc ions are present in $(Q)_{compound}$ + (Q)4KCl

●●●