# JEE Advanced (2025)

# PAPER

## Chemistry

#### 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.** During sodium nitroprusside test of sulphide ion in an aqueous solution, one of the ligands coordinated to the metal ion is converted to
  - (A) NOS<sup>-</sup> (B) SCN<sup>-</sup>
  - (C) SNO<sup>-</sup> (D) NCS<sup>-</sup>
- **2.** The complete hydrolysis of ICl,  $ClF_3$  and  $BrF_5$ , respectively, gives
  - (A)  $IO^-$ ,  $CIO_2^-$  and  $BrO_3^-$
  - (B)  $IO_3^-$ ,  $CIO_2^-$  and  $BrO_3^-$
  - (C)  $IO^-$ ,  $CIO^-$  and  $BrO_2^-$
  - (D)  $IO_3^-$ ,  $CIO_4^-$  and  $BrO_2^-$
- **3.** Monocyclic compounds P, Q, R and S are the major products formed in the reaction sequences given below.





The product having the highest number of unsaturated carbon atom(s) is

(A) P	(B)	Q
(C) R	(D)	S

4. The correct reaction/reaction sequence that would produce a dicarboxylic acid as the major product is



### General Instructions:

#### SECTION 2 (Maximum Marks: 16)

- This section contains FOUR (04) 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 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 (A) will get +1 mar.
  - choosing ONLY (B) will get +1 mark;
  - choosing ONLY (D) will get +1 mark;
  - choosing no option (i.e., the question is unanswered) will get 0 marks and
  - choosing any other combination of option(s) will get -2 marks.

- 5. The correct statement(s) about intermolecular forces is(are)
  - (A) The potential energy between two point charges approaches zero more rapidly than the potential energy between a point dipole and a point charge as the distance between them approaches infinity.
  - (B) The average potential energy of two rotating polar molecules that are separated by a distance r has 1/r<sup>3</sup> dependence.
  - (C) The dipole-induced dipole average interaction energy is independent of temperature.
  - (D) Nonpolar molecules attract one another even though neither has a permanent dipole moment.
- 6. The compound(s) with P-H bond(s) is(are)

(A)	$H_3PO_4$	(B)	H <sub>3</sub> PO <sub>3</sub>
(C)	$H_4P_2O_7$	(D)	H <sub>3</sub> PO <sub>2</sub>

 For the reaction sequence given below, the correct statement(s) is(are)

(i) Strong heating (ii) KMnO<sub>4</sub>, H<sup>+</sup>,  $\Delta$  (ii) Ethanolic KOH (iii) NH<sub>3</sub>  $\Delta$ , -2H<sub>2</sub>O X (iii) R-Br Y NaOH Aromatic compound +Z

#### General Instructions:

- (A) Both X and Y are oxygen containing compounds.
- (B) Y on heating with CHCl<sub>2</sub>/KOH forms isocyanide.
- (C) Z reacts with Hinsberg's reagent.
- (D) Z is an aromatic primary amine.
- 8. For the reaction sequence given below, the correct statement(s) is(are)



- (A) P is optically active.
- (B) S gives Bayer's test.
- (C) Q gives effervescence with aq. NaHCO<sub>3</sub>.
- (D) R is an alkyne.
- SECTION 3 (Maximum Marks: 32)
- This section contains EIGHT (08) 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 <u>according to the following marking scheme:</u> *Full Marks* : +4 If ONLY the correct numerical value is entered in the designated place; *Zero Marks* : 0 In all other cases.
- **9.** The density (in g cm<sup>-3</sup>) of the metal which forms a cubic close packed (ccp) lattice with an axial distance (edge length) equal to 400 pm is \_\_\_\_\_.

**Use:** Atomic mass of metal = 105.6 amu and Avogadro's constant =  $6 \times 10^{23}$  mol<sup>-1</sup>

- 10. The solubility of barium iodate in an aqueous solution prepared by mixing 200 mL of 0.010 M barium nitrate with 100 mL of 0.10 M sodium iodate is  $X \times 10^{-6}$  mol dm<sup>-3</sup>. The value of X is \_\_\_\_\_\_. Use: Solubility product constant (K<sub>sp</sub>) of barium iodate =  $1.58 \times 10^{-9}$
- **11.** Adsorption of phenol from its aqueous solution on to fly ash obeys Freundlich isotherm. At a given temperature, from 10 mg g<sup>-1</sup> and 16 mg g<sup>-1</sup> aqueous phenol solutions, the concentrations of adsorbed phenol are measured to be 4 mg g<sup>-1</sup> and 10 mg g<sup>-1</sup>, respectively. At this temperature, the concentration (in mg g<sup>-1</sup>) of adsorbed phenol from 20 mg g<sup>-1</sup> aqueous solution of phenol will be \_\_\_\_\_.

**Use:**  $\log_{10} 2 = 0.3$ 

**12.** Consider a reaction  $A + R \rightarrow$  Product. The rate of this reaction is measured to be k[A][R]. At the start of the reaction, the concentration of R,  $[R]_0$ , is 10 times the concentration of A,  $[A]_0$ . The reaction can be considered to be a pseudo first-order reaction with assumption that k[R] = k' is constant. Due to this assumption, the relative error (in %) in the rate when this reaction is 40 % complete, is \_\_\_\_\_.

[k and k' represent corresponding rate constants]

**13.** At 300 K, an ideal dilute solution of a macromolecule exerts osmotic pressure that is expressed in terms of the height (h) of the solution (density =  $1.00 \text{ g cm}^{-3}$ ) where h is equal to 2.00 cm. If the concentration of the dilute solution of the macromolecule is  $2.00 \text{ g dm}^{-3}$ , the molar mass of the macromolecule is calculated to be  $X \times 10^4 \text{ g mol}^{-1}$ . The value of *X* is \_\_\_\_\_.

**Use:** Universal gas constant (R) = 8.3 J K<sup>-1</sup> mol<sup>-1</sup> and acceleration due to gravity (g) = 10 m s<sup>-2</sup>

14. An electrochemical cell is fuelled by the combustion of butane at 1 bar and 298 K. Its cell potential is  $X/F \times 10^3$  volts, where F is the Faraday constant. The value of X is

**Use:** Standard Gibbs energies of formation at 298 K are:  $\Delta_f G^0_{CO_2} = -394 \text{ kJ mol}^{-1}$ ;  $\Delta_f G^0_{water} = -237 \text{ kJ mol}^{-1}$ ;  $\Delta_f G^0_{butane} = -18 \text{ kJ mol}^{-1}$ 

- **15.** The sum of the spin only magnetic moment values (in B.M.) of [Mn(Br)<sub>6</sub>]<sup>3-</sup> and [Mn(CN)<sub>6</sub>]<sup>3-</sup> is \_\_\_\_\_.
- **16.** A linear octasaccharide (molar mass =  $1024 \text{ g mol}^{-1}$ ) on complete hydrolysis produces three monosaccharides: ribose, 2-deoxyribose and glucose. The amount of 2-deoxyribose formed is 58.26% (w/w) of the total amount of the monosaccharides produced in the hydrolysed products. The number of ribose unit(s) present in one molecule of octasaccharide is

**Use:** Molar mass (in g mol<sup>-1</sup>): ribose = 150, 2-deoxyribose = 134, glucose = 180; Atomic mass (in amu): H = 1, O = 16

A	nswer	Key

Q.No.	Answer key	Chapter name	Topic's name
1	(A)	Practical Organic Chemistry	Organic Chemistry - Basic Principles and Techniques
2	(A)	Inter Halogen Compound	p Block Elements
3	(D)	Carboxylic Acid	Aldehyde, Ketone and Carboxylic Acid
4	(C)	Elimination Reaction	Haloalkanes and Haloarenes
5	(C, D)	Secondary Forces	Chemical Bonding and Molecular Structure
6	(B, D)	Group 15 Elements	p Block
7	(A, C)	Phtalimide Synthesis Reaction	Amines
8	(B, C)	Oxidation and Reduction Reaction	Alcohol Phenol and Ether
9	[10.85–11.1]	Density Formula	Solid State
10	[3.85-4.15]	Solubility and Solubility Product	Equilibrium
11	[15.5–16.5]	Freundlich Isotherm	Surface Chemistry
12	[4 to 4.25]	Order of Reaction	Chemical Kine <mark>tics</mark>
13	[2.4 to 2.55]	Osmotic Pressure	Solution
14	[105.4 to 105.6]	Electrode Potential	Electrochemistry
15	[7.5 to 7.8]	Magnetic Moment	d and f Block Elements
16	[2]	Stoichiometry	Some Basic Concepts of Chemistry

## **ANSWERS WITH EXPLANATIONS**

1. Correct option is (A).

 $S^{2-} + [Fe(CN)_5NO]^{2-} \rightarrow [Fe(CN)_5NOS]^{4-}$ 

Violet

- 2. Correct option is (A).
  - $ICl + H_2O \rightarrow HIO + HCl$
  - $ClF_3 + 2H_2O \rightarrow HClO_2 + 3HF$
  - $BrF_5 + 3H_2O \rightarrow HBrO_3 + 5HF$
- 3. Correct option is (D).





Aldol reaction







(S) Unsaturated C-atom=10

4. Correct option is (C)



5. Correct options are (C, D).

Potential energy between point charges  $\infty = \frac{1}{2}$ 

P.E. between dipole and charge  $\propto \frac{1}{r^2}$ Hence, (A) is incorrect.

- (B) is incorrect as the dependence in rotating polar molecule  $\propto \frac{1}{r^6}$
- (C) is correct as average interaction energy  $\propto \frac{\mu^2 \alpha}{r^6}$ where  $\mu$  is the dipole moment of polar molecule and  $\alpha$  is polarisability of non-polar molecular, it is independent of temperature because thermal motion has no effect on the averaging process.
- (D) Interaction between non polar molecular molecules are van der Waal forces



X and Y both are oxygen containing compound so option A is correct. N-alkylphthalimide does not give carbyl amine reaction. So, option B is incorrect. Z is primary aliphatic amine that can reacts with Hinsberg reagent. So, option C is also correct. Z is aliphatic amine that's why option D is incorrect.

8. Correct options are (B, C).



P does not contain chiral carbon that's why p is optically inactive.So, option A is incorrect. S can give bayer's test. So, option B is correct. Q contain –COOH group that's why it gives effervescence with aq. NaHCO<sub>3</sub>. So, option C is also correct. R does not contain triple bond that's why option D is incorrect.

9. Correct answer is [11.00]. For CCP: Z = 4,  $a = 400 \text{ pm} - 10 = 400 \times 10^{-10} \text{ cm}$ d =  $\frac{Z \times Mw}{N_A \times a^3} = \frac{4 \times 105.6}{6 \times 10^{23} \times (400 \times 10^{-10})^3}$  $= \frac{4 \times 105.6}{6 \times 10^{23} \times 4 \times 4 \times 4 \times 10^{-24}} = 11 \text{ g/cm}^3.$ 10. Correct answer is [3.95].  $Ba(NO_3)^{2+} + 2NaIO_3 \rightarrow Ba(IO_3)_{2(s)} \downarrow + 2NaNO_3$ 2 m mol 10 m mol -2 m mol-4 m mol +2 m mol = 4 m mol6 m mol = 2 m mol = 4 m molFurther,  $[NaIO_3] = \frac{6}{300} = 2 \times 10^{-3} M$ Further,  $Ba(IO_3)_2 \rightleftharpoons Ba^{2+} + 2IO_3^{-1}$ S  $2S + \frac{6}{300}$  $K_{sp} = (Ba^{2+}) (IO_3^{-})^2$ (S)  $(2S + 0.02)^2 = 1.58 \times 10^{-9}$  $S = 3.95 \times 10^{-6} M$ X = 3.9511. Correct answer is [15.62].  $\left(\frac{x}{m}\right) = K(C)^{1/n}$  $\log\left(\frac{x}{m}\right) = \log K + \frac{1}{n}\log C$  $\log 4 = \log K + \frac{1}{n}\log 10$  $0.6 = \log K + \frac{1}{2}$  $\log 10 = \log K + \frac{1}{n}\log 16$  $1 = \log K + \frac{1}{n} \times 1.2$ From Eqs. (i) and (ii)  $-0.4 = \frac{1}{n} \times -0.2 \Longrightarrow \frac{1}{n} = 2$ n = 0.5and from equation (ii)  $\log K = -1.4$  $\log \frac{x}{m} = \log K + \frac{1}{n} \log C$  $= -1.4 + 2 \times \log 20 = 1.4 + 2.6 = 1.2$  $\frac{x}{m} = 10^{1.2} = 16$  $\frac{x}{m} = K \times C^{\frac{1}{n}}$  $4 = k(10)^{1/n} - (1)$  $10 = k(16)^{1/n} - (2)$  $x = k(20)^{1/n} - (3)$ 

On solving 1 and 3,  $\frac{4}{r} = \left(\frac{10}{20}\right)^2 \implies x = 16$ On solving 2 and 3,  $\frac{10}{x} = \left(\frac{16}{20}\right)^2 \Rightarrow x = 15.625$ 12. Correct answer is [4.17]. А +  $R \rightarrow Product$ t = 0 $A_0$  $10A_0$  $t = t = 0.6A_0$ 9.6 A<sub>0</sub>  $(Rate_1) = K(A)(R) = k(0.6 A_0) \times (9.6 A_0)$ ...(i)  $R \rightarrow Product$ А + t = 0 $A_0$  $10A_0$  (exces)  $t = t = 0.6A_0$  $10 A_0$ Rate = K'[A], as K' = K[R] $(Rate_2) = (K \times 10A_0) \times (0.6 A_0)$ relative error in (%) = 100 ×  $\frac{\Delta(Rate)}{(Rate)_1} = \frac{(0.6 \times 10) - (0.6 \times 9.6)}{0.6 \times 9.6}$  $\times 100 = 4.166$ = 4.17%13. Correct answer is [2.49]. Given  $d = 1 \text{g/cm}^3 = 10^3 \text{ kg/m}^3$  $h = 2 \text{ cm} = 2 \times 10^{-2} \text{ m}$  $\pi = dgh = 10^3 \frac{kg}{m^3} \times 10 \frac{m}{S^2} \times 2 \times 10^{-2} m = 200 \frac{kg}{m^2}$  $C = \frac{\text{Weight of Salute}}{\text{md} \cdot \text{wt}} \times \frac{1}{V(\text{in dm}^3)} = \frac{2\text{gm}}{M} \times \frac{1}{1\text{dm}^3}$  $1 \,\mathrm{dm^3} = 10^{-3} \,\mathrm{m^3}$  $C = \frac{2g}{r} \times \frac{10^3}{m^3}$  $R = 8.3 \frac{J}{K \text{ mol}} = 8.3 \frac{\text{kgm}^2}{\text{S}^2} \times \frac{1}{\text{K mol}}$  $200 \frac{\text{K}}{\text{ms}^2} = \frac{2\text{gm}}{\text{M}} \times \frac{10^3}{\text{m}^3} \times 8.3 \frac{\text{kgm}^2}{\text{S}^2 \text{ K mol}} 300 \text{ K}$  $M = \frac{2 \times 10^3 \times 8.3 \times 300}{200} \text{ m/mol}$  $M = 2.49 \times 10^4 \text{ g/mol}$ X = 2.4914. Correct answer is [105.5].  $C_4H_{10} + \frac{13}{2}O_2 \rightarrow 4CO_2 + 5H_2O_2$  $\Delta_r G^0 = 4 \times (\Delta G^0_f) CO_2 + 5(\Delta G^0_f) H_2 O - (\Delta G^0_f) C_4 H_{10}$  $= 4 \times -394 + 5 \times -237 - (-18)$ = -1576 + (-1185) + 18 $\Delta_r G^0 = -2743 \text{ kJ/mol}$ So,  $\Delta G_{r}^{0} = -nFE_{cell}^{0}$ (n = 26 for combustion of butane) $E^{0}_{cell} = \frac{2743 \times 10^{3}}{26 \times F} = \frac{105.5 \times 10^{3}}{F} , X = 105.50$ 15. Correct answer is [7.73]

 $(MnBr_{6})^{3-}$ 

...(i)

...(ii)

Oxidation State of Mn = +3 E.C. of Mn<sup>3+</sup> = 3d<sup>4</sup>  $t_{2g}^{3} e_{g}^{1}$ Number of unpaired e<sup>-</sup> = 4 Spin only magnetic moment =  $\sqrt{n(n+2)}$  B.M =  $\sqrt{4(4+2)} = \sqrt{24} = 4.9$  B.M [Mn (CN)<sub>6</sub>]<sup>3-</sup> Mn<sup>3+</sup>  $\Rightarrow t_{2g}^{4} e_{g}^{0}$ Number of unpaired e<sup>-</sup> = 2  $\mu = \sqrt{2(2+2)} = \sqrt{8} = 2.83$  B.M So, total spin only magnetic moment = 4.9 + 2.83 = 7.73

### 16. Correct answer is [2].

Octasaccharide  $\xrightarrow{H_3O^{\oplus}}$  Ribose + 2-deoxyribose + glucose It has 7 C - O - C linkage. So, it will had 7 H<sub>2</sub>O molecule for hydrolysis. (w/w%) of 2-deoxyribose = 58.26  $58.26 = \frac{134 \times n \times 100}{1150}$ n = 5mass of ribose + mass of glucose = 1150 - 134 × 5 = 480 So, number of ribose of unit will be 2 and number of glucose unit will be 1.