zigyan

PREVIOUS YEAR PAPER · 2024

OLYMPIAD · STAGE I

NSEC

National Standard Examination in Chemistry

2024

Question paper, answer key and Zigyan solutions

60	216	120 min	31
Questions	Maximum marks	Time	Paper code

Question paper and official answer key: Indian Association of Physics Teachers (IAPT), NSEC 2024, paper code 31.
Solutions and notes: Zigyan. This booklet is not an IAPT publication.

Prepare for the Olympiads with Zigyan

www.zigyan.com

zigyan

SCO No. 107, Sector 16, Faridabad, Haryana 121002
0129-4048800 · +91 92115 38800 · info@zigyan.com

zigyan

JEE 2026 RESULTS

OUR TOPPERS

When talent meets the right guidance.

Saksham Bishnoi and Sulokya Bibhuty - our JEE 2026 toppers from Zigyan, Sector 16 - with the programme they took and the rank they earned.



Rahul Kaushik Sir
Founder & Director, Zigyan Eduvision
23 years of teaching



Saksham Bishnoi

4 YEARS CLASSROOM

JEE ADVANCED 2026	JEE MAIN 2026
AIR 168	AIR 811
	99.95 percentile



Sulokya Bibhuty

3 YEARS CLASSROOM

JEE ADVANCED 2026	JEE MAIN 2026
AIR 1,315	AIR 1,095
	99.94 percentile

OLYMPIAD RESULTS

Above the Minimum Admissible Score - the national band for the subject

CHEMISTRY

- Sulokya Bibhuty — 3 Years Classroom
- Anay Gupta — 3 Years Classroom
- Akshat Khator — 3 Years Classroom
- Harshit Goyal — 4 Years Classroom
- Hardik Sharma — 3 Years Classroom
- Aarush Kumar — 1 Year Classroom

PHYSICS

- Sulokya Bibhuty — 3 Years Classroom
- Saksham Bishnoi — 4 Years Classroom

ASTRONOMY

- Sulokya Bibhuty — 3 Years Classroom

MATHEMATICS (IOQM)

- Priyanshi — 4 Years Classroom

Saksham Bishnoi qualified the Chemistry Olympiad twice and was selected for the Orientation-cum-Selection Camp at HBCSE, Mumbai.

16 selections	16 of 35	AIR 168
in JEE Advanced 2026	students of the batch selected	best JEE Advanced rank

Start where they started.

Register for ZEST - ₹200 · www.zigyan.com/scholarship/zest

+91 92115 38800
info@zigyan.com

Given in the question paper

Useful constants

Charge of electron, $e = 1.602 \times 10^{-19}\,C$

Mass of electron, $m_e = 9.1 \times 10^{-31}\,kg$

Planck's constant, $h = 6.63 \times 10^{-34}\,J\,s$

Speed of light, $c = 3.0 \times 10^{8}\,ms^{-1}$

Avogadro constant, $N_A = 6.022 \times 10^{23}\,mol^{-1}$

Faraday constant $F = 96500\,C\,mol^{-1}$

Molar gas constant, $R = 0.082\,L\,atm\,mol^{-1}K^{-1}$

$= 8.314\,J\,mol^{-1}\,K^{-1}$

PART A-1 · ONE CORRECT OPTION

Q. 1 – 48 · +3 for a correct answer, –1 for a wrong one

1. A closed vessel with rigid walls contains 1.0 mol of component M (vapour pressure p_M^*): 0.9 mol liquid and 0.1 mol vapor. 0.1 mol of component N (vapour pressure p_N^*) is added slowly to maintain equilibrium conditions. Assume M and N form an ideal solution. The total pressure at the end of the addition will:

(A) decrease if $p_M^* < p_N^*$

(B) decrease irrespective of relation between p_M^* and p_N^*

(C) increase if $p_M^* < p_N^*$

(D) increase irrespective of relation between p_M^* and p_N^*

Solution · Q1 **Answer: (C)**

Some liquid remains, so by Raoult's law,

$$P = x_M p_M^* + x_N p_N^*$$

$$\Rightarrow P - p_M^* = x_N(p_N^* - p_M^*)$$

The starting pressure is that of pure M.

$\therefore$ the pressure rises only when N is more volatile than M, as stated in (C).

IAPT answer: (C) | **Zigyan answer:** (C)

2. A scuba diver accidentally surfaces from a depth of 100 feet in water (pressure = 4 atm). The solubility of nitrogen from air (78% N_2 in air) in water in standard conditions is 15 mg L^{-1} at 37 °C. The volume of N_2 gas released into the bloodstream of the diver from each litre of blood is:

(Assume blood to behave similarly as water)

(A) 14 mL (B) 41 mL (C) 55 mL (D) 12 mL

Solution · Q2 **Answer: (B)**

By Henry's law, solubility is proportional to pressure.

At 4 atm of air,

$$S = 4 \times 15 = 60\ mg\ L^{-1}$$

Nitrogen released from each litre:

$$60 - 15 = 45 \text{ mg} = 0.045 \text{ g}$$

Volume at 37 °C and 1 atm:

$$V = \frac{0.045 \times 0.082 \times 310}{28 \times 1}$$

$$\Rightarrow V \approx 0.041 \text{ L} = 41 \text{ mL}$$

IAPT answer: (B) | **Zigyan answer:** (B)

3. A 35 degree drop in temperature from 25 °C causes a 8.2-fold decrease in the rate of a first order reaction. If the half-life of the reaction is 3.2 h, what will be the half-life at a temperature of –10°C?

(A) 12.8 h (B) 19.8 h (C) 26.2 h (D) 23.4 min

Solution · Q3 **Answer: (C)**

The temperature falls from 25 °C to –10 °C. The half-life of 3.2 h is taken to be at 25 °C.

For a first order reaction,

$$t_{1/2} \propto 1/k$$

The rate constant becomes 8.2 times smaller, so at –10 °C,

$$t_{1/2} = 8.2 \times 3.2 = 26.24 \text{ h}$$

IAPT answer: (C) | **Zigyan answer:** (C)

4. An ideal-gas reaction equilibrium is represented as $A + B \rightleftharpoons C + D$. Considering, the fact that all components are ideal and that only A and B are present initially, which of the following options is **ALWAYS true** at equilibrium? 'N' is the number of moles of the species.

(A) $N_C = N_A$ (B) $N_C + N_D = N_A + N_B$

(C) $N_C = N_D$ (D) $N_A = N_B$

Solution · Q4 **Answer: (C)**

Take a mol of A and b mol of B at the start. Let x mol of each react.

$$N_A = a - x$$

$$N_B = b - x$$

$$N_C = N_D = x$$

The values of a, b and x are not fixed, so only (C) is always true.

IAPT answer: (C) | **Zigyan answer:** (C)

5. Which of the following statements is **correct**?

(A) The addition of neon to a gas-phase reaction mixture at equilibrium at constant T and constant V does not alter the equilibrium.

(B) For a reversible reaction in a closed system with constant T and constant P if $\left(\frac{\partial G}{\partial \xi}\right)_{T,P} > 0$, the reaction proceeds in the reverse direction. Here 'ξ' is the extent of the reaction.

(C) Complete dissociation of a weak electrolyte takes place in the limit of infinite dilution in aqueous solution.

(D) The standard state of a species is always a pure substance.

Solution · Q5 **As per Zigyan: (B)**

IAPT final key: (A) or (B). Both are accepted; (B) needs no extra condition, while (A) assumes ideal gases.

(B) At constant T and P, a spontaneous change lowers G. When

$$\left(\frac{\partial G}{\partial \xi}\right)_{T,P} > 0$$

G falls only if ξ decreases, so the reaction runs backward. ∴ true.

(A) At constant V, neon leaves each partial pressure unchanged. ∴ true for ideal gases; in real gases it may change fugacities.

(C) NCERT gives complete dissociation as the limit. Strictly, water's own ions remain, so for a very dilute weak acid,

$$\alpha \to \frac{K_a}{K_a + 10^{-7}}$$

This is below 1 (at 25 °C). ∴ strictly false.

(D) For a dissolved solute, the standard state is a solution of unit concentration (ideal behaviour), not the pure substance. ∴ false.

Reference: NCERT Chemistry Class XI (Part I), Unit 6 'Equilibrium', section 6.7: with positive ΔG the forward change is not spontaneous, and its products turn back into reactants.

Reference: Same Unit, section 6.8.3: an inert gas added at constant volume leaves partial pressures, and so the equilibrium, unchanged.

IAPT answer: (A) or (B) | **Zigyan answer:** (B)

6. Consider the following statements about the given mechanism:

$$A + B \rightarrow C + D$$
$$2C \rightarrow F$$
$$F + B \rightarrow 2A + G$$

(i) The overall reaction is **3B → 2D + G**

(ii) A is a catalyst and B is a reactant.

(iii) C and F are intermediates.

(iv) D and G are products

The correct set of statements is

(A) (i) and (ii) only

(B) (iii) and (iv) only

(C) (ii), (iii) and (iv) only

(D) All (i), (ii), (iii) and (iv)

Solution · Q6 **Answer: (D)**

Take the first reaction twice:

$2A + 2B \rightarrow 2C + 2D$

$2C \rightarrow F$

$F + B \rightarrow 2A + G$

On adding,

$3B \rightarrow 2D + G$

$\therefore$ (i) is true.

A is used and formed again (catalyst), while B is consumed: (ii) is true.

C and F are formed and then used up (intermediates): (iii) is true.

D and G remain as products: (iv) is true.

IAPT answer: (D) | **Zigyan answer:** (D)

7. For one mole of a van der Waal gas with b = 0, the plot of PV versus 1/V at 298 K gives an intercept of 24.4 L atm K mol^{-1} and slope of – 2.5 L^2 atm mol^{-2}. The value of the van der Waal constant a is

(A) 12.5 L^2 atm mol^{-2}

(B) 5.0 L^2 atm mol^{-2}

(C) 4.5 L^2 atm mol^{-2}

(D) 2.5 L^2 atm mol^{-2}

Solution · Q7 **Answer: (D)**

For one mole of this gas,

$$\left(P + \frac{a}{V^2}\right)V = RT$$
$$\Rightarrow PV = RT - \frac{a}{V}$$

So the slope of the line of PV against 1/V is −a.

$$-a = -2.5\ L^2\ atm\ mol^{-2}$$
$$\therefore a = 2.5\ L^2\ atm\ mol^{-2}$$

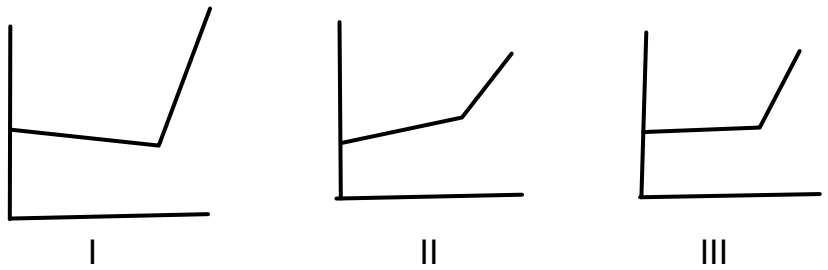
IAPT answer: (D) | **Zigyan answer:** (D)

8. The following three plots show the variation of conductance with mL of titrant added for three titrations of aqueous solutions of Na_2SO_4, $(NH_4)_2SO_4$, $BaCl_2$

Given: Molar ionic conductivities in S cm^2 mol^{-1} are

Ba^{2+}	Cl^-	Na^+	SO_4^{2-}	NH_4^+
127.3	**76.4**	**50.1**	**160**	**73.6**

Titration	Analyte	Titrant
A	$BaCl_2$	$(NH_4)_2SO_4$
B	Na_2SO_4	$BaCl_2$
C	$BaCl_2$	Na_2SO_4



Assign the plots to the respective titrations

(A) I-A, II–B, III-C (B) I-B, II–C, III-A (C) I-C, II–A, III-B (D) I-B, II–A, III-C

Solution · Q8 **Answer: (C)**

Change in ionic conductivity per mole of titrant, before the end point:

A: Ba^{2+} is replaced by $2NH_4^+$.

$$2(73.6) - 127.3 = +19.9$$

B: SO_4^{2-} is replaced by $2C\ell^-$.

$$2(76.4) - 160 = -7.2$$

C: Ba^{2+} is replaced by $2Na^+$.

$$2(50.1) - 127.3 = -27.1$$

Only A gives a rise, so II is A. C falls more steeply than B, so I is C and the nearly level III is B.

IAPT answer: (C) | **Zigyan answer:** (C)

9. 150 g of liquid water at 20°C is mixed with 40 g of ice at 0°C in a coffee cup calorimeter. The final temperature (in °C) reached will be (assuming no heat loss or gain by the surroundings)

Latent heat of ice = 334.72 J/g

Specific heat of water = 4.2 J/g °C

(A) 1.35 (B) -1.35 (C) 0 (D) 4

Solution · Q9 **Answer: (C)**

Heat given out by the water on cooling to 0 °C:

$$q_1 = 150 \times 4.2 \times 20 = 12600 \text{ J}$$

Heat needed to melt all the ice:

$$q_2 = 40 \times 334.72 = 13388.8 \text{ J}$$

$$q_1 < q_2$$

Some ice stays unmelted, so the final temperature is 0 °C.

IAPT answer: (C) | **Zigyan answer:** (C)

10. A chemical reaction, X (g) + Y(g) → Z (g) has following mechanism:

$$X_{(g)} + S_{(s)} \underset{k_2}{\overset{k_1}{\rightleftharpoons}} [X-S]\ (s)$$

$$[X-S]\ (s) + Y_{(g)} \underset{k_4}{\overset{k_3}{\rightleftharpoons}} Z_{(g)} + S\ (s)$$; [where (S) is solid catalyst]

The overall equilibrium constant for above reaction can be represented as

(A) $K = \frac{k1 \,.\, k2}{k3 \,.\, k4}$ (B) $K = \frac{k1 \,.\, k3}{k2 \,.\, k4}$

(C) $K = \frac{k4 \,.\, k1}{k2 \,.\, k3}$ (D) $K = \frac{k4 \,.\, k2}{k3 \,.\, k1}$

Solution · Q10 **Answer: (B)**

For the two equilibria,

$$K_1 = k_1/k_2$$

$$K_2 = k_3/k_4$$

On adding them, S and [X–S] cancel, so the constants multiply:

$$K = K_1 K_2 = \frac{k_1 k_3}{k_2 k_4}$$

IAPT answer: (B) | **Zigyan answer:** (B)

11. Given below is a galvanic cell

$Cu\ (s)\ |\ Cu^{2+}\ (aq.)\ (x\ M)\ ||\ Ag^{+}\ (aq.)\ (y\ M)|Ag\ (s)$

The possible condition for the galvanic cell to develop emf of 0.5 V is:

[Given: $E°_{Cu^{2+}/Cu} = 0.34V$ and $E°_{Ag^{+}/Ag} = 0.8V$]

(A) x = 0.015 and y = 0.3 (B) x = 0.05 and y = 0.25

(C) x = 0.04 and y = 0.2 (D) x = 0.011 and y = 0.5

Solution · Q11 **Answer: (D)**

$$E°_{cell} = 0.80 - 0.34 = 0.46\ V$$

Cell reaction:

$Cu + 2Ag^{+} \rightarrow Cu^{2+} + 2Ag$

By the Nernst equation at 298 K,

$$0.50 = 0.46 - \frac{0.059}{2}\log\frac{x}{y^2}$$

$$\Rightarrow \log\frac{x}{y^2} \approx -1.36$$

$$\Rightarrow \frac{x}{y^2} \approx 0.044$$

Option (D) gives this ratio:

$$\frac{0.011}{(0.5)^2} = 0.044$$

IAPT answer: (D) | **Zigyan answer:** (D)

12. If 5A current is passed for an hour through one dm^3 0.5 M aqueous solution of sodium acetate, then the amount of ethane produced will be:

(A) 2.79 g (B) 4.2 g (C) 1.39 g (D) 5.58 g

Solution · Q12 **Answer: (A)**

Kolbe electrolysis at the anode, taking 100% current efficiency:

$2CH_3COO^{-} \rightarrow C_2H_6 + 2CO_2 + 2e^{-}$

$$Q = 5 \times 3600 = 18000\ C$$

Moles of ethane:

$$n = \frac{18000}{2 \times 96500} = 0.0933\ mol$$

$$\Rightarrow m = 0.0933 \times 30 \approx 2.80\ g$$

The matching option is 2.79 g.

IAPT answer: (A) | **Zigyan answer:** (A)

13. The results obtained when the finely divided metal powders of P, Q, R and S added to the aqueous solutions of different metal nitrates are given below:

Metal	Silver Nitrate	Lead Nitrate	Nickel Nitrate	Zinc Nitrate
P	√	√	√	x
Q	√	√	√	√
R	√	√	x	x
S	√	x	x	x

Displacement = √, No reaction = x

[Given: $E°_{Ag^+/Ag} = 0.80$ V, $E°_{Zn^{2+}/Zn} = -0.76$ V, $E°_{Ni^{2+}/Ni} = -0.25$ V, $E°_{Pb^{2+}/Pb} = -0.13$ V]

If these elements are to be arranged as per their positions in the electrochemical series, then which of the following will represent the above set of observations?

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

Solution · Q13 **As per Zigyan: (C)**

A metal displaces from solution only a metal whose E° is higher than its own.

Q displaces even Zn:

$$E°_Q < -0.76 \text{ V}$$

P displaces Ni but not Zn:

$$-0.76 \text{ V} < E°_P < -0.25 \text{ V}$$

R displaces Pb but not Ni:

$$-0.25 \text{ V} < E°_R < -0.13 \text{ V}$$

S displaces only Ag:

$$-0.13 \text{ V} < E°_S < 0.80 \text{ V}$$

So the order in the activity series (displacing, or reducing, power) is:

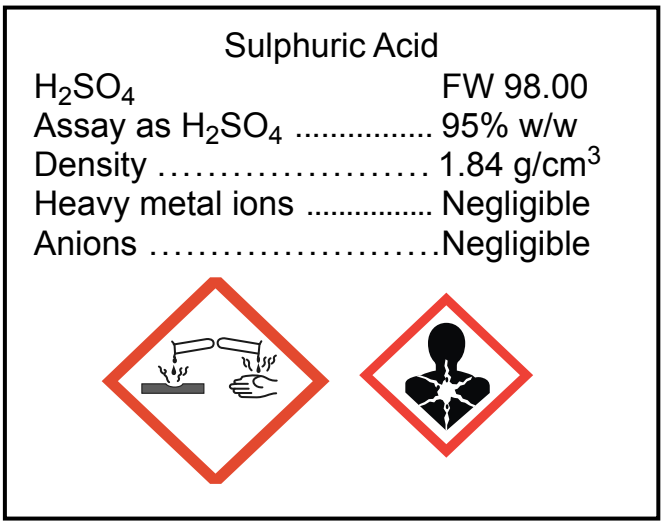
$$Q > P > R > S$$

Why Zigyan differs from IAPT: S > R > P > Q puts first the metal that displaces only silver, the reverse of the observations.

Reference: NCERT Chemistry Class XI (Part II), Unit 7 'Redox Reactions', section 7.2.1: the activity (electrochemical) series ranks metals by their tendency to release electrons, written Zn>Cu>Ag.

IAPT answer: (B) | **Zigyan answer:** (C)

14. The molarity of the commercially available concentrated sulphuric acid solution with label on the bottle is as shown below is:



(A) 19.38 M (B) 17.83 M (C) 20.77 M (D) 18.34 M

Solution · Q14 **Answer: (B)**

Mass of 1 L solution:

$$m = 1000 \times 1.84 = 1840 \text{ g}$$

Mass of H_2SO_4 in it:

$$w = 0.95 \times 1840 = 1748 \text{ g}$$

Molarity:

$$c = \frac{1748}{98} = 17.836 \text{ M}$$

This matches 17.83 M.

IAPT answer: (B) | **Zigyan answer:** (B)

15. Oxide ions with ions of metals A and B together, form a crystal. The oxide ions get organized into a cubic closed packed (ccp) lattice. In the oxide lattice, the metal ion A occupy 25% of the octahedral voids and the metal ion B occupies 50% of the tetrahedral voids. Oxidation states of A and B respectively are:

(A) +3, +1 (B) +4, +1 (C) +1, +3 (D) +2, +4

Solution · Q15 **Answer: (B)**

Per unit cell, ccp has 4 oxide ions, 4 octahedral voids and 8 tetrahedral voids.

$$A = 0.25 \times 4 = 1$$

$$B = 0.50 \times 8 = 4$$

Formula:

AB_4O_4

For charges a on A and b on B:

$$a + 4b = 8$$

$$\Rightarrow a = +4, b = +1$$

IAPT answer: (B) | **Zigyan answer:** (B)

16. Consider the statements

(i) Energy of the electron in the fourth orbit of He^+ ion is less than the energy of the electron in the fourth orbit of hydrogen atom.

(ii) Radius of the first orbit of He^+ ion is 0.529 Å.

(iii) In the Lyman series as the energy liberated during the transition increases then the distance between the spectral lines goes on decreasing.

(iv) If the radius of the 2nd orbit of Li^{2+} is x, the expected radius of the 3rd orbit of Be^{3+} is $\frac{9}{4}x$.

(v) In hydrogen atom, 3p and 3d orbitals are not degenerate orbitals.

The correct set of statements is

(A) (i) and (ii)
(B) (i) and (iii)
(C) (ii), (iii) and (iv)
(D) (i), (iii) and (v)

Solution · Q16 **Answer: (B)**

$$E = -13.6\frac{Z^2}{n^2}\ eV$$

Fourth orbit:

$$E(He^+) = -3.4\ eV,\ E(H) = -0.85\ eV$$

(i) is true.

$$r = 0.529\frac{n^2}{Z}\ Å$$

$$r_1(He^+) = 0.2645\ Å$$

(ii) is false.

(iii) is true: Lyman lines crowd together as the transition energy rises.

$$\frac{r_3}{r_2} = \frac{9/4}{4/3} = \frac{27}{16}$$

$$\Rightarrow r_3 = 27x/16$$

(iv) is false.

(v) is false: in H, 3p and 3d are degenerate.

IAPT answer: (B) | **Zigyan answer:** (B)

17. The mixture of $Al(OH)_3$ and $Fe(OH)_3$ can be separated by:

(i) leaching method

(ii) froth floatation method

(iii) gravity separation method

(iv) magnetic separation method

(A) (i) and (ii) only
(B) (ii) and (iii) only
(C) (i) and (iv) only
(D) (iii) and (iv) only

Solution · Q17 **Answer: (C)**

$A\ell(OH)_3$ is amphoteric, so alkali leaches it out:

$A\ell(OH)_3 + NaOH \rightarrow Na[A\ell(OH)_4]$

$Fe(OH)_3$ stays undissolved.

Fe^{3+} compounds are paramagnetic and $A\ell(OH)_3$ is diamagnetic, so magnetic separation is the second method.

So (i) and (iv).

IAPT answer: (C) | **Zigyan answer:** (C)

18. The anions giving white precipitate completely soluble in concentrated hydrochloric acid with barium chloride solution are:

(i) sulphite ; (ii) carbonate ; (iii) sulphate ; (iv) nitrate

(A) (i) and (ii) only
(B) (ii) and (iii) only
(C) (i) and (iv) only
(D) (i), (iii) and (iv) only

Solution · Q18 **Answer: (A)**

$Ba^{2+} + SO_3^{2-} \rightarrow BaSO_3\downarrow$

$BaSO_3 + 2HC\ell \rightarrow BaC\ell_2 + SO_2 + H_2O$

$Ba^{2+} + CO_3^{2-} \rightarrow BaCO_3\downarrow$

$BaCO_3 + 2HC\ell \rightarrow BaC\ell_2 + CO_2 + H_2O$

White $BaSO_4$ does not dissolve in conc. $HC\ell$, and nitrate gives no such precipitate.

So (i) and (ii) only.

IAPT answer: (A) | **Zigyan answer:** (A)

19. The substituted silanes which can produce dimeric and cyclic trimeric silicone polymers, respectively on hydrolysis are:

1. $RSiCl_3$
2. R_2SiCl_2
3. R_3SiCl

(A) 1, 2 (B) 1, 3 (C) 3, 2 (D) 2, 3

Solution · Q19 **Answer: (C)**

A dimer needs one –OH on each Si:

$R_3SiC\ell + H_2O \rightarrow R_3SiOH + HC\ell$

$2R_3SiOH \rightarrow R_3Si{-}O{-}SiR_3 + H_2O$

A cyclic trimer needs two –OH on each Si:

$R_2SiC\ell_2 + 2H_2O \rightarrow R_2Si(OH)_2 + 2HC\ell$

$3R_2Si(OH)_2 \rightarrow (R_2SiO)_3 + 3H_2O$

So 3 and 2.

IAPT answer: (C) | **Zigyan answer:** (C)

20. Identify the correct pair of species with the correct description.

(A) $CH_4 \rightarrow {}^{-}CH_3$ -change in both hybridization and shape

(B) $NH_3 \rightarrow NH_4^{+}$ - no change in shape and change in hybridization

(C) $BF_3 \rightarrow BF_4^{-}$ -change in both hybridization and shape

(D) $H_2O \rightarrow H_3O^{+}$ -no change in hybridization as well as shape

Solution · Q20 **Answer: (C)**

(A) sp^3 stays sp^3; tetrahedral becomes pyramidal. Only shape changes.

(B) sp^3 stays sp^3; pyramidal becomes tetrahedral. Shape changes.

(C) sp^2 becomes sp^3; trigonal planar becomes tetrahedral. Both change: correct.

(D) sp^3 stays sp^3; bent becomes pyramidal. Shape changes.

IAPT answer: (C) | **Zigyan answer:** (C)

21. A student mixed three sodium salts accidentally. To identify these salts, some tests were performed and found that

i. When chromyl chloride test was performed, mixture of colored gases released and NaOH solution turned yellow and gave positive test.

ii. Brown ring test was positive but brown coloured gas was not intensified on adding copper turnings on heating the mixture with conc. H_2SO_4.

iii. Aqueous solution of the mixture was treated with $CHCl_3$ and chlorine water. From this chloroform layer $CHCl_3$ test was performed. A violet organic layer was first visible then on more addition of concentrated HNO_3, it changed to orange yellow. The observations indicate the presence of:

(A) chloride, bromide and iodide
(B) nitrate, bromide and iodide
(C) fluoride, nitrate and iodide
(D) chloride, nitrite and iodide

Solution · Q21 **As per Zigyan: (A)**

Yellow NaOH solution in the chromyl chloride test shows $C\ell^-$.

The violet $CHC\ell_3$ layer shows I^-:

$2I^- + C\ell_2 \rightarrow I_2 + 2C\ell^-$

More oxidant turns I_2 into colourless iodic acid:

$I_2 + 10HNO_3 \rightarrow 2HIO_3 + 10NO_2 + 4H_2O$

The orange-yellow colour then seen is that of Br_2, so Br^- is present.

Brown gas not increased by copper means no NO_3^-.

Conc. H_2SO_4 itself frees coloured Br_2 and I_2 from these halides, so the brown colour in the ring test is not due to nitrate.

So chloride, bromide and iodide.

Why Zigyan differs from IAPT: an orange-brown organic layer is the confirmatory test for bromide, and option (D) contains no bromide.

Reference: NCERT Chemistry Laboratory Manual Class XII, Unit 7 'Systematic Qualitative Analysis': with chlorine water, a violet organic layer shows iodide and an orange-brown one bromide; yellow NaOH in the chromyl chloride test belongs to chloride.

Reference: The same unit shows nitrate by excess brown fumes on heating with copper turnings and conc. H_2SO_4; heating bromide or iodide salts with this acid gives Br_2 or I_2 vapours.

IAPT answer: (D) | **Zigyan answer:** (A)

22. Total number of stereoisomers shown by the complex $[W(CO)_4\{P(OR)_3\}SR']$ (where R = $-C_6H_5$; R' = $-CH_3$)

(A) Two (B) One (C) Three (D) Four

Solution · Q22 **Answer: (A)**

This is an octahedral $[MA_4BC]$ complex, with A as CO, B as $P(OR)_3$ and C as SR′ (each taken as a single point).

B and C can be trans or cis: two geometrical isomers.

Both have a mirror plane. In the cis form, the plane through W, B and C reflects the other two CO groups into each other.

So there is no optical isomer, and the total is 2.

IAPT answer: (A) | **Zigyan answer:** (A)

23. **A**, **B** and **C** are three complexes of chromium (III) with empirical formula $H_{12}O_6Cl_3Cr$. All the three complexes have water and chloride ions as ligands. **W**hen subjected to heating at 200°C the mass of A was found to be constant, while that of B suffered a loss of 6.7%. When 2.66 g of C was treated with $AgNO_3$ it gave 1.43 g of AgCl. The complexes B and C are respectively:

1. $[Cr(H_2O)_6Cl_3]$
2. $[Cr(H_2O)_6]Cl_3$
3. $[Cr(H_2O)_5Cl]Cl_2.H_2O$
4. $[Cr(H_2O)_4Cl_2]Cl.2H_2O$
5. $[Cr(H_2O)_3Cl_3].3H_2O$

(A) 3, 4 (B) 3, 5 (C) 1, 2 (D) 2, 5

Solution · Q23 **Answer: (A)**

Molar mass of $CrC\ell_3\cdot 6H_2O$:

$$M = 266.5\ g\ mol^{-1}$$

Only water outside the coordination sphere is taken to leave on heating. Loss for one H_2O:

$$\frac{18}{266.5}\times 100 \approx 6.75\%$$

So B is $[Cr(H_2O)_5C\ell]C\ell_2\cdot H_2O$ (3).

For C:

$$n(C) = \frac{2.66}{266.5} \approx 0.01\ mol$$

$$n(AgC\ell) = \frac{1.43}{143.5} \approx 0.01\ mol$$

So C has one ionisable $C\ell^-$: $[Cr(H_2O)_4C\ell_2]C\ell\cdot 2H_2O$ (4).

IAPT answer: (A) | **Zigyan answer:** (A)

24. 126 g oxalic acid ($H_2C_2O_4.2\ H_2O$) under acidic conditions will be oxidized by:

i. $\frac{1}{3}$ mole of $K_2Cr_2O_7$

ii. $\frac{5}{2}$ mol $K_2Cr_2O_7$

iii. $\frac{1}{3}$ mol $KMnO_4$

iv. $\frac{5}{2}$ mol $KMnO_4$

(A) i and iii only (B) i and iv only (C) ii and iii only (D) ii and iv only

Solution · Q24 **As per Zigyan: no option is correct**

The molar mass of the dihydrate is 126 g mol^{-1}, and each mole gives 2 mol of electrons.

Moles of oxalic acid:

$$n = 126/126 = 1 \text{ mol}$$

$K_2Cr_2O_7$ accepts 6 electrons:

$$n = \frac{2}{6} = \frac{1}{3} \text{ mol}$$

(i) is true and (ii) is false.

$KMnO_4$ accepts 5 electrons:

$$n = \frac{2}{5} \text{ mol}$$

(iii) and (iv) are false.

So only (i) is correct, and no option lists (i) alone.

Why Zigyan differs from IAPT: 5/2 mol of either oxidant is not the amount that oxidises 1 mol of acid, so (ii) and (iv) are wrong.

Reference: NCERT Chemistry Laboratory Manual Class XII, Unit 7: the permanganate test for oxalate, in dilute H_2SO_4, is balanced with 2 mol $KMnO_4$ for 5 mol oxalic acid.

Check: balancing dichromate separately, one mole of $K_2Cr_2O_7$ oxidises three moles of oxalic acid, giving six moles of carbon dioxide.

IAPT answer: (B) or (D) | **Zigyan answer:** none of the options is correct

25. A carbonyl complex of Iridium (electronic configuration- [Xe] $4f^{14}$ $5d^7$ $6s^2$) with the formula IrCl(CO)$(PPh_3)_2$ is known as Vaska's complex. Which of the following ligand substitution/s will decrease the triple bond character of CO in Vaska's complex?

(A) Both PPh_3 by PMe_3

(B) Cl^- by CH_3^-

(C) Cl^- by PF_3

(D) Both PPh_3 by $P(CH_2Cl)_3$

Solution · Q25 **As per Zigyan: (A)**

The C–O triple bond character falls when Ir pushes more electron density into the π* orbital of CO.

PMe_3 is a stronger electron donor than PPh_3.

So on replacing both PPh_3 by PMe_3, Ir becomes richer in electrons.

∴ Ir → CO back bonding increases and the C–O bond order decreases.

Reference: NCERT Chemistry Class XII (Part I), Unit 5 'Coordination Compounds', section 5.6: the metal to carbon π bond forms when a filled metal d orbital donates electrons into the empty π* orbital of CO.

Reference: LibreTexts, Johns Hopkins University course 030.356, 'Carbon Monoxide and backbonding': electron-rich phosphine ligands on a metal lower the CO stretching frequency because back-bonding improves.

IAPT answer: (A) | **Zigyan answer:** (A)

26. A water sample is analysed and found to have concentration of Zn = 5.0 g m^{-3}, Fe = 0.5 µg mL^{-1}, Mn = 0.05 ppm and Cd = 0.005 ppb. The maximum prescribed concentration of metals in drinking water in mg dm^{-3} is Zn = 5.0, Fe = 0.2, Mn = 0.05 and Cd = 0.005. Identify the correct statement about the sample of water.

(A) The water sample is having excess of Zn than the maximum prescribed concentration.

(B) The water sample is having lower concentration of Mn and Cd than the maximum prescribed concentration.

(C) The water sample is potable (suitable for drinking).

(D) The concentration of Fe is 0.5ppm.

Solution · Q26 **Answer: (D)**

Each value in mg dm^{-3}:

$$\text{Zn: } 5.0 \text{ g } m^{-3} = 5.0 \text{ mg } dm^{-3}$$

$$\text{Fe: } 0.5 \text{ µg } mL^{-1} = 0.5 \text{ mg } dm^{-3}$$

⇒ Fe is 0.5 ppm.

$$\text{Mn: } 0.05 \text{ ppm} = 0.05 \text{ mg } dm^{-3}$$

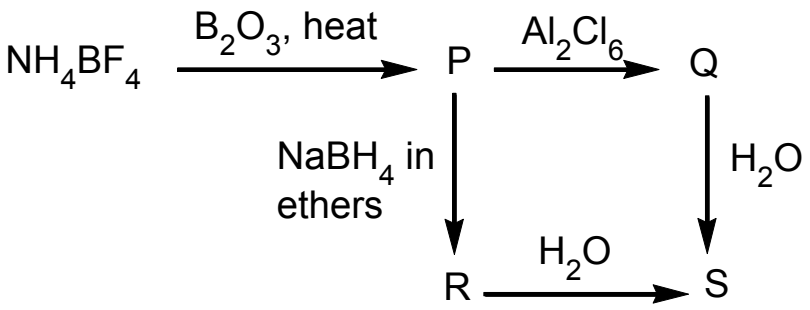
$$\text{Cd: } 0.005 \text{ ppb} = 5 \times 10^{-6} \text{ mg } dm^{-3}$$

Zn and Mn are at their limits, Cd is below its limit and Fe is above it, so the water is not potable.

∴ only the statement about Fe is correct.

IAPT answer: (D) | **Zigyan answer:** (D)

27. In the following reaction sequence, identify P, Q, R and S



(A) P = BF_3, Q = BCl_3, R = B_2H_6, S = $B(OH)_3$

(B) P = NH_4BO_2, Q = B_2Cl_4, R = $B(OH)_3$, S = $B(OH)_4^-$

(C) P = NH_4BO_2, Q = $B(OH)_3$, R = $NaBO_2$, S = $B(OH)_3$

(D) P = BF_3, Q = B_2Cl_4, R = $B(OH)_3$, S = $B(OH)_4^-$

Solution · Q27 **Answer: (A)**

On heating with B_2O_3, NH_4BF_4 gives BF_3, which is P.

$2BF_3 + A\ell_2C\ell_6 \rightarrow 2BC\ell_3 + 2A\ell F_3$

$4BF_3 + 3NaBH_4 \rightarrow 2B_2H_6 + 3NaBF_4$

$BC\ell_3 + 3H_2O \rightarrow B(OH)_3 + 3HC\ell$

$B_2H_6 + 6H_2O \rightarrow 2B(OH)_3 + 6H_2$

$\therefore$ Q is $BC\ell_3$, R is B_2H_6 and S is $B(OH)_3$.

IAPT answer: (A) | **Zigyan answer:** (A)

28. The correct order of CFSE for the ions in the complexes having same ligands is:

(A) $V^{+2} < Mn^{+2} < Fe^{+2} < Co^{+2} < Ni^{+2}$

(B) $V^{+2} > Mn^{+2} = Fe^{+2} > Co^{+2} = Ni^{+2}$

(C) $Ni^{+2} < Co^{+2} < Fe^{+2} < Mn^{+2} < V^{+2}$

(D) $Mn^{+2} < V^{+2} < Co^{+2} < Fe^{+2} < Ni^{+2}$

Solution · Q28 **As per Zigyan: no option is correct**

In an octahedral field, each t_{2g} electron contributes $-0.4\Delta_o$ and each e_g electron $+0.6\Delta_o$.

Size of CFSE for high spin ions, in units of Δ_o:

V^{2+} (d^3): 1.2

Mn^{2+} (d^5): 0

Fe^{2+} (d^6): 0.4

Co^{2+} (d^7): 0.8

Ni^{2+} (d^8): 1.2

In the low spin case, without pairing energy, three values change:

Mn^{2+}: 2.0, Fe^{2+}: 2.4, Co^{2+}: 1.8

None of the four printed orders fits either set of values.

Why Zigyan differs from IAPT: option (A) needs V^{2+} below Mn^{2+}, which fails for high spin ions, and Fe^{2+} below Co^{2+}, which fails for low spin ions.

Reference: NCERT Chemistry Class XII (Part I), Unit 5 'Coordination Compounds', section 5.5.4: in an octahedral field the two e_g orbitals rise by three-fifths of Δ_o and the three t_{2g} orbitals fall by two-fifths of it; filling from d^4 depends on Δ_o and the pairing energy.

IAPT answer: (A) | **Zigyan answer:** none of the options is correct

29. Complexes with ..... geometry can exhibit different types of hybridization of central metal .

(A) square planar

(B) tetrahedral

(C) octahedral

(D) trigonal bipyramidal

Solution · Q29 **Answer: (C)**

Octahedral complexes use either of two hybridisations of the metal:

d^2sp^3 (inner orbital complex)

sp^3d^2 (outer orbital complex)

$\therefore$ the geometry is octahedral.

IAPT answer: (C) | **Zigyan answer:** (C)

30. In the following given pairs, the one with an acidic oxide and a neutral oxide respectively is-

(A) NO, N_2O (B) N_2O_5, NO (C) N_2O, N_2O_5 (D) N_2O, NO

Solution · Q30 **Answer: (B)**

N_2O_5 is acidic, as it is the anhydride of nitric acid.

$N_2O_5 + H_2O \rightarrow 2HNO_3$

NO and N_2O are neutral oxides.

$\therefore$ the required pair is N_2O_5, NO.

IAPT answer: (B) | **Zigyan answer:** (B)

31. Out of the following substances, the one that forms a white solid, has a high melting point and dissociates in water to form a basic solution is-

(A) CO_2 (B) P_4O_{10} (C) Na_2O (D) Cl_2O_7

Solution · Q31 **Answer: (C)**

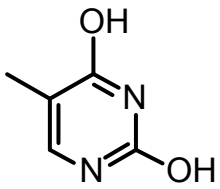
Na_2O is an ionic oxide: a white solid with a high melting point.

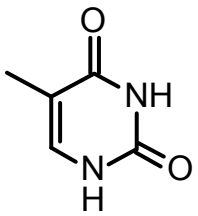
With water it gives a basic solution.

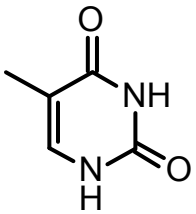
$Na_2O + H_2O \rightarrow 2NaOH$

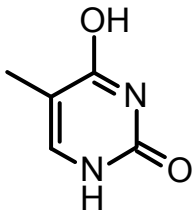
IAPT answer: (C) | **Zigyan answer:** (C)

32. The form in which thymine, the base present in DNA, remains at pH ~ 10, is:

(A) 

(B) 

(C) 

(D) 

Solution · Q32 **As per Zigyan: (B)**

The stable form of thymine is the diketo form, with C=O at C2 and C4 and H on both ring nitrogen atoms.

Its pK_a is about 9.9, so near pH 10 it is only partly ionised by loss of an N–H proton.

The un-ionised molecules keep the diketo structure.

∴ among the structures given, thymine remains in the diketo form.

Why Zigyan differs from IAPT: (A) is the dihydroxy form with two O–H groups. A mildly basic solution only removes a proton from thymine; it does not turn the neutral base into this tautomer.

Reference: NCERT Chemistry Class XII (Part II), Unit 10 'Biomolecules', section 10.5.1: thymine, a base of DNA, is drawn with two carbonyl groups and two ring N–H bonds.

Reference: A research article on DNA bases in water, archived by the US National Library of Medicine (PMC3557938), uses a pK_a of 9.9 for thymine.

IAPT answer: (A) | **Zigyan answer:** (B)

33. The compound not having a planar molecular configuration is:

(A) $H_2C = CH_2$

(B) $H_2C = CH - C \equiv CH$

(C) $H_2C = C = CHCl$

(D) $H_2C = C = C = CH_2$

Solution · Q33 **Answer: (C)**

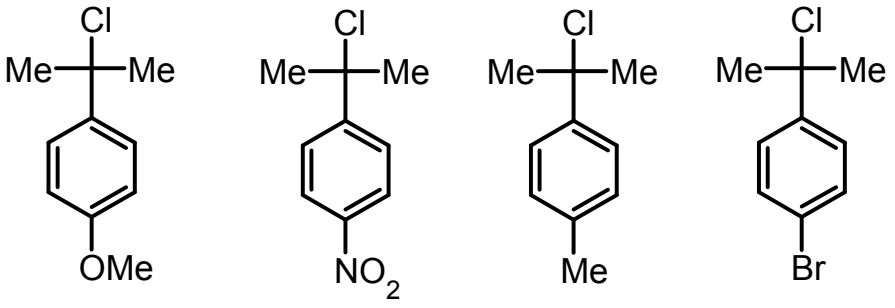
In $H_2C{=}C{=}CH\ell$ the middle carbon is sp hybridised and forms two π bonds at right angles.

So the CH_2 group and the CHCℓ group lie in perpendicular planes.

∴ this molecule is not planar.

IAPT answer: (C) | **Zigyan answer:** (C)

34. For the following molecules, the correct order of reactivity towards S_N1 reaction is:



(I) (II) (III) (IV)

(A) (III) > (II) > (I) > (IV)

(B) (II) > (IV) > (III) > (I)

(C) (I) > (III) > (IV) > (II)

(D) (IV) > (II) > (III) > (I)

Solution · Q34 **Answer: (C)**

The S_N1 rate follows the stability of the tertiary benzylic carbocation.

Effect of the para group on this cation:

OMe: strong +R, most stabilising

Me: +I and hyperconjugation

Br: weakly destabilising, as –I outweighs +R

NO_2: strong –R and –I, most destabilising

∴ (I) > (III) > (IV) > (II)

IAPT answer: (C) | **Zigyan answer:** (C)

35. Relationship of X and Y is :



X Y

(A) same molecules

(B) enantiomers

(C) diastereoisomeres

(D) positional isomers

Solution · Q35 **Answer: (B)**

Both are hexane-2,3,4-triol. Number the chain from the Me end.

X: (2S, 3S, 4R)

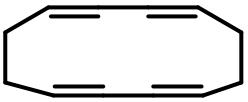
Y: (2R, 3R, 4S)

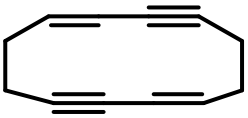
Every stereocentre is inverted, so Y is the mirror image of X.

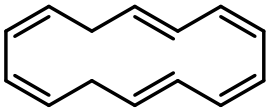
∴ X and Y are enantiomers.

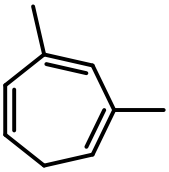
IAPT answer: (B) | **Zigyan answer:** (B)

36. An unsaturated hydrocarbon "M" on oxidative ozonolysis gave a mixture of butanedioic acid and oxalic acid. The structure of the hydrocarbon "M" is:

(A) 

(B) 

(C) 

(D) 

Solution · Q36 **As per Zigyan: (A)**

Oxidative ozonolysis cuts every carbon–carbon double bond and turns each cut CH carbon into COOH.

In (A), the 12-carbon ring has two conjugated diene parts joined by two CH_2CH_2 links.

Each central CH–CH unit of a diene part gives oxalic acid:

2 HOOC–COOH

Each link, with one CH carbon on both sides, gives butanedioic acid:

2 HOOC–CH_2CH_2–COOH

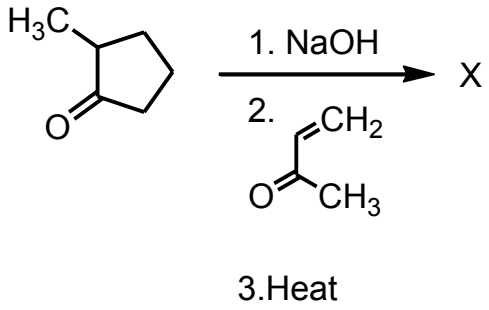
∴ M is the cyclic tetraene (A).

Reference: NCERT Chemistry Class XI (Part II), Unit 9 'Hydrocarbons', section 9.3.5: ozonolysis cleaves an alkene at its double bond, and acidic $KMnO_4$ oxidises but-2-ene to two molecules of ethanoic acid.

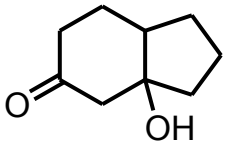
Check: two oxalic acid units and two butanedioic acid units together account for all twelve carbon atoms of the ring in (A).

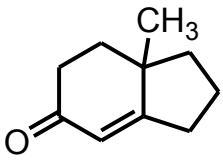
IAPT answer: (A) | **Zigyan answer:** (A)

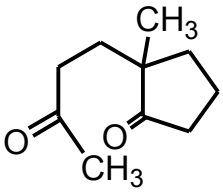
37. When 2-Methylcyclopentanone is treated with but-3-en-2-one under alkaline condition followed by heating gives the major product 'X'.

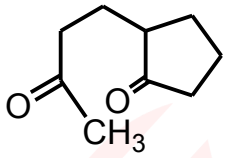


This 'X' is:

(A)


(B)


(C)


(D)


Solution · Q37 **Answer: (B)**

Michael addition: the enolate formed at the CH–CH_3 carbon adds to but-3-en-2-one.

2-methylcyclopentanone + CH_2=CHCOCH$_3$ → 2-methyl-2-(3-oxobutyl)cyclopentanone

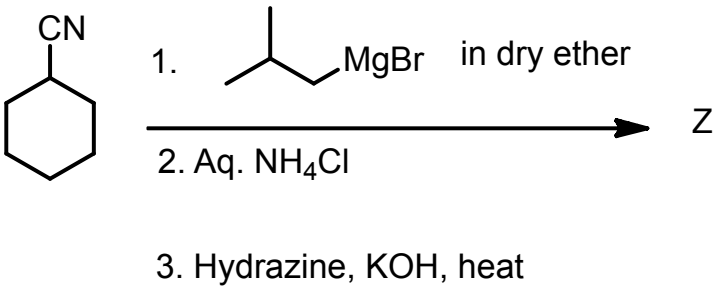
In this 1,5-diketone, the enolate from the side-chain CH_3 attacks the ring C=O (intramolecular aldol reaction).

Heating removes water (Robinson annulation).

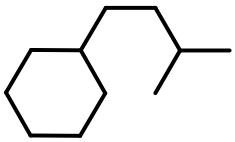
X is the bicyclic α,β-unsaturated ketone with CH_3 at the ring junction.

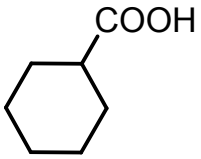
IAPT answer: (B) | **Zigyan answer:** (B)

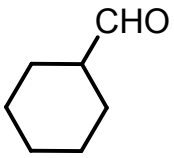
38. Consider the following chemical reaction

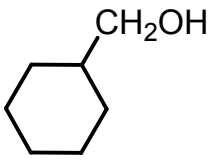


The major product 'Z' formed in the reaction is:

(A) 

(B) 

(C) 

(D) 

Solution · Q38 **Answer: (A)**

The Grignard reagent adds to the nitrile, and work-up gives a ketone:

$$C_6H_{11}CN \rightarrow C_6H_{11}C(=NMgBr)CH_2CH(CH_3)_2$$

$\rightarrow C_6H_{11}COCH_2CH(CH_3)_2$

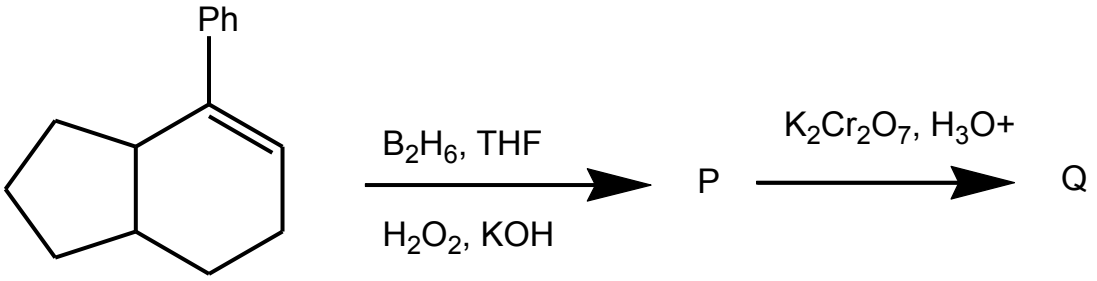
Wolff–Kishner reduction converts C=O into CH_2:

$C_6H_{11}COCH_2CH(CH_3)_2 \rightarrow C_6H_{11}CH_2CH_2CH(CH_3)_2$

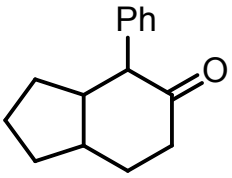
Z is (3-methylbutyl)cyclohexane.

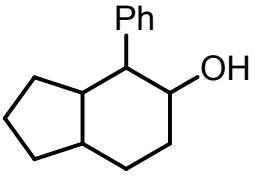
IAPT answer: (A) | **Zigyan answer:** (A)

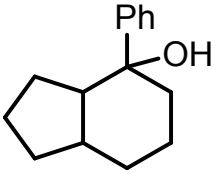
39. Consider the set of the following reactions

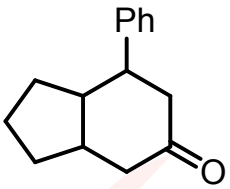


The final major product 'Q' is:

(A) 

(B) 

(C) 

(D) 

Solution · Q39 **Answer: (A)**

Hydroboration–oxidation is a syn, anti-Markovnikov addition of water.

So OH goes to the alkene CH next to the C–Ph carbon, and P is a secondary alcohol:

$$-C(Ph)=CH- \rightarrow -CH(Ph)-CH(OH)-$$

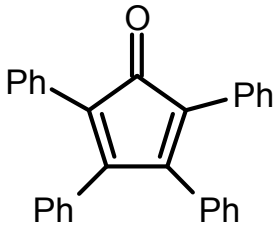
Acidified $K_2Cr_2O_7$ oxidises it to a ketone:

$-CH(Ph)-CH(OH)- \rightarrow -CH(Ph)-CO-$

Q has C=O on the carbon next to CH–Ph.

IAPT answer: (A) | **Zigyan answer:** (A)

40. The following product 'P' given below is obtained by Aldol condensation of ...



product 'P'

(A) 2 moles of dibenzyl ketone, $(PhCH_2)_2CO$

(B) 1 mole of dibenzyl ketone, $(PhCH_2)_2CO$ and 1 mole of acetone CH_3COCH_3

(C) 1 mole of dibenzyl ketone, $(PhCH_2)_2CO$ and 1 mole of benzil (PhCOCOPh)

(D) 2 moles of benzophenone, PhCOPh.

Solution · Q40 **Answer: (C)**

Both CH_2 groups of dibenzyl ketone have acidic H atoms.

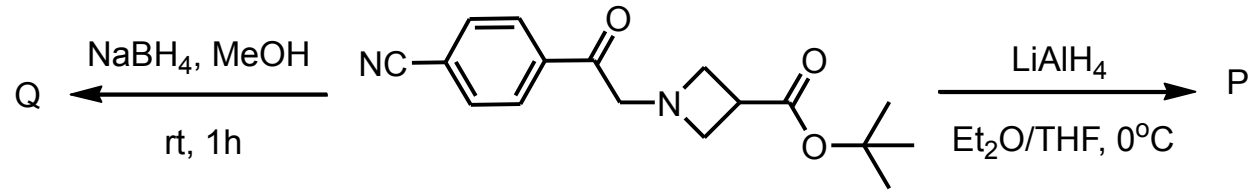
Each of them undergoes aldol condensation with one C=O of benzil:

$(PhCH_2)_2CO + PhCOCOPh \rightarrow C_{29}H_{20}O + 2H_2O$

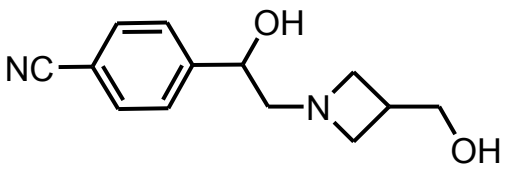
The product P is tetraphenylcyclopentadienone.

IAPT answer: (C) | **Zigyan answer:** (C)

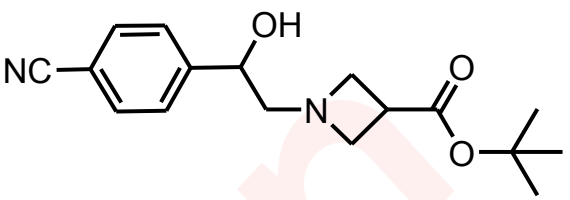
41. The structures of 'P' and 'Q' formed in the following reactions are :



(A)

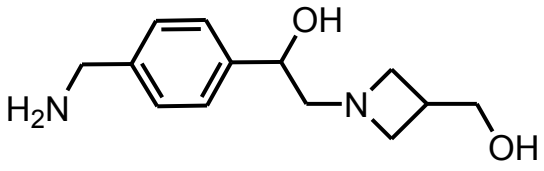


P

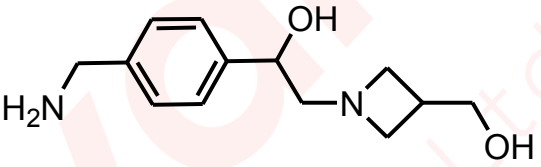


Q

(B)

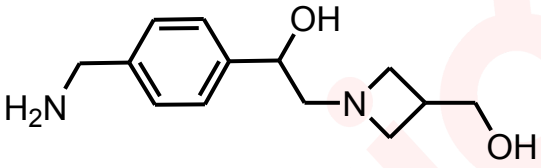


P

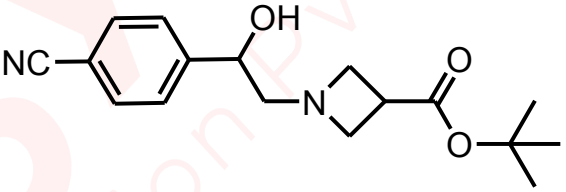


Q

(C)

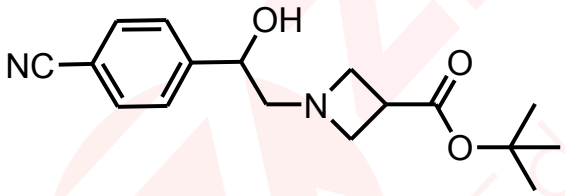


P

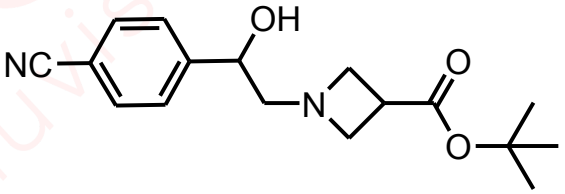


Q

(D)



P



Q

Solution · Q41 **Answer: (C)**

$LiA\ell H_4$ is a strong reducing agent. It reduces the ketone, the ester and the nitrile:

$$C{=}O \rightarrow CH(OH)$$

$COOC(CH_3)_3 \rightarrow CH_2OH$

$C{\equiv}N \rightarrow CH_2NH_2$

$NaBH_4$ in MeOH reduces only the ketone. The ester and the nitrile remain unchanged.

So P has CH_2NH_2 and two OH groups, while Q is a hydroxy compound that keeps CN and the ester.

IAPT answer: (C) | **Zigyan answer:** (C)

42. An amount of 0.45 g of an organic compound X containing C, H and N on combustion produces 1.1 g of CO_2 and 0.3 g of water. Empirical formula of X is:

(A) CH_2N_2 (B) C_2H_3N (C) C_3H_4N (D) C_2H_5N

Solution · Q42 **Answer: (C)**

Moles of C (from CO_2):

$$n_C = \frac{1.1}{44} = 0.025 \text{ mol}$$

Moles of H (from H_2O):

$$n_H = 2 \times \frac{0.3}{18} = 0.0333 \text{ mol}$$

Mass of N:

$$m_N = 0.45 - (0.025 \times 12) - (0.0333 \times 1)$$

$$\Rightarrow m_N = 0.1167 \text{ g}$$

$$\Rightarrow n_N = \frac{0.1167}{14} = 0.0083 \text{ mol}$$

$$C : H : N = 0.025 : 0.0333 : 0.0083$$

$$\Rightarrow C : H : N = 3 : 4 : 1$$

Empirical formula: C_3H_4N

IAPT answer: (C) | **Zigyan answer:** (C)

43. Heptane-2,6-dione was treated with aqueous alkali and heated. The major product obtained is:

(A) 2, 3-dimethylcyclohex-1-ene-2-one (B) 2, 3-dimethylcyclohex-1-ene-3-one

(C) 2, 3-dimethylcyclohex-2-ene-1-one (D) 3-methylcyclohex-2-enone

Solution · Q43 **Answer: (D)**

Intramolecular aldol reaction: the enolate from a terminal CH_3 attacks the other C=O, closing a six-membered ring.

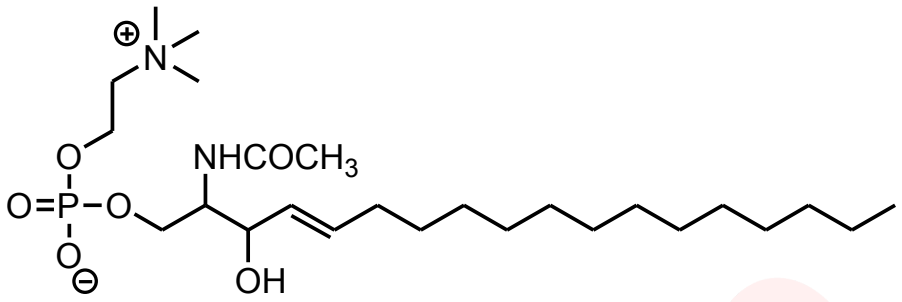
$CH_3CO(CH_2)_3COCH_3 \rightarrow$ 3-hydroxy-3-methylcyclohexanone

On heating, water is lost:

3-hydroxy-3-methylcyclohexanone $\rightarrow$ 3-methylcyclohex-2-enone + H_2O

IAPT answer: (D) | **Zigyan answer:** (D)

44. The number of chiral carbon(s) in Sphingomyelin, an important constituent of a class of lipids with the following structure is:



(A) 2 (B) 1 (C) 3 (D) 4

Solution · Q44 **Answer: (A)**

A chiral carbon carries four different groups.

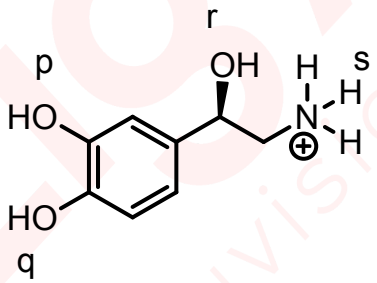
The carbon bearing $NHCOCH_3$ and the carbon bearing OH satisfy this.

Every other sp^3 carbon has at least two H atoms, and sp^2 carbons cannot be chiral centres.

Number of chiral carbons: 2

IAPT answer: (A) | **Zigyan answer:** (A)

45. In the following ion the strongest hydrogen bond donor site is:



(A) p (B) q (C) r (D) s

Solution · Q45 **Answer: (D)**

A strong hydrogen bond donor has a highly positive H atom.

The H atoms at s are on the positively charged N atom ($-NH_3^+$).

They form charge-assisted (ionic) hydrogen bonds, which are stronger than those from the neutral O–H groups p, q and r.

IAPT answer: (D) | **Zigyan answer:** (D)

46. The double bond equivalents for the compounds with the following molecular formulae are respectively:

(i) $C_{13}H_9BrO$

(ii) C_3H_7N

(iii) $C_{10}H_7Cl$

(A) 1, 5, 6 (B) 5, 6, 1 (C) 9, 1, 7 (D) 7, 9, 1

Solution · Q46 **Answer: (C)**

For $C_cH_hN_nX_x$ (X is a halogen; O is not counted):

$$\text{DBE} = \frac{2c + 2 + n - h - x}{2}$$

(i) $C_{13}H_9BrO$:

$$\text{DBE} = \frac{26 + 2 - 9 - 1}{2} = 9$$

(ii) C_3H_7N:

$$\text{DBE} = \frac{6 + 2 + 1 - 7}{2} = 1$$

(iii) $C_{10}H_7C\ell$:

$$\text{DBE} = \frac{20 + 2 - 7 - 1}{2} = 7$$

IAPT answer: (C) | **Zigyan answer:** (C)

47. Match the following in which acetaldehyde is converted into different compounds (Column 1) using specific reagents (Column 2).

Column 1	Column 2
i. $CH_3CH{=}CHCHO$	1. EtMgI in dry ether, H_3O^+, acid dichromate
ii. CH_3COCl	2. Dilute NaOH/Heat
iii. CHI_3	3. Acid dichromate, PCl_5
iv. CH_3COEt	4. I_2, NaOH

(A) i - 1, ii - 3, iii - 4, iv - 2 (B) i - 4, ii - 3, iii - 2, iv - 1

(C) i - 2, ii - 4, iii - 1, iv - 3 (D) i - 2, ii - 3, iii - 4, iv - 1

Solution · Q47 **Answer: (D)**

i → 2 (aldol condensation):

$$2CH_3CHO \rightarrow CH_3CH{=}CHCHO + H_2O$$

ii → 3 (oxidation, then $PC\ell_5$):

$CH_3CHO \rightarrow CH_3COOH \rightarrow CH_3COC\ell$

iii → 4 (iodoform reaction):

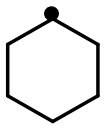
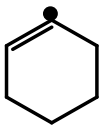
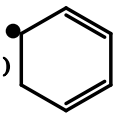
$CH_3CHO \rightarrow CHI_3 + HCOONa$

iv → 1 (Grignard addition, hydrolysis, oxidation):

$CH_3CHO \rightarrow CH_3CH(OH)Et \rightarrow CH_3COEt$

IAPT answer: (D) | **Zigyan answer:** (D)

48. The increasing order of stability of the following free radicals is:

(i)  (ii)  (iii)  (iv) 

(A) iv < ii < iii < i

(B) iii < i < ii < iv

(C) iii < ii < i < iv

(D) ii < i < iii < iv

Solution · Q48 **Answer: (B)**

(iii) is a vinylic radical. Its odd electron is not delocalised, so it is the least stable.

(i) is a secondary alkyl radical, stabilised by hyperconjugation.

(ii) is an allylic radical, in resonance with one C=C bond.

(iv) is in resonance with two conjugated C=C bonds, so its odd electron is spread the most.

Increasing stability:

iii < i < ii < iv

IAPT answer: (B) | **Zigyan answer:** (B)

PART A-2 · ONE OR MORE CORRECT OPTIONS

Q. 49 – 60 · 6 marks only if all correct options are marked · no negative marking

49. A 2 g piece of "dry ice" is dropped in a 5 L glass vessel containing air at 1 atm and 25 °C and the vessel is sealed. After some time, dry ice disappeared.

(Assume that the temperature is kept constant throughout.)

Identify the **correct** statement(s).

(A) Partial pressure of oxygen increases with respect to its initial value in air.

(B) Partial pressure of CO_2 increases with respect to its initial value in air.

(C) Total pressure of the vessel increases with respect to its initial value in air.

(D) Disappearance of dry ice is due to the evaporation process.

Solution · Q49 **Answer: (B), (C)**

Temperature and volume are constant and the amount of O_2 is unchanged.

So the partial pressure of O_2 does not change. ∴ (A) is false.

The dry ice becomes CO_2 gas. The added pressure is

$$\Delta p = \frac{nRT}{V}$$

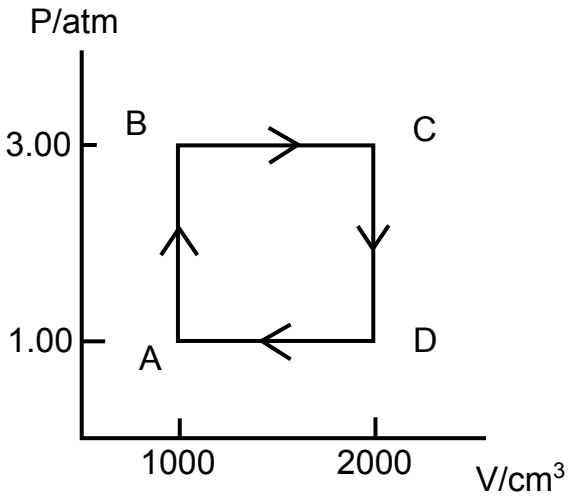
$$\Rightarrow \Delta p = \frac{\frac{2}{44} \times 0.0821 \times 298}{5} \approx 0.22 \text{ atm}$$

The partial pressure of CO_2 and the total pressure both increase. ∴ (B), (C) are true.

A direct change from solid to gas is sublimation. ∴ (D) is false.

IAPT answer: (B), (C) | **Zigyan answer:** (B), (C)

50. A thermo-dynamical process is represented by the cycle shown below in which 0.1 mol of a perfect gas undergoes the reversible cyclic process A → B → C → D → A



Given that $C_{v,m} = \frac{3}{2}R$ independent of temperature

All symbols have their usual meaning

Identify the correct statement(s)

(A) $T_B = 365.8$ K

(B) $q_{B\to C} = 760.5$ J

(C) $w_{B\to C} = -30$ J

(D) $\left(\frac{\partial U}{\partial V}\right)_T = 0$ for a perfect gas

Solution · Q50 **Answer: (A), (B), (D)**

(A) At B:

$$T_B = \frac{PV}{nR} = \frac{3\times 1}{0.1\times 0.082} \approx 365.8 \text{ K}$$

∴ true.

(B) B → C is at constant pressure and the volume doubles.

$$T_C = 2T_B$$

$$q = nC_{p,m}(T_C - T_B)$$

$$\Rightarrow q = 0.1\times\frac{5}{2}\times 8.314\times 365.8 \approx 760 \text{ J}$$

∴ true.

(C) Work in the expansion B → C:

$$w = -P\Delta V = -3 \text{ atm} \times 1 \text{ L}$$

$$\Rightarrow w \approx -304 \text{ J}$$

∴ false.

(D) The internal energy of a perfect gas depends only on temperature. ∴ true.

IAPT answer: (A), (B), (D) | **Zigyan answer:** (A), (B), (D)

51. Identify the correct statement(s) for the binary solutions

(A) The volume of a solution at T and P equals the sum of the volumes of its pure components at T and P.

(B) At constant T and P, the values of ΔG_{mix} and ΔS_{mix} are negative and positive respectively.

(C) Inter-molecular interactions are negligible in an ideal solution.

(D) The mixture of n-hexane and n-heptane form a nearly ideal solution.

Solution · Q51 **Answer: (B), (D)**

(A) Volumes are additive only when the mixing volume is zero, that is, for an ideal solution. ∴ false.

(B) For spontaneous mixing to an ideal solution:

$$\Delta G_{mix} < 0 \text{ and } \Delta S_{mix} > 0$$

∴ true.

(C) In an ideal solution the A–B interactions are nearly equal to the A–A and B–B interactions. They are not negligible. ∴ false.

(D) n-Hexane and n-heptane have similar structures and similar intermolecular forces, so the solution is nearly ideal. ∴ true.

IAPT answer: (B), (D) | **Zigyan answer:** (B), (D)

52. The heat of combustion (kJ mol^{-1}) of ethane, propane and butane are −1560, −2220, −2878 respectively. When 100 g of each undergo complete combustion. Which of the following statement/s is/are correct?

(A) The heat generated by combustion of propane will be maximum.

(B) The heat generated by combustion of butane will be minimum.

(C) At constant temperature and pressure, the work done during the combustion of ethane is minimum.

(D) At constant temperature and pressure, the work done during the combustion of butane is maximum.

Solution · Q52 **As per Zigyan: (B)**

Heat released by 100 g of each gas:

$$q_{ethane} = \frac{100}{30} \times 1560 = 5200 \text{ kJ}$$

$$q_{propane} = \frac{100}{44} \times 2220 = 5045 \text{ kJ}$$

$$q_{butane} = \frac{100}{58} \times 2878 = 4962 \text{ kJ}$$

It is least for butane and greatest for ethane. ∴ (A) false, (B) true.

With water formed as liquid, the work done on the system is

$$w = -\Delta n_g RT$$

Values of $-\Delta n_g$ per mole are 5/2, 3 and 7/2. For 100 g:

$$w_{ethane} = \frac{100}{30} \times \frac{5}{2} \times RT = 8.33RT$$

$$w_{propane} = \frac{100}{44} \times 3 \times RT = 6.82RT$$

$$w_{butane} = \frac{100}{58} \times \frac{7}{2} \times RT = 6.03RT$$

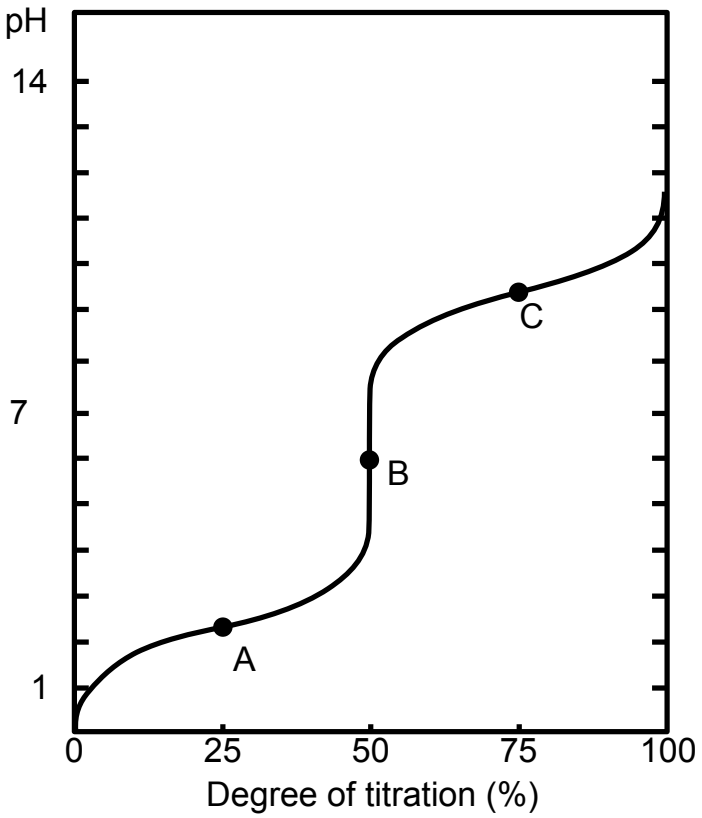
The work is maximum for ethane and minimum for butane. ∴ (C), (D) false.

Why Zigyan differs from IAPT: statements (C) and (D) state the reverse order. For 100 g samples, ethane gives the largest fall in gaseous moles and butane the smallest.

Reference: NCERT Chemistry Class XI (Part I), Unit 5 'Thermodynamics', sections 5.2.1 and 5.5(a): work done on the system is minus external pressure times volume change; the butane combustion equation shows water as a liquid.

IAPT answer: (B), (C), (D) | **Zigyan answer:** (B)

53. pH titration curve of aqueous solution of simple aliphatic amino acid with general formula NH_2-CHR-COOH (where R = Alkyl group) against NaOH is represented below.



Identify the **correct** statement(s) pertaining to it:

(A) In aqueous solution, amino acid mainly exists as $^{+}NH_3$-CHR-COOH

(B) At point 'A', [$^{+}NH_3$-CHR-COOH] = [$^{+}NH_3$-CHR-COO^{-}]

(C) At point 'B' amino acid exists in zwitter ion form.

(D) At point 'C', [NH_2-CHR-COO^{-}] = [$^{+}NH_3$-CHR-COO^{-}]

Solution · Q53 **As per Zigyan: (B), (C), (D)**

(A) In aqueous solution the amino acid exists mainly as the zwitter ion. ∴ false.

The curve starts in strongly acidic medium with the cation. NaOH removes two protons one after the other:

$^{+}NH_3$-CHR-COOH → $^{+}NH_3$-CHR-COO^{-} → NH_2-CHR-COO^{-}

(B) A is the half-way point of the first step:

$$[^{+}NH_3\text{-CHR-COOH}] = [^{+}NH_3\text{-CHR-COO}^{-}]$$

∴ true.

(C) B is the first equivalence point, where the zwitter ion is present. ∴ true.

(D) C is the half-way point of the second step:

$$[NH_2\text{-CHR-COO}^{-}] = [^{+}NH_3\text{-CHR-COO}^{-}]$$

∴ true.

Why Zigyan differs from IAPT: the cation is the main form only in strong acid, as at the start of this titration. The amino acid in water is mainly the zwitter ion.

Reference: NCERT Chemistry Class XII (Part II), Unit 10 'Biomolecules', section 10.2.2: in water the carboxyl group can lose a proton and the amino group accept one, giving the dipolar zwitter ion.

IAPT answer: (A), (B), (C), (D) | **Zigyan answer:** (B), (C), (D)

54. An aqueous solution of $CuSO_4$(X) is treated with certain reagents. Identify the **incorrect** statement/s.

(A) Addition of NH_4OH to the aqueous solution of X develops green colour.

(B) X is treated with H_2S in acidic medium giving black precipitate soluble in hot aqueous KOH solution.

(C) X on treatment with KI in weakly acidic medium gives white precipitate of CuI_2 liberating I_2 gas.

(D) An aqueous solution of X when treated with $BaCl_2$ solution gives white precipitate.

Solution · Q54 **Answer: (A), (B), (C)**

(A) NH_4OH gives a blue precipitate that dissolves in excess to a deep blue solution, not green. ∴ incorrect.

$$Cu^{2+} + 4NH_3 \rightarrow [Cu(NH_3)_4]^{2+}$$

(B) H_2S gives black CuS, which does not dissolve in hot aqueous KOH. ∴ incorrect.

(C) The reaction with KI is:

$$2Cu^{2+} + 4I^{-} \rightarrow Cu_2I_2\downarrow + I_2$$

The white solid is Cu_2I_2, not CuI_2, and I_2 is not given off as a gas. ∴ incorrect.

(D) White $BaSO_4$ is precipitated. ∴ correct.

$$Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4\downarrow$$

IAPT answer: (A), (B), (C) | **Zigyan answer:** (A), (B), (C)

55. Chlorine (Cl_2) gas can be prepared by the action of concentrated (or Conc.) H_2SO_4 on a mixture of sodium chloride (NaCl) and manganese dioxide (MnO_2). Identify the set(s) of correct reactions.

(A) $MnO_2 + H_2SO_4 \rightarrow MnSO_4 + H_2O + 1/2\ O_2$
$2NaCl + H_2SO_4 \rightarrow Na_2SO_4 + Cl_2 + H_2$

(B) $2\ NaCl + H_2SO_4 \rightarrow Na_2SO_4 + 2HCl$
$MnO_2 + 2HCl + H_2SO_4 \rightarrow MnSO_4 + Cl_2 + H_2O$

(C) $4\ NaCl + 4\ H_2SO_4 \rightarrow 4\ NaHSO_4 + 4\ HCl$
$MnO_2 + 4\ HCl \rightarrow MnCl_2 + Cl_2 + 2\ H_2O$

(D) $MnO_2 + 2\ NaCl \rightarrow MnCl_2 + Na_2O + 1/2\ O_2$
$MnCl_2 + H_2SO_4 \rightarrow MnSO_4 + Cl_2 + H_2$

Solution · Q55 **As per Zigyan: (C)**

Conc. H_2SO_4 liberates $HC\ell$ from $NaC\ell$, and MnO_2 oxidises $HC\ell$ to $C\ell_2$.

(A), (D): H_2 gas is not formed in this preparation. ∴ wrong.

(B) The second equation, as written, is not balanced:

$MnO_2 + 2HC\ell + H_2SO_4 \rightarrow MnSO_4 + C\ell_2 + H_2O$

It has 4 H and 6 O atoms on the left, but only 2 H and 5 O atoms on the right. ∴ wrong.

(C) Both equations are balanced. On adding them:

$4NaC\ell + MnO_2 + 4H_2SO_4 \rightarrow MnC\ell_2 + 4NaHSO_4 + C\ell_2 + 2H_2O$

∴ correct.

Check: the added equation has 4 Na, 4 Cℓ, 1 Mn, 4 S, 8 H and 18 O atoms on each side.

IAPT answer: (C) | **Zigyan answer:** (C)

56. The 18-valence electron rule asserts that transition metal compounds are thermodynamically stable when they have a total of 18 valence electrons on the central metal, which include the metal's d electrons and the electrons provided by the ligands attached to the metal.

The 18-electron rule is obeyed by:

(A) $[Fe\ (CO)_5]$ (B) $[Mn\ (CO)_5]$ (C) $[Ni(CO)_4]$ (D) $[Cr\ (CO)_6]$

Solution · Q56 **Answer: (A), (C), (D)**

Count the valence electrons of the metal and add 2 for each CO.

Fe: 8 + 10 = 18

Mn: 7 + 10 = 17

Ni: 10 + 8 = 18

Cr: 6 + 12 = 18

∴ $[Fe(CO)_5]$, $[Ni(CO)_4]$ and $[Cr(CO)_6]$ obey the rule.

IAPT answer: (A), (C), (D) | **Zigyan answer:** (A), (C), (D)

57. Identify the correct statement(s) from the following:

(A) The number bridging carbonyl groups in $Co_2(CO)_8$ is 2

(B) The number of lone pair (s) in $XeOF_4$ is zero

(C) B_5H_{10} is not an example of borane

(D) The number of bonding and lone pairs of electrons in XeF_2 are 2 and 6, respectively.

Solution · Q57 **Answer: (A), (C)**

(A) In the bridged structure of $Co_2(CO)_8$, two CO groups bridge the Co–Co bond. ∴ true.

(B) Xe has 8 valence electrons. Four go into Xe–F bonds and two into the Xe=O bond, leaving one lone pair on Xe. ∴ false.

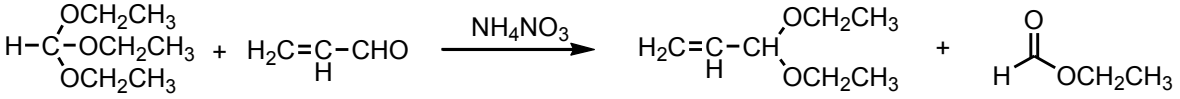
(C) Common boranes are of the types B_nH_{n+4} (B_5H_9) and B_nH_{n+6} (B_5H_{11}).

B_5H_{10} has an odd number of valence electrons and is not a borane. ∴ true.

(D) XeF_2 has 2 bond pairs. It has 3 lone pairs on Xe and 3 on each F, 9 in all, not 6. ∴ false.

IAPT answer: (A), (C) | **Zigyan answer:** (A), (C)

58. Consider the following reaction:



triethyl orthoformate acrylaldehyde ethyl formate

The correct statement(s) pertinent to the above mentioned reaction is/are:

(A) It is an example of acetal exchange reaction.

(B) It is an example of rearrangement reaction.

(C) Conventional reaction of acraldehyde and ethanol will produce better yield of the acetal.

(D) Water produced in the reaction is taken out of the equilibrium by the hydrolysis of the orthoester.

Solution · Q58 **Answer: (A), (D)**

(A) The orthoester, which behaves like an acetal, gives two ethoxy groups to the aldehyde and becomes ethyl formate. ∴ true.

(B) The carbon skeletons do not rearrange. ∴ false.

(C) With ethanol and acid, ethanol can also add to the C=C bond, and acetal formation is reversible. The yield is poorer. ∴ false.

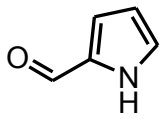
(D) Water formed during acetal formation is used up by the orthoester:

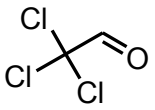
$HC(OC_2H_5)_3 + H_2O \rightarrow HCOOC_2H_5 + 2C_2H_5OH$

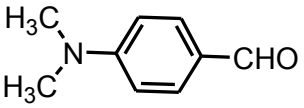
The equilibrium therefore shifts forward. ∴ true.

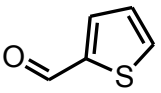
IAPT answer: (A), (D) | **Zigyan answer:** (A), (D)

59. Tendency to undergo Cannizaro reaction depends upon the electrophilic nature of the carbonyl group.


pyrrole-2-aldehyde


chloral


p-N,N-dimethylaminobenzaldehyde


thiophene-2-aldehyde

Identify the **incorrect** statement(s) from those listed below

(A) Thiophene-2-aldehyde will undergo Cannizaro reaction.

(B) Only chloral will not undergo Cannizaro reaction but others will follow.

(C) pyrrole-2-aldehyde, chloral and *p-N,N*-dimethylaminobenzaldehyde will not follow Cannizaro reaction.

(D) All the four molecules will undergo Cannizaro reaction since no one contains any enolisable α - hydrogen atom.

Solution · Q59 **Answer: (B), (D)**

With alkali, chloral undergoes C–C bond cleavage, not the Cannizzaro reaction:

$CC\ell_3CHO + OH^- \rightarrow CHC\ell_3 + HCOO^-$

Pyrrole-2-aldehyde loses its N–H proton to OH^-. The anion donates electrons to C=O, so no Cannizzaro reaction occurs.

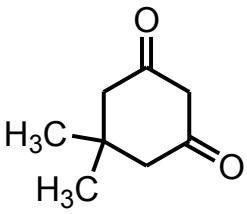
In p-N,N-dimethylaminobenzaldehyde, the strong +M effect of $N(CH_3)_2$ makes C=O weakly electrophilic, so it does not react.

Thiophene-2-aldehyde has no α-H and undergoes the Cannizzaro reaction.

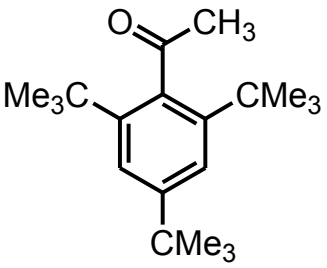
(A), (C) are therefore correct statements and (B), (D) are incorrect.

IAPT answer: (B), (D) | **Zigyan answer:** (B), (D)

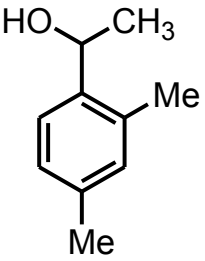
60. In the haloform reaction, the trihalogenated intermediate ($-CO-CX_3$) formed is then subjected to a nucleophilic attack by the hydroxide ion (OH^-) at the carbonyl carbon (C=O) producing a tetrahedral intermediate, which eventually breaks down, expelling the $^-CX_3$ group and leading to the formation of a carboxylate anion.



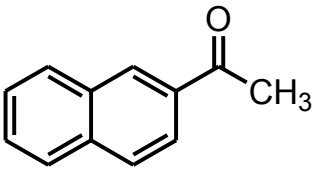
P



Q



R



S

Identify the **correct** statement(s) regarding iodoform reaction:

(A) 'Q', 'R' and 'S' will take part in iodoform reaction.

(B) 'P', 'R' and 'S' will take part in iodoform reaction.

(C) 'P' and 'Q' will not take part in iodoform reaction.

(D) 'Q' will not take part in iodoform reaction.

Solution · Q60 **Answer: (B), (D)**

P: the CH_2 between the two C=O groups is iodinated. OH^- then opens the ring to give a $COCHI_2$ end.

This end is iodinated to $COCI_3$ and releases CHI_3. So P reacts.

Q: the two bulky ortho CMe_3 groups block the attack of OH^- on the carbonyl carbon. So Q does not react.

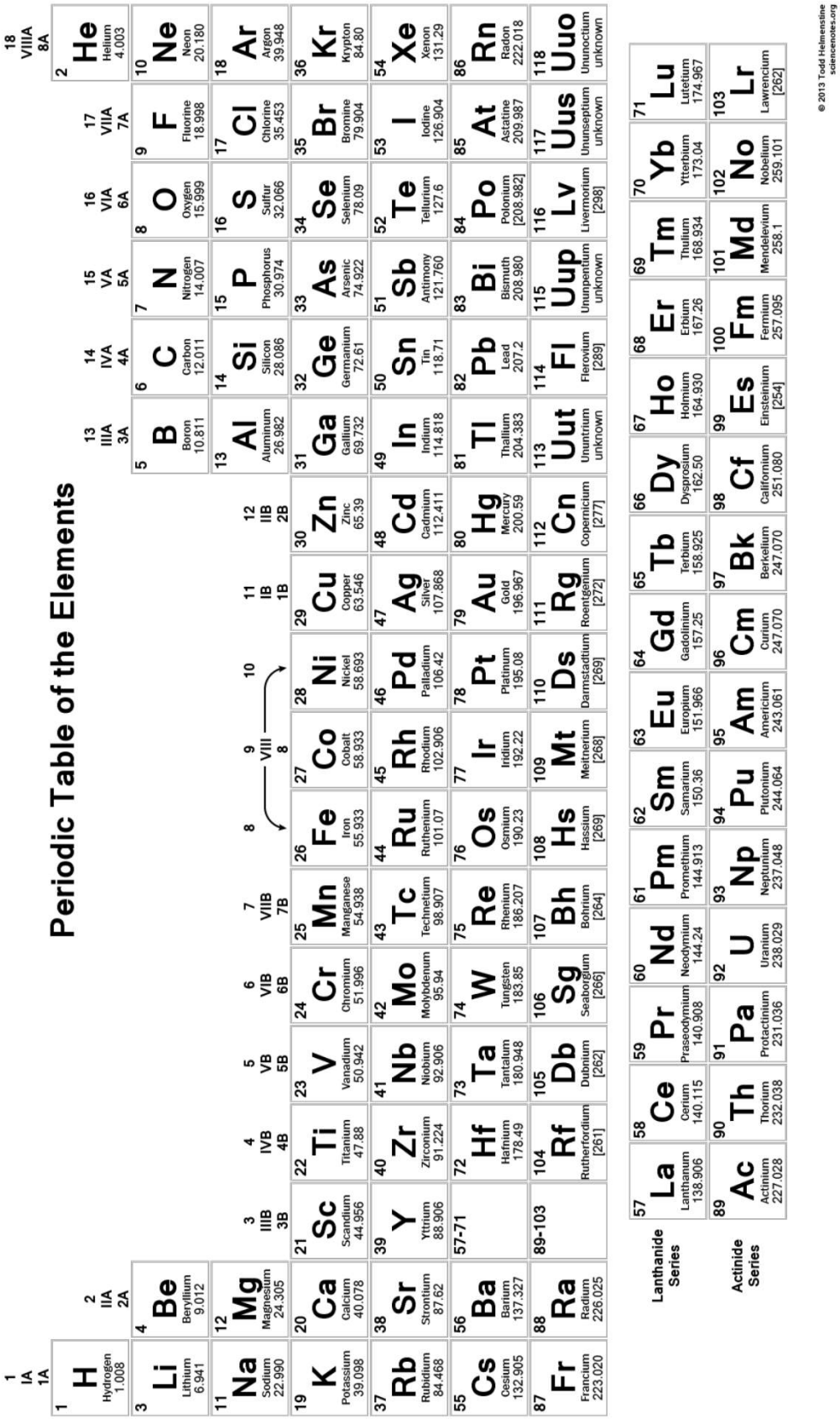
R: I_2 in alkali oxidises $CH(OH)CH_3$ to $COCH_3$. So R reacts.

S: it is a methyl ketone, so it reacts.

∴ (B) and (D) are correct.

IAPT answer: (B), (D) | **Zigyan answer:** (B), (D)

Given in the question paper



ANSWER KEY

NSEC 2024 · PAPER CODE 31

60
QUESTIONS · 216 MARKS

IAPT final answer key for paper code 31. ★ marks an answer given as per Zigyan.

1	(C)	2	(B)	3	(C)	4	(C)	5	(B)★
6	(D)	7	(D)	8	(C)	9	(C)	10	(B)
11	(D)	12	(A)	13	(C)★	14	(B)	15	(B)
16	(B)	17	(C)	18	(A)	19	(C)	20	(C)
21	(A)★	22	(A)	23	(A)	24	–★	25	(A)★
26	(D)	27	(A)	28	–★	29	(C)	30	(B)
31	(C)	32	(B)★	33	(C)	34	(C)	35	(B)
36	(A)★	37	(B)	38	(A)	39	(A)	40	(C)
41	(C)	42	(C)	43	(D)	44	(A)	45	(D)
46	(C)	47	(D)	48	(B)	49	(B), (C)	50	(A), (B), (D)
51	(B), (D)	52	(B)★	53	(B), (C), (D)★	54	(A), (B), (C)	55	(C)★
56	(A), (C), (D)	57	(A), (C)	58	(A), (D)	59	(B), (D)	60	(B), (D)

★ Answers as per Zigyan

- **Q5** — As per Zigyan: (B); IAPT key (A) or (B).
- **Q13** — As per Zigyan: (C); IAPT key (B).
- **Q21** — As per Zigyan: (A); IAPT key (D).
- **Q24** — As per Zigyan: no option is correct; IAPT key (B) or (D).
- **Q25** — As per Zigyan: (A); IAPT key (A).
- **Q28** — As per Zigyan: no option is correct; IAPT key (A).
- **Q32** — As per Zigyan: (B); IAPT key (A).
- **Q36** — As per Zigyan: (A); IAPT key (A).
- **Q52** — As per Zigyan: (B); IAPT key (B), (C), (D).
- **Q53** — As per Zigyan: (B), (C), (D); IAPT key (A), (B), (C), (D).
- **Q55** — As per Zigyan: (C); IAPT key (C).

zigyan

OLYMPIADS · 2026

Olympiad results



TOP ACHIEVEMENT · CHEMISTRY

Qualified the Chemistry Olympiad twice, and selected for the HBCSE camp.

Saksham Bishnoi reached the national stage of the Chemistry Olympiad in two consecutive years and was selected for the Orientation-cum-Selection Camp at HBCSE, Mumbai. 4 Years Classroom - the same student who took AIR 168 in JEE Advanced 2026.

Qualified twice | HBCSE selection camp | Only student from Faridabad

Above MAS means above the **Minimum Admissible Score**: clearing it puts a student in the national band for their subject. It is a real threshold, not a participation marker.

CHEMISTRY · ABOVE MAS



Sulokya Bibhuty
Class XII
3 Years Classroom
Above MAS



Anay Gupta
Class XI
3 Years Classroom
Above MAS



Akshat Khator
Class XI
3 Years Classroom
Above MAS



Harshit Goyal
Class XII
4 Years Classroom
Above MAS



Hardik Sharma
Class XI
3 Years Classroom
Above MAS



Aarush Kumar
Class XII
1 Year Classroom
Above MAS

PHYSICS · ASTRONOMY · MATHEMATICS

PHYSICS



Sulokya Bibhuty
Class XII
3 Years Classroom
Above MAS

PHYSICS



Saksham Bishnoi
Class XII
4 Years Classroom
Above MAS

ASTRONOMY



Sulokya Bibhuty
Class XI
3 Years Classroom
Above MAS

MATHEMATICS · IOQM



Priyanshi
Class XI
4 Years Classroom
IOQM Qualifier

OLYMPIADS WE PREPARE STUDENTS FOR

NSEP	NSEC	NSEB	NSEA	IOQM	NSEJS
Physics	Chemistry	Biology	Astronomy	Mathematics	Class X and below

The olympiad pathway starts in Class 8.

NSEJS is open to Class 10 and below - the habit of staying with one hard problem is the one JEE Advanced rewards.

Zigyan Eduvision Pvt. Ltd. · SCO No. 107, Sector 16, Faridabad 121002
0129-4048800 · +91 92115 38800 · info@zigyan.com

zigyan

RESULTS · 2021 – 2026

Our toppers, year by year

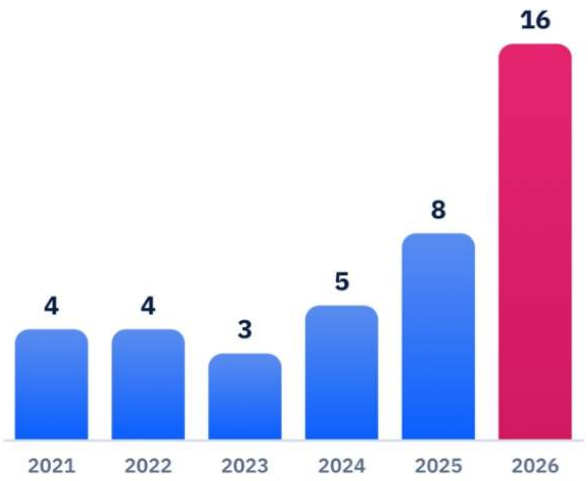
40
JEE Advanced selections in 6 years

AIR 168
best rank — Saksham Bishnoi, 2026

16 of 35
students selected, JEE Advanced 2026

14 of 35
above 98 percentile, JEE Main 2026

JEE ADVANCED SELECTIONS PER YEAR



BEST RANK EACH YEAR

YEAR	JEE ADVANCED	JEE MAIN
2026	**Saksham Bishnoi** AIR 168 · 4 Years Classroom	**Saksham Bishnoi** AIR 811 · 99.95 %ile
2025	**Chakshu** AIR 4,233 · 2 Years Classroom	**Chakshu** AIR 8,538 · 99.44 %ile
2024	**Harshit** AIR 777 · 2 Years Classroom	**Harshit** AIR 1,473 · 99.91 %ile
2023	**Aditya Jain** AIR 2,373 · 2 Years Classroom	**Aditya Jain** AIR 2,503 · 99.79 %ile
2022	**Rachit Sharma** AIR 698 · 1 Year Classroom	**Rachit Sharma** AIR 1,016 · 99.90 %ile
2021	**Sparsh Mittal** AIR 2,237 · 1 Year Classroom	**Sparsh Mittal** AIR 1,562

JEE ADVANCED 2026 — THIRTEEN NAMED SELECTIONS



Saksham Bishnoi
AIR 168
4 Years Classroom



Sulokya Bibhuty
AIR 1,315
3 Years Classroom



Aarush
AIR 2,699
1 Year Classroom



Manishka
AIR 2,869
4 Years Classroom



Oojit Kumar
AIR 5,765
4 Years Classroom



Harshit Goyal
AIR 6,407
4 Years Classroom



Pranab Sharma
AIR 6,750
3 Years Classroom



Aditya Dhar
AIR 15,183
3 Years Classroom



Arpit Anshuman
AIR 19,308
4 Years Classroom



Lokesh
AIR 22,857
3 Years Classroom



Arjun
AIR 24,674
3 Years Classroom



Sanyam Gulyani
AIR 25,123
1 Year Classroom



Saket
AIR 27,628
3 Years Classroom

Sixteen students of the 2026 batch were selected in JEE Advanced; the thirteen above are named with their All India Rank.

JEE MAIN 2026 — TOP SIX, WITH PERCENTILE



Saksham Bishnoi
AIR 811
99.95 %ile
4 Years Classroom



Sulokya Bibhuty
AIR 1,095
99.94 %ile
3 Years Classroom



Harshit Goyal
AIR 2,662
99.83 %ile
4 Years Classroom



Manishka
AIR 4,817
99.70 %ile
4 Years Classroom



Oojit Kumar
AIR 5,040
99.69 %ile
4 Years Classroom



Aarush
AIR 5,276
99.67 %ile
1 Year Classroom

14 of the 35 students in the 2026 batch scored above the 98th percentile in JEE Main.

Zigyan Eduvision Pvt. Ltd. · SCO No. 107, Sector 16, Faridabad 121002
0129-4048800 · +91 92115 38800 · info@zigyan.com