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PREVIOUS YEAR PAPER · 2021-22

OLYMPIAD · STAGE I

IOQC

Indian Olympiad Qualifier in Chemistry (Part I)

2021-22

Question paper with official answer key

32	120	75 min	31
Questions	Maximum marks	Time	Paper code

Question paper and official answer key: Indian Association of Physics Teachers (IAPT), IOQC 2021-22, paper code 31.
Solutions and notes: Zigyan. This booklet is not an IAPT publication.

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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
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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, $h = 6.626 \times 10^{-34} J\,s$
Speed of light, $c = 3.0 \times 10^{8}\ ms^{-1}$
Avogadro constant, $N_A = 6.022 \times 10^{23}\ mol^{-1}$
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 – 24 · +3 for a correct answer, –1 for a wrong one

1. The correct order of CFSE of the following complex ions is

$[Zn(NH_3)_4]^{2+}$, $[Co(NH_3)_6]^{2+}$, $[Co(NH_3)_6]^{3+}$, $[Ir(NH_3)_6]^{3+}$

(A) $[Ir(NH_3)_6]^{3+} > [Co(NH_3)_6]^{3+} > [Co(NH_3)_6]^{2+} > [Zn(NH_3)_4]^{2+}$

(B) $[Zn(NH_3)_4]^{2+} > [Co(NH_3)_6]^{2+} > [Co(NH_3)_6]^{3+} > [Ir(NH_3)_6]^{3+}$

(C) $[Ir(NH_3)_6]^{3+} > [Co(NH_3)_6]^{3+} > [Zn(NH_3)_4]^{2+} > [Co(NH_3)_6]^{2+}$

(D) $[Co(NH_3)_6]^{3+} > [Ir(NH_3)_6]^{3+} > [Co(NH_3)_6]^{2+} > [Zn(NH_3)_4]^{2+}$

2. Solvents are classified as polar and nonpolar based on their dipole moments.

Given below are some solvents.

(p)1,2-dibromobenzene

(q) diisopropylether

(r) trans-1,2-dichloroethene

(s) 1,2-dichloroethane

(t) N-ethyl-N-methylpropan-1-amine

The set in which all solvents are polar is

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

3. Which of the following statement/s is/are correct?

I. Half-life is 50 % of the total time taken for the completion of a reaction

II. Collision frequency (Z), which is the number of collisions per second per unit volume, is same as the rate constant of the reaction

III. A change in the activation energy of a reaction at a particular temperature will result in a proportional change in the rate and rate constant of the reaction at the same temperature

IV. All first order reactions are not unimolecular

V. For a zero order reaction, slope of a plot of $t_{1/2}$ Vs. initial concentration will be zero

(A) I, IV (B) II only (C) IV only (D) II, III,V

4. The orange colour of $K_2Cr_2O_7$ and yellow colour of K_2CrO_4 are, respectively, due to

(A) charge transfer transitions and d-d transitions
(B) d-d transitions and charge transfer transitions
(C) charge transfer transitions in both
(D) d-d transitions in both

5. One mole of neon (atomic mass = 20 g mol^{-1}) and one mole of argon (atomic mass = 40 g mol^{-1}) are stored in two separate containers I and II, at temperature T and 2T respectively. If both the gases are assumed to behave ideally

(A) K.E. and average velocity of the gas molecules will be the same in both I and II
(B) K.E. and average velocity of the gas molecules in II will be twice that of the gas molecules in I
(C) K.E. of the gas molecules in II will be twice that in I and average velocity of the gas molecules in both I and II will be the same
(D) Both K.E. and average velocity of the gas molecules in I will be twice that of the gas molecules in II

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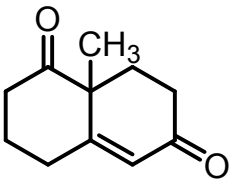
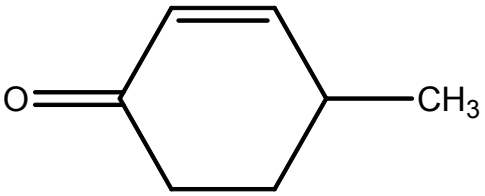
6. An aldehyde/ketone in the presence of a base forms a carbanion at the α-position which can react with a carbonyl group in an Aldol type of reaction. It can also react with an olefinic double bond which is activated by groups like CO, CN, NO_2 attached to the double bond. The latter reaction is an addition reaction across the double bond. Wieland-Miescher ketone is an important synthetic intermediate used to synthesize many compounds

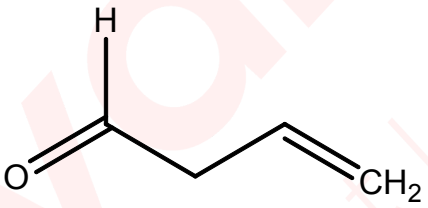


Wieland-Miescher Ketone

The pair of starting materials suitable for preparation of Wieland-Miescher ketone through a base catalysed reaction is

(A)





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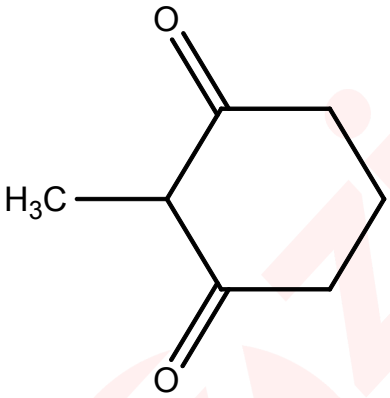

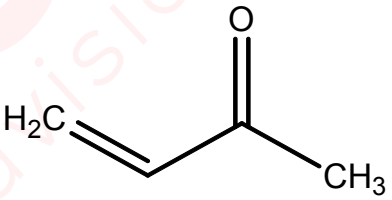

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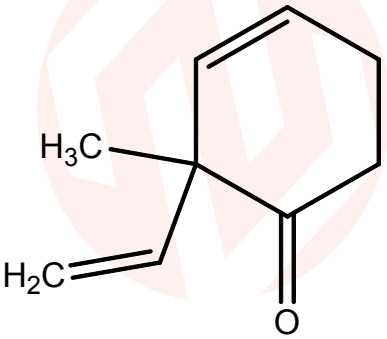
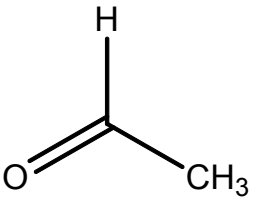
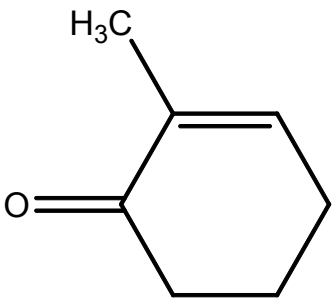
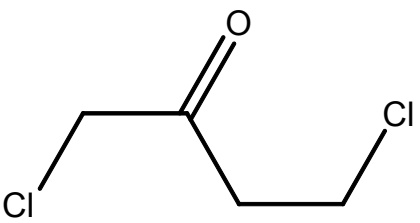


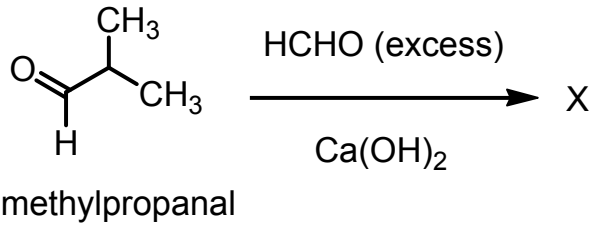


(D)





7. '**X**' in the following reaction is



2-methylpropanal

(A) 2,2-Dimethyl-1,3-propanediol (B) 2-Methylpropan-1-ol
(C) iso-butyric acid (D) 3-Hydroxy-2,2-dimethylpropanal

8. When 0.805 g of the potassium salt $(CH_2)_n(COOK)_2$ of a dibasic organic acid was reduced, 0.323 g of potassium was obtained. Molar mass of the acid is

(A) 194 (B) 116 (C) 118 (D) 156

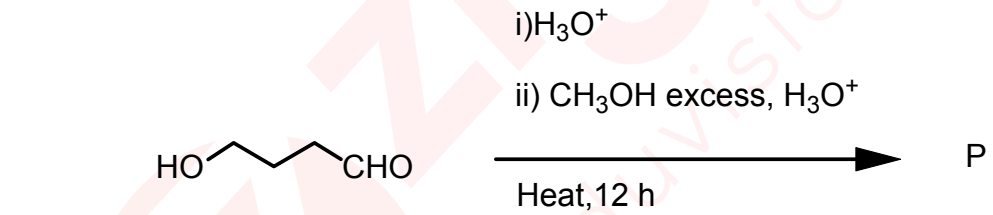
9. Among (i) HCl, (ii) HOClO, (iii) $HOClO_2$ and (iv) $HOClO_3$, which cannot undergo a disproportionation reaction?

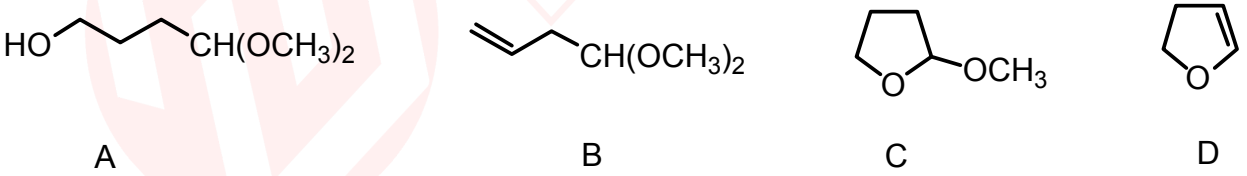
(A) Only (i) (B) (ii) and (iii)
(C) (i) and (iv) (D) (ii), (iii) and (iv)

10. The electronic transition in He^+ ion that will occur at the same wavelength as that of the n = 2 to n = 1 transition in H atom is

(A) n = 2 to n = 1 (B) n = 3 to n = 1 (C) n = 3 to n = 2 (D) n = 4 to n = 2

11. '**P**' in the following reaction is





A B C D

(A) A (B) B (C) C (D) D

12. The number of stereoisomers is maximum for (ox = $C_2O_4^{2-}$)

(A) $[Co(ox)_3]^{3-}$ (B) $[Co(ox)_2ClBr]^{3-}$
(C) $[Co(ox)Cl_2Br_2]^{3-}$ (D) $[CoCl_3Br_3]^{3-}$

13. Maximum number of electrons with m_s = ½ which can be accommodated in subshells having total three nodes is

(A) 10 (B) 16 (C) 20 (D) 32

14. The Hinsberg test of the compound **X** produces a solid compound **Y** that is insoluble in 10 % aq. NaOH. **Y** dissolves in 10 % aq. sulphuric acid. The compound **X** is

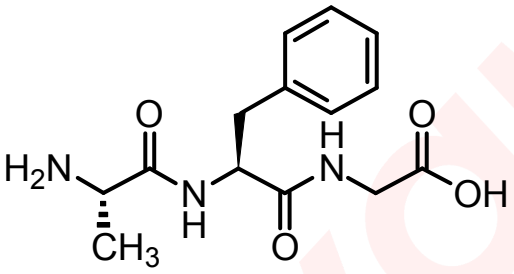
(A) $NH_2CH_2CH_2CH_2N(CH_3)_2$ (B) $(CH_3)_2NCH_2CH_2NHCH_3$

(C) $NH_2CH_2C(CH_3)_2CH_2NH_2$ (D) $(CH_3)_2NCH_2N(CH_3)_2$

15. An ionic species, M^{3+}, is isoelectronic with $CuCl_2$ and has (Z+2) neutrons. The molar mass of M^{3+} is

(A) 128 (B) 62 (C) 68 (D) 134

16. In compound **X,** the number of chiral centres and the number of peptide linkages are, respectively



X

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

17. Which of the following reactions is *NOT* an example of Lewis acid-Lewis base reaction?

(A) $Zn + I_3^- \rightarrow Zn^{2+} + 3I^-$ (B) $I_2 + I_3^- \rightarrow I_5^-$

(C) $CoCl_3 + Cl^- \rightarrow CoCl_4^-$ (D) $SO_3 + H_2O \rightarrow H^+ + HSO_4^-$

18. A student intended to prepare 1000 mL of a 10 ppm solution of K^+ from KCl. He made appropriate calculations, weighed the salt accordingly and prepared the solution. However, after making the solution, he realized that the salt he used was KNO_3 and not KCl. The concentration of K^+ (ppm) in this prepared solution is

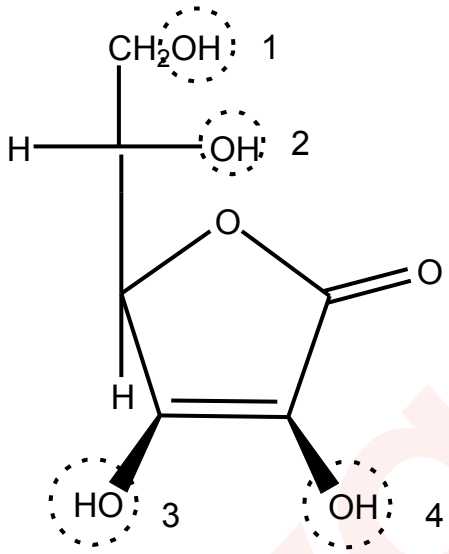
(A) 7.37 (B) 10.00 (C) 13.55 (D) 3.86

19. Oxide A is soluble in NaOH, oxide B in HCl and oxide C in both. The correct set of A, B and C is

A B C

(A) CO_2 SO_2 PbO_2 (B) CO_2 Na_2O ZnO (C) SO_2 ZnO SnO_2 (D) SO_2 BaO Na_2O

20. Ascorbic acid (Vitamin C), a naturally occurring water soluble vitamin and abundantly found in lemon, shows antioxidant properties. In ascorbic acid, the OH with the lowest pKa is



Ascorbic Acid

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

21. Compound **'X'** ($C_7H_{12}O_2$) gives - i) a positive silver mirror test and ii) a yellow precipitate on treatment with I_2/NaOH. The compound **'X'** is

(A) 2-hydroxy-3,3-dimethylcyclopentanone (B) 2,5-heptanedione
(C) 2,2-dimethyl-3-oxopentanal (D) 2,2-dimethyl-4-oxopentanal

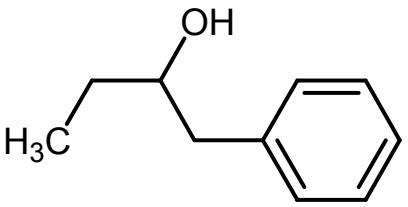
22. If the ratio of the concentrations of the oxidized and reduced forms of a species in an electrochemical reaction can be given as [Ox]/[Red] = 1.0×10^{-3}, the correct expression among the following at 25°C is

(A) $E = E^o + \frac{1}{3}(0.0592 / n)$ (B) $E - E^o = 3 \times (0.0592/ n)$
(C) $E = E^o - \frac{1}{3}(0.0592 / n)$ (D) $E - E^o = (0.0592/n)^{1/3}$

23. Among the following numbers, the one in which all the zeros are significant is

(A) 0.0004 (B) 0.0400 (C) 40.000 (D) 0.0040

24. Among the following sets of compounds, the one in which a reaction between them followed by hydrolysis that *does not* lead to the formation of 1-phenyl-2- butanol is



1-phenyl-2-butanol

(A) phenylacetaldehyde and ethylmagnesium bromide
(B) butanal and phenylmagnesium bromide
(C) propanal and benzylmagnesium bromide
(D) 1-phenyl-2-butanone and $NaBH_4$

PART A-2 · ONE OR MORE CORRECT OPTIONS

Q. 25 – 32 · 6 marks only if all correct options are marked · no negative marking

25. At room temperature, NaCl(s) and KCl(s) were taken in equal masses and dissolved in equal volumes of water in two separate closed containers I and II respectively.

Of the following, correct option/s is/are

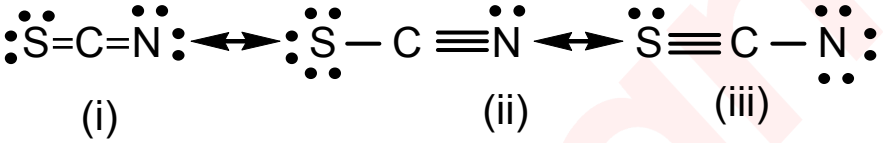
(A) To compare molarities in (I) and (II), masses of both the solutions need to be known
(B) Molalities cannot be compared without measuring the mass of water added in each case
(C) If (I) and (II) are completely transferred into another container (III), $[Cl^-]$ in (III) will be sum of that in (I) and (II)
(D) Information given is sufficient to compare the vapour pressures in (I) and (II)

26. In a pair of isomers of molecular formula C_5H_8, both the compounds undergo catalytic hydrogenation to form compounds of molecular formula C_5H_{10}. On ozonolysis followed by oxidative workup (H_2O_2), one of the isomers gives a diacid ($C_5H_8O_4$) while the other isomer gives a ketoacid ($C_5H_8O_3$). The pair/s which give/s above set of reactions is/are

(A) 3-ethylcyclopropene and 1-pentyne
(B) cyclopentene and 1-methylcyclobutene
(C) 1-methylcyclobutene and 3-methylcyclobutene
(D) 1,2-dimethylcyclopropene and 3-methylcyclobutene

27. The resonance structures of SCN^- are given below along with the S-C and C-N bond lengths

	S-C (in pm)	C-N (in pm)
SCN^-	165	117
Single bond	181	147
Double bond	155	128
Triple bond	-----	116



(i) (ii) (iii)

Among the following, the *incorrect* statement/s is/ are

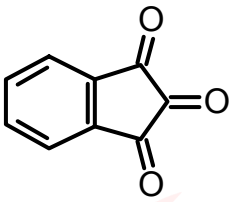
(A) The contribution from resonance structures (i) and (ii) is more important than that from structure (iii)

(B) The formal charge on S in structure (iii) is zero

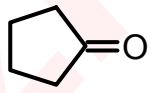
(C) The degree of contribution of these structures is in the order: i > ii > iii

(D) The formal charge on N in structure (ii) is zero

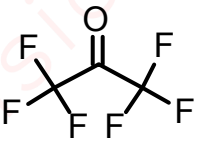
28. The compound/s which form/s stable hydrate/s is/are



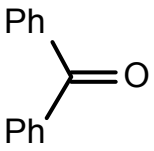
(a)



(b)



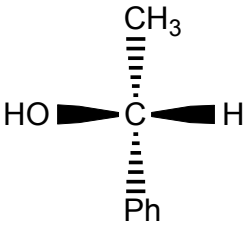
(c)



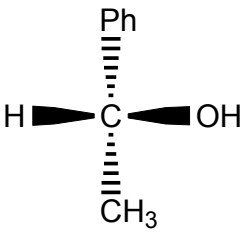
(d)

(A) a (B) b (C) c (D) d

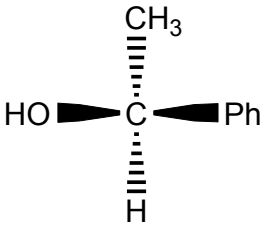
29. The formula/e which also represent/s a compound with formula **X** is/are



X



a



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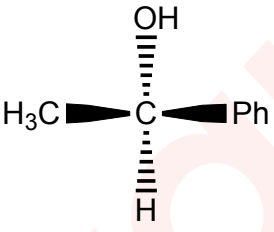

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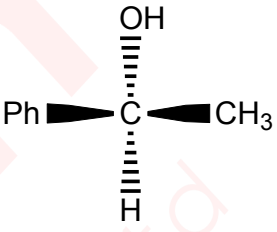


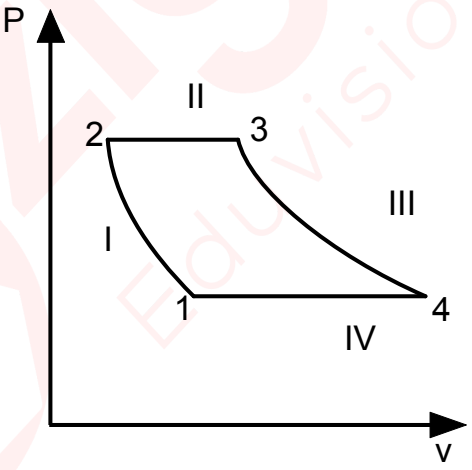
d

(A) a (B) b (C) c (D) d

30. Following is the P vs V plot of a cyclic process 1 → 2, 2 → 3, 3 → 4, 4 → 1, denoted as I, II, III and IV respectively for a system of one mole of an ideal gas.

Assume that there is heat exchange between the system and surroundings only in II and IV.

Which of the following is/are correct?



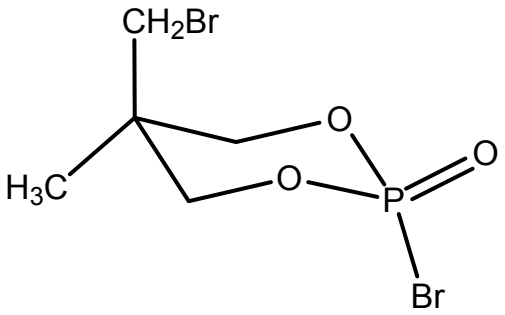
(A) In II and IV ΔS is zero

(B) In I and III, ΔS is zero

(C) I and III are isothermal and reversible

(D) In II and IV, change in internal energy of the gas (ΔU) is zero

31. For the given compound, % s character of phosphorous hybrid orbitals which contribute to various bonds are given in the table below.



Bond	% s character
P=O	40
P-Br	< 20
P-O	20

This difference in % 's' character of various phosphorous bonds could be due to

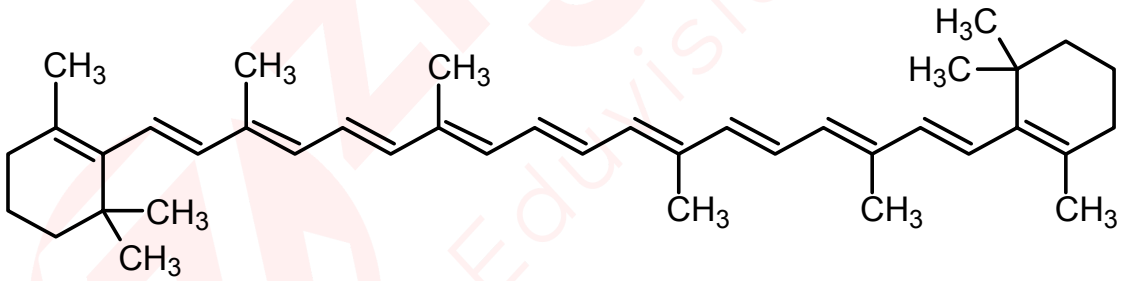
(A) The large size of bromine atom

(B) The large electronegativity difference between P and O

(C) Increased overlap of σ-orbitals of terminal P-O bond

(D) Stronger covalent character of P-O in cyclic oxygen atoms

32. β-carotene and related compounds are plant pigments that give red, orange and yellow vegetables their vibrant colour. The structure of β-carotene is given below.



It is approved as a food additive in many countries. The correct statement/s that describe/s β-carotene is/are

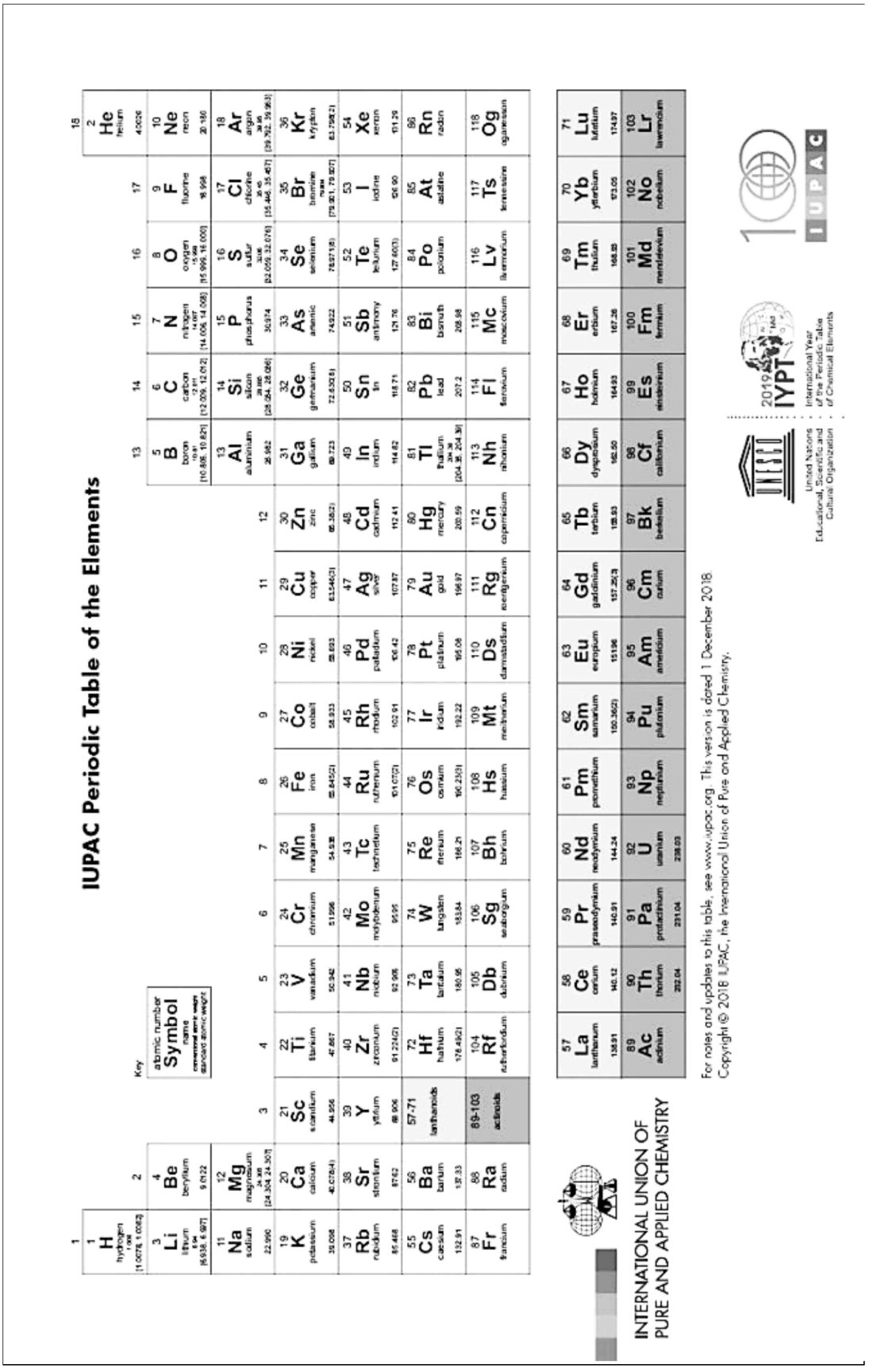
(A) It is a strong oxidizing agent

(B) It reacts with singlet oxygen, an excited form of O_2, to produce an epoxide

(C) It absorbs red/yellow light of electromagnetic spectrum

(D) It comes in the oil phase when carrots are cooked in oil and water in a curry

Given in the question paper



ANSWER KEY

IOQC 2021-22 · PAPER CODE 31

32
QUESTIONS · 120 MARKS

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

1	(A)	2	(A)	3	(C)	4	(C)	5	(C)
6	(B)	7	(A)	8	(C)	9	(C)	10	(D)
11	(C)	12	(C)	13	(B)	14	(B)	15	(D)
16	(C)	17	(A)	18	(A)	19	(B)★	20	(C)
21	(D)	22	–★	23	(C)	24	(B)	25	(D)
26	(B), (C)	27	(B), (C)★	28	(A), (C)	29	(A), (C)	30	(B)
31	(A), (C)	32	(D)★						

★ Answers as per Zigyan

- **Q19** — As per Zigyan: (B); IAPT key (B) or (C).
- **Q22** — As per Zigyan: no option is correct; IAPT key (B).
- **Q27** — As per Zigyan: (B), (C); IAPT key (B) or (B), (C).
- **Q32** — As per Zigyan: (D); IAPT key (B), (D).

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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.

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RESULTS · 2021 – 2026

Our toppers, year by year

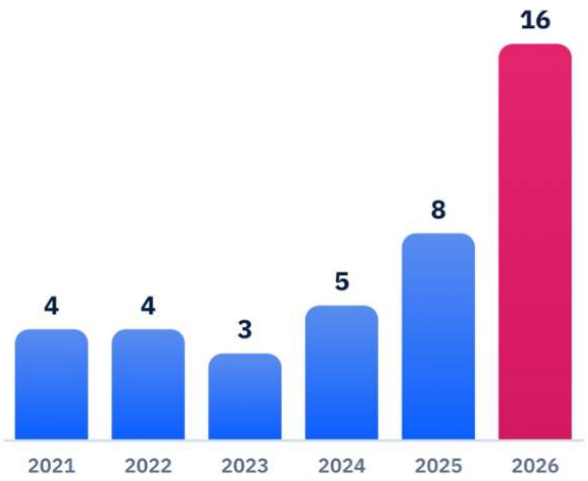
40
JEE Advanced selections in 6 years

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.

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