47 JEE ADVANCED

YEARS (2024 TO 1978)

CHAPTER-WISE & TOPIC-WISE SOLVED PAPERS

FIRST TIME EVER!

Analyse the question-wise difficulty level in real-time with Correct (C), Wrong (W) and Unattempted (UA) questions response tagging provided by IIT-JEE

CHEMISTRY

ANSWER KEY VERIFIED FROM OFFICIAL WEBSITE OF JEE ADVANCED

JEE ADVANCED 2024 Paper Analysis

Paper 1

Section	Question Type	No. of Questions	Marks per Question	Negative marks per question	Total Marks (Section wise)
1	Single Correct MCQs	4	3	–1	12
2	More than One Correct MCQs	3	4	–2	12
3	Non Negative Integer Type Questions	6	4	0	24
4	Matrix Type Questions	4	3	–1	12
	Total Questions per subject	17			60

Paper 2

Section	Question Type	No. of Questions	Marks per Question	Negative marks per question	Total Marks (Section wise)
1	Single Correct MCQs	4	3	–1	12
2	More than One Correct MCQs	3	4	–2	12
3	Non Negative Integer Type Questions	6	4	0	24
4	(Numerical Value Based Questions)	4	3	–1	12
	Total Questions per subject	17			60

Total No. of Questions in Part 1 = 51 Questions
Total No. of Questions in Part 2 = 51 Questions
Each Subject Carries = 60 Marks
Total Marks = 180

Paper Analysis

Paper Difficulty Compared to Last Year	Easier Compared to 2023 Paper
Overall Difficulty Level of JEE 2024	
Easy	18%
Moderate	49%
Difficult	33%

Chemistry Topics	Paper 1 Difficulty Level	Paper 2 Difficulty Level	Comments/Remarks	
Physical	Paper 1 easier compared to last year	Paper2 easy to moderate compared to last year		No question from Ionic equilibrium question from every topic
Inorganic	Same	Slightly Tougher		No question from metallurgy
Organic	Overall Tougher	Tougher to moderate	No Questions from GOC, sterio-isomerism, nomenclature	1 Easy level question from combined chemistry in every day life and Biomolecule. Questions based on Name reaction + Polymer, Alkyl halide

Overall Analysis

Paper Difficulty Compared to Last Year
- Easy to moderate - Equal distribution among Physical, Organic, inorganic - in paper 1, slightly more Questions from organic - in paper 2, slightly more Questions from physical - 3 questions were difficult and out of the box - 1 question from paper1 from organic chemistry was out of the box - 2 question in paper 2 was out of the box - 5 questions from Paper 1 and 4 Question from paper 2 was very easy - Rest of the questions were moderate - Chemistry will decide the rank

CONTENTS

HINTS AND SOLUTIONS

2024

JEE ADVANCED SOLVED PAPER

Chemistry Paper-1

SECTION 1 (Maximum Marks: 12)

- This section contains **FOUR (04)** questions.
- Each question has **FOUR** options (*a*), (*b*), (*c*) and (*d*). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated <u>according to the following marking scheme:</u>

Full Marks : +3 If **ONLY** the correct option is chosen;
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : –1 In all other cases.

1. A closed vessel contains 10 g of an ideal gas **X** at 300 K, which exerts 2 atm pressure. At the same temperature, 80 g of another ideal gas **Y** is added to it and the pressure becomes 6 atm. The ratio of root mean square velocities of **X** and **Y** at 300 K is

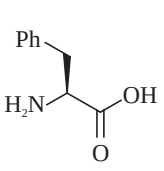
(*a*) $2\sqrt{2}:\sqrt{3}$ (*b*) $2\sqrt{2}:1$
(*c*) 1 : 2 (*d*) 2 : 1

2. At room temperature, disproportionation of an aqueous solution of *in situ* generated nitrous acid (HNO_2) gives the species

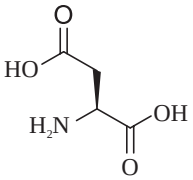
(*a*) H_3O^+, NO_3^- and NO (*b*) H_3O^+, NO_3^- and NO_2
(*c*) H_3O^+, NO^- and NO_2 (*d*) H_3O^+, NO_3^- and N_2O

3. Aspartame, an artificial sweetener, is a dipeptide aspartyl phenylalanine methyl ester. The structure of aspartame is

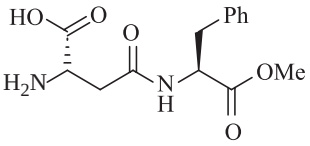
Structures of phenylalanine and aspartic acid are given below.

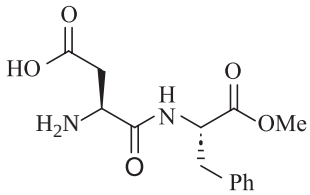


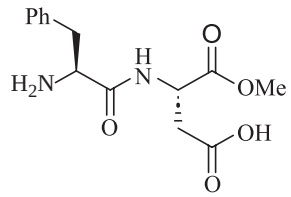
Phenylalanine

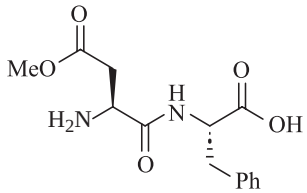


Aspartic acid

(*a*) 

(*b*) 

(*c*) 

(*d*) 

4. Among the following options, select the option in which each complex in **Set-I** shows geometrical isomerism and the two complexes in **Set-II** are ionization isomers of each other.

[en = $H_2NCH_2CH_2NH_2$]

(*a*) **Set-I:** $[Ni(CO)_4]$ and $[PdCl_2(PPh_3)_2]$
Set-II: $[Co(NH_3)_5Cl]SO_4$ and $[Co(NH_3)_5(SO_4)]Cl$

(*b*) **Set-I:** $[Co(en)(NH_3)_2Cl_2]$ and $[PdCl_2(PPh_3)_2]$
Set-II: $[Co(NH_3)_6][Cr(CN)_6]$ and $[Cr(NH_3)_6][Co(CN)_6]$

(*c*) **Set-I:** $[Co(NH_3)_3(NO_2)_3]$ and $[Co(en)_2Cl_2]$
Set-II: $[Co(NH_3)_5Cl]SO_4$ and $[Co(NH_3)_5(SO_4)]Cl$

(*d*) **Set-I:** $[Cr(NH_3)_5Cl]Cl_2$ and $[Co(en)(NH_3)_2Cl_2]$
Set-II: $[Cr(H_2O)_6]Cl_3$ and $[Cr(H_2O)_5Cl]Cl_2{\cdot}H_2O$

SECTION 2 (Maximum Marks: 12)

- This section contains **THREE (03)** questions.
- Each question has **FOUR** options (*a*), (*b*), (*c*) and (*d*). **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated <u>according to the following marking scheme</u>:

Full Marks : +4 **ONLY** if (all) the correct option(s) is(are) chosen;

2 ATOMIC STRUCTURE

JEE-Advanced

Subatomic Particles and Atomic Models

Single Correct

1. Rutherford's experiment, which established the nuclear model of the atom, used a beam of **(IIT JEE 2002)**

(*a*) β-particles, which impinged on a metal foil and got absorbed
(*b*) γ-rays, which impinged on a metal foil and got scattered
(*c*) helium atoms, which impinged on a metal foil and got scattered
(*d*) helium nuclei, which impinged on a metal foil and got scattered

2. Rutherford's alpha particle scattering experiment eventually led to the conclusion that **(IIT JEE 1986)**

(*a*) mass and energy are related
(*b*) electrons occupy space around the nucleus
(*c*) neutrons are buried deep in the nucleus
(*d*) the point of impact with matter can be precisely determined

3. The radius of an atomic nucleus is of the order of **(IIT JEE 1985)**

(*a*) 10^{-10} cm (*b*) 10^{-13} cm
(*c*) 10^{-15} cm (*d*) 10^{-18} cm

4. The increasing order (lowest first) for the values of e/m (charge/mass) for electron (e), proton (p), neutron (n) and alpha particle (α) is **(IIT JEE 1984)**

(*a*) e, p, n, α (*b*) n, p, e, α
(*c*) n, p, α, e (*d*) n, α, p, e

5. Rutherford's scattering experiment is related to the size of the **(IIT JEE 1983)**

(*a*) nucleus (*b*) atom (*c*) electron (*d*) neutron

6. Rutherford's experiment on scattering of α-particles showed for the first time that the atom has **(IIT JEE 1981)**

(*a*) electrons (*b*) protons (*c*) nucleus (*d*) neutrons

Multiple Correct

7. The atomic nucleus contains **(IIT JEE 1988)**

(*a*) protons (*b*) neutrons
(*c*) electrons (*d*) photons

8. The sum of the number of neutrons and proton in the isotope of hydrogen is **(IIT JEE 1986)**

(*a*) 6 (*b*) 5 (*c*) 4 (*d*) 3

9. When alpha particles are sent through a thin metal foil, most of them go straight through the foil, because **(IIT JEE 1984)**

(*a*) alpha particles are much heavier than electrons
(*b*) alpha particles are positively charged
(*c*) most part of the atom is empty space
(*d*) alpha particles move with high velocity

10. Many elements have non-integral atomic masses, because **(IIT JEE 1984)**

(*a*) they have isotopes
(*b*) their isotopes have non-integral masses
(*c*) their isotopes have different masses
(*d*) the constituents, neutrons, protons and electrons, combine to give fractional masses

11. An isotone of $^{76}_{32}Ge$ **(IIT JEE 1984)**

(*a*) $^{77}_{32}Ge$ (*b*) $^{77}_{33}As$ (*c*) $^{77}_{34}Se$ (*d*) $^{78}_{34}Se$

Fill in the Blanks

12. Elements of the same mass number but of different atomic numbers are known as ..... **(IIT JEE 1983)**

13. The mass of a hydrogen is ..... kg. **(IIT JEE 1982)**

14. Isotopes of an element differ in the number of ..... in their nuclei. **(IIT JEE 1982)**

True/False

15. In a given electric field, β-particles are deflected more than α-particles in spite of α-particles having larger charge. **(IIT JEE 1993)**

Developments Leading to the Bohr's Model of Atom

Single Correct

16. The first use of quantum theory to explain the structure of atom was made by **(IIT JEE 1997)**

(*a*) Heisenberg (*b*) Bohr
(*c*) Planck (*d*) Einstein

17. Which of the following relates to photons both as wave motion and as a stream of particles? **(IIT JEE 1992)**

(*a*) Interference (*b*) $E = mc^2$
(*c*) Diffraction (*d*) $E = hv$

36. According to Bohr's theory,

E_n = Total energy K_n = Kinetic Energy V_n = Potential Energy r^n = Radius of nth orbit **(IIT JEE 2006)**

	Column-I		Column-II
A.	V_n / K_n = ?	p	0
B.	If radius of *n*-th orbit $\propto E_n^x$, x = ?	q	–1
C.	Angular momentum in lowest	r.	–2
D.	$\frac{1}{r^n} \propto Z^y$, y = ?	s	1

Numerical/Integer Types

37. For He^+, a transition takes place from the orbit of radius 105.8 pm to the orbit of radius 26.45 pm. The wavelength (in nm) of the emitted photon during the transition is ___.

[Use: Bohr radius, a = 52.9 pm

Rydberg constant, $R_H = 2.2 \times 10^{-18}$ J

Planck's constant, $h = 6.6 \times 10^{-34}$ J s

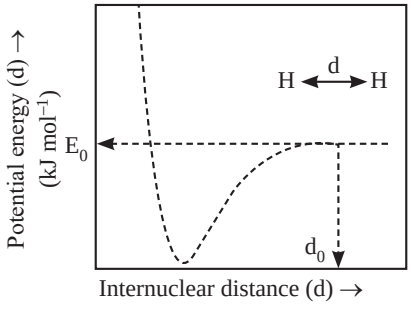
Speed of light, $c = 3 \times 10^8$ m s^{-1}]

C-11.93 W-66.52 UA-21.55 (JEE Adv. 2023)

38. The figure below is the plot of potential energy versus internuclear distance (d) of H_2 molecule in the electronic ground state. What is the value of the net potential energy E_0 (as indicated in the figure) in kJ mol^{-1}, for $d = d_0$ at which the electron-electron repulsion and the nucleus-nucleus repulsion energies are absent? As reference, the potential energy of H atom is taken as zero when its electron and the nucleus are infinitely far apart.

Use Avogadro constant as 6.023×10^{23} mol^{-1}.

C-0.14 W-65.68 UA-34.18 (JEE Adv. 2020)



Fill in the Blanks

39. 8 *g* each of oxygen and hydrogen at 27°C will have the total kinetic energy in the ratio of ..... **(IIT JEE 1989)**

Subjective

40. (*a*) Calculate velocity of electron in first Bohr orbit of hydrogen atom (Given $r = a_0$).

(*b*) Find de-Broglie wavelength of the electron in first Bohr orbit.

(*c*) Find the orbital angular momentum of 2*p*-orbital in terms of $h / 2\pi$ units. **(IIT JEE 2005)**

41. The wavelength corresponding to maximum energy for hydrogen is 91.2 nm. Find the corresponding wavelength for He^+ ion **(IIT JEE 2003)**

42. Calculate the energy required to excite 1 L of hydrogen gas at 1 atm and 298 K to the first excited state of atomic hydrogen. The energy for the dissociation of H – H bond is 436 kJ mol^{-1}. **(IIT JEE. 2000)**

43. With what velocity should an α-particle travel towards the nucleus of a copper atom so as to arrive at a distance 10^{-13} *m* from the nucleus of the copper atom? **(IIT JEE 1997)**

44. Consider the hydrogen atom to be proton embedded in a cavity of radius a_0 (Bohr's radius) whose charge is neutralised by the addition of an electron to the cavity in vacuum, infinitely slowly. Estimate the average total energy of an electron in its ground state in a hydrogen atom as the work done in the above neutralisation process. Also, if the magnitude of the average kinetic energy is half the magnitude of the average potential energy, find the average potential energy. **(IIT JEE 1996)**

45. Find out the number of waves made by a Bohr's electron in one complete revolution in its 3rd orbit. **(IIT JEE 1994)**

46. Estimate the difference in energy between 1st and 2nd Bohr's orbit for a hydrogen atom. At what minimum atomic number, a transition from $n = 2$ to $n = 1$ energy level would result in the emission of X-rays with $l = 3.0 \times 10^{-8}$ *m*? Which hydrogen atom-like species does this atomic number correspond to? **(IIT JEE 1993)**

47. According to Bohr's theory, the electronic energy of hydrogen atom in the nth Bohr's orbit is given by:

$$E_n = \frac{-21.7 \times 10^{-19}}{n^2} J$$

Calculate the longest wavelength of electron from the third Bohr's orbit of the He^+ ion **(IIT JEE 1990)**

48. The electron energy in hydrogen atom is given by $E_n = -\frac{21.7 \times 10^{-12}}{n^2}$ erg. Calculate the energy required to remove an electron completely from the n = 2 orbit. What is the longest wavelength (in cm) of light that can be used to cause this transition? **(IIT JEE 1984)**

49. Calculate the wavelength in Angstroms of the photon that is emitted when an electron in the Bohr's orbit, $n = 2$ returns to the orbit, $n = 1$ in the hydrogen atom. The ionisation potential of the ground state hydrogen atom is 2.17×10^{-11} *erg* per atom. **(IIT JEE 1982)**

50. The energy of the electron in the second and third Bohr's orbits of the hydrogen atom is -5.42×10^{-12} erg and -2.41×10^{-12} erg respectively. Calculate the wavelength of the emitted light when the electron drops from the third to the second orbit. **(IIT JEE 1981)**

Towards Quantum Mechanical Model of the Atom

Single Correct

51. The wavelength associated with a golf ball weighing 200 g and moving at a speed of 5 m / h is of the order **(IIT JEE 2001)**

(*a*) 10^{-10} m (*b*) 10^{-20} m

(*c*) 10^{-30} m (*d*) 10–40 m

Numerical/Integer Types

52. Consider a Helium (He) atom that absorbs a photon of wavelength 330 nm. The change in the velocity (in cm s^{-1}) of He atom after the photon absorption is _____.

(Assume: Momentum is conserved when photon is absorbed).

Use: Planck constant = 6.6×10^{-34} Js, Avogadro number = 6×10^{23} mol^{-1}, molar mass of He = 4 g mol^{-1}

C-7.56 W-73.79 UA-18.65 (JEE Adv. 2021)

Fill in the Blanks

53. The uncertainty principle and the concept of wave nature of matter were proposed by ..... and ..... respectively

(IIT JEE 1988)

Subjective

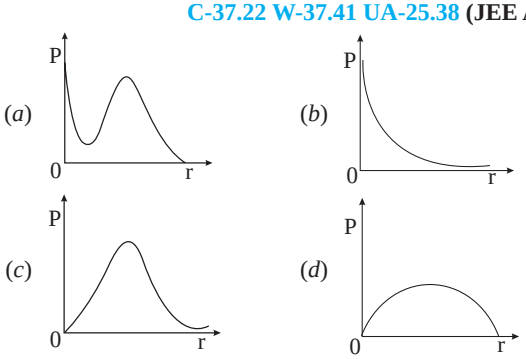
54. An electron beam can undergo diffraction by crystals. Through what potential should a beam of electrons be accelerated so that its wavelength becomes equal to 1.54Å. **(IIT JEE 1997)**

Quantum Mechanical Model of the Atom

Single Correct

55. P is the probability of finding the 1s electron of hydrogen atom in a spherical shell of infinitesimal thickness, dr, at a distance r from the nucleus. The volume of this shell is $4\pi r^2$ dr. The qualitative sketch of the dependence of P on r is

C-37.22 W-37.41 UA-25.38 (JEE Adv. 2016)



56. The number of radial nodes in 3s and 2p respectively are

(IIT JEE 2005)

(*a*) 2 and 0 (*b*) 0 and 2 (*c*) 1 and 2 (*d*) 2 and 1

57. If the nitrogen atom had electronic configuration $1s^7$, it would have energy lower than that of the normal ground state configuration $1s^2 2s^2 2p^3$, because the electrons would be closer to the nucleus, yet $1s^7$ is not observed, because it violates **(IIT JEE 2002)**

(*a*) Heisenberg uncertainty principle

(*b*) Hund's rule

(*c*) Pauli exclusion principle

(*d*) Bohr postulate of stationary orbits

58. The quantum numbers $+\frac{1}{2}$ and $-\frac{1}{2}$ for the electron spin represent **(IIT JEE 2001)**

(*a*) rotation of the electron in clockwise and anti-clockwise direction respectively

(*b*) rotation of the electron in anti-clockwise and clockwise direction respectively

(*c*) magnetic moment of the electron pointing up and down respectively

(*d*) two quantum mechanical spin states which have no classical analogue

59. The number of nodal planes in a p_x orbital is **(IIT JEE 2001)**

(*a*) one (*b*) two (*c*) three (*d*) zero

60. The electronic configuration of an element is $1s^2$, $2s^2 2p^6$, $3s^2 3p^6 3d^5$, $4s^1$. This represents its **(IIT JEE 2000)**

(*a*) excited state (*b*) ground state

(*c*) cationic form (*d*) anionic form

61. The electrons, identified by quantum numbers n and *l*, (i) $n = 4$, $l = 1$, (ii) n = 4, $l = 0$, (iii) n = 3, $l = 2$, (iv) n = 3, $l = 1$ can be placed in order of increasing energy, from the lowest to highest, as

(IIT JEE 1999)

(*a*) (iv) < (ii) < (iii) < (i) (*b*) (ii) < (iv) < (i) < (iii)

(*c*) (i) < (iii) < (ii) < (iv) (*d*) (iii) < (i) < (iv) < (ii)

62. For a d-electron, the orbital angular momentum is

(IIT JEE 1997)

(*a*) $\sqrt{6}\left(\frac{h}{2\pi}\right)$ (*b*) $\sqrt{2}\left(\frac{h}{2\pi}\right)$

(*c*) $\left(\frac{h}{2\pi}\right)$ (*d*) $2\left(\frac{h}{2\pi}\right)$

63. The orbital angular momentum of an electron in 2*s*-orbital is

(IIT JEE 1996)

(*a*) $+\frac{1}{2}\cdot\frac{h}{2\pi}$ (*b*) zero

(*c*) $\frac{h}{2\pi}$ (*d*) $\sqrt{2}\cdot\frac{h}{2\pi}$

64. The outermost electronic configuration of the most electronegative element is **(IIT JEE 1990)**

(*a*) $ns^2\, np^3$ (*b*) $ns^2\, np^4$

(*c*) $ns^2\, np^5$ (*d*) $ns^2\, np^6$

65. The correct set of quantum numbers for the unpaired electron of chlorine atom is **(IIT JEE 1989)**

(*a*) n = 2, l = 1, m = 0 (*b*) n = 2, l = 1, m = 1

(*c*) n = 3, l = 1, m = 1 (*d*) n = 3, l = 0, m = 0

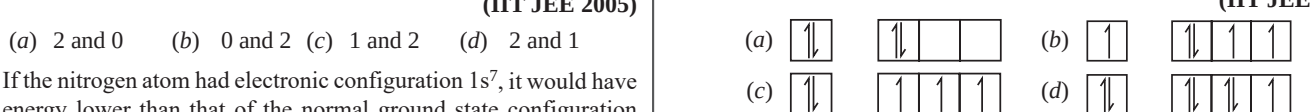
66. The correct ground state electronic configuration of chromium atom is **(IIT JEE 1989)**

(*a*) $[Ar]3d^5 4s^1$ (*b*) $[Ar]3d^4 4s^2$

(*c*) $[Ar]3d^6 4s^0$ (*d*) $[Ar]4d^5 4s^1$

67. The orbital diagram in which the Aufbau principle is violated

(IIT JEE 1988)



68. Which one of the following sets of quantum numbers represents an impossible arrangement? for n, l, m, s **(IIT JEE 1986)**

(*a*) $\left(3, 2, -2, \frac{1}{2}\right)$ (*b*) $4, 0, 0, \frac{1}{2}$

(*c*) $3, 2, -3, \frac{1}{2}$ (*d*) $5, 3, 0, -\frac{1}{2}$

69. Correct set of four quantum numbers for the valence (outermost) electron of rubidium ($Z = 37$) is **(IIT JEE 1984)**

(*a*) $5, 0, 0, +\frac{1}{2}$ (*b*) $5, 0, 1, +\frac{1}{2}$

(*c*) $5, 1, 1, +\frac{1}{2}$ (*d*) $6, 0, 0, +\frac{1}{2}$

70. The principal quantum number of an atom is related to the

(IIT JEE 1983)

(*a*) size of the orbital

(*b*) spin angular momentum

(*c*) orientation of the orbital in space

(*d*) orbital angular momentum

71. Any *p*-orbital can accommodate upto **(IIT JEE 1983)**

(*a*) four electrons

(*b*) six electrons

(*c*) two electrons with parallel spins

(*d*) two electrons with opposite spins

Multiple Correct

72. The ground state energy of hydrogen atom is –13.6 eV. Consider an electronic state of He^+ whose energy, azimuthal quantum number and magnetic quantum number are –3.4 eV, 2 and 0, respectively.

Which of the following statement(s) is (are) true for the state Ψ?

C-23.82 W-41.54 UA-20.07 PC-14.57 (JEE Adv. 2019)

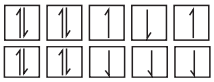
(*a*) It is a 4 d state

(*b*) The nuclear charge experienced by the electron in this state is less than 2e, where e is the magnitude of the electronic charge

(*c*) It has 2 angular nodes

(*d*) It has 3 radial nodes

73. The ground state electronic configuration of nitrogen atom can be represented by **(IIT JEE 1999)**

(*a*)  (*b*) 

(*c*)  (*d*) 

74. Which of the following statement (s) is (are) correct?

(IIT JEE 1998)

(*a*) The electronic configuration of Cr is $[Ar]3d^5 4s^1$ (atomic number of Cr = 24)

(*b*) The magnetic quantum number may have a negative value

(*c*) In silver atom, 23 electrons have a spin of one type and 24 of the opposite type. (Atomic number of Ag = 47)

(*d*) The oxidation state of nitrogen in HN_3 is –3

Assertion Reason/Statement Based

Read the following questions and answer as per the direction given below:

(*a*) Statement-I is correct; Statement-II is correct Statement-II is the correct explanation of Statement-I

(*b*) Statement-I is correct; Statement-II is correct Statement-II is not the correct explanation of Statement-I

(*c*) Statement-I is correct; Statement-II is incorrect

(*d*) Statement-I is incorrect; Statement-II is correct

75. **Statement-I:** The first ionisation energy of Be in greater than that of B.

Statement-II: 2p-orbital is lower in energy than 2s. **(IIT JEE 2000)**

Comprehension/Passage Based

The hydrogen-like species Li^{2+} is in a spherically symmetric state S_1 with one radial node. Upon absorbing light, the ion undergoes transition to a state S_2. The state S_2 has one radial node and its energy is equal to the ground state energy of the hydrogen atom.

76. The state S_1 is **(IIT JEE 2010)**

(*a*) 1s (*b*) 2s (*c*) 2p (*d*) 3s

77. Energy of the state S_1 in units of the hydrogen atom ground state energy is **(IIT JEE 2010)**

(*a*) 0.75 (*b*) 1.50 (*c*) 2.25 (*d*) 4.50

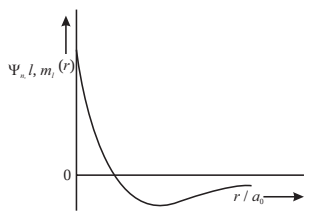
78. The orbital angular momentum quantum number of the state S_2 is **(IIT JEE 2010)**

(*a*) 0 (*b*) 1 (*c*) 2 (*d*) 3

Match the Column

The wave function, ψ_n, l, m_l is a mathematical function whose value depends upon spherical polar coordinates (r, θ, ϕ) of the electron and characterised by the quantum number n, l and m_l. Here r is distance from nucleus, θ is colatitude and ϕ is azimuth. In the mathematical functions given in the Table, Z is atomic number and a_0 is Bohr radius.

	Column-I		Column-II
(I)	Is-orbital	(i)	$\psi_{n,l,m_l} \propto \left(\frac{Z}{a_0}\right)^{\frac{3}{2}} e^{-\left(\frac{Zr}{a_0}\right)}$
(II)	2s-orbital	(ii)	one radial node
(III)	$2p_z$ - orbital	(iii)	$È_{n,l,m_l} \propto \left(\frac{Z}{a_0}\right)^{\frac{5}{2}} re^{-\left(\frac{Zr}{a_0}\right)} \cos$,
(IV)	$3d_z^2$ – orbital	(iv)	xy-plane is a nodal plane

	Column-III
(P)	
(Q)	Probability density at nucleus $\propto \frac{1}{a_0^3}$
(R)	Probability density is maximum at nucleus
(S)	Energy needed to excite electron from n = 2 state to n = 4 state is $\frac{27}{32}$ times the energy needed to excite electron from n = 2 state to n = 6.

79. For He^+ ion, the only INCORRECT combination is

C-16.69 W-40.53 UA-42.78 (JEE Adv. 2017)

(*a*) (I) (i) (S) (*b*) (II) (ii) (Q)

(*c*) (I) (iii) (R) (*d*) (I) (i) (R)

80. For the given orbital in Column-I, the only CORRECT combination for nay hydrogen-like species is

C-28.59 W-30.39 UA-41.01 (JEE Adv. 2017)

(*a*) (II) (ii) (P) (*b*) (I) (ii) (S)

(*c*) (IV) (iv) (R) (*d*) (III) (iii) (P)

81. For hydrogen atom, the only CORRECT combination is

C-32.01 W-30.18 UA-37.8 (JEE Adv. 2017)

(*a*) (I) (i) (P) (*b*) (I) (iv) (R)

(*c*) (II) (i) (Q) (*d*) (I) (i) (S)

Numerical/Integer Types

82. Not considering the electronic spin, the degeneracy of the second excited state (n = 3) of H-atom is 9 , while the degeneracy of the second excited state of H^- is **(JEE Adv. 2015)**

83. In an atom, the total number of electrons having quantum numbers $n = 4, |m_l| = 1$ and $m_s = -\frac{1}{2}$ is

C-26.82 W-69.72 UA- 3.46 (JEE Adv. 2014)

84. The maximum number of electrons that can have principal quantum number, n = 3 and spin quantum number, m_s = –1/2, is

(IIT JEE 2011)

Fill in the Blanks

85. The outermost electronic configuration of Cr is _____.
(IIT JEE 1994)

86. Wave functions of electrons in atoms and molecules are called _____.
(IIT JEE 1993)

87. The $2p_x$, $2p_y$ and $2p_z$ orbitals of atom have identical shapes but differ in their _____.
(IIT JEE 1993)

88. When there are two electrons in the same orbital, they have _____ spins
(IIT JEE 1983)

True/False

89. The electron density in the *XY*-plane in $3d_{x^2-y^2}$ orbital zero.
(IIT JEE 1986)

90. The energy of the electron in the 3d-orbital is less than that in the 4*s* orbital in the hydrogen atom.
(IIT JEE 1983)

91. The outer electronic configuration of the ground state chromium atom is $3d^44S^2$.
(IIT JEE 1982)

Subjective

92. The Schrodinger wave equation for hydrogen atom is

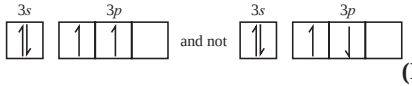
$$\psi_{2s} = \frac{1}{4(2\pi)^{1/2}}\left(\frac{1}{a_0}\right)^{3/2}\left(2-\frac{r}{a_0}\right)e^{-r/2a_0}$$

where, a_0 is Bohr's radius. Let the radial node in 2s be at r_0. Then, find r in terms of a_0.

(*b*) A base ball having mass 100 g moves with velocity 100 m/s. Find out the value of wavelength of baseball.
(IIT JEE 2004)

93. What is the maximum number of electrons that may be present in all the atomic orbitals with principal quantum number 3 and azimuthal quantum number 2?
(IIT JEE 1985)

94. Give reason why the ground state outermost electronic configuration of silicon is



(IIT JEE 1985)

ANSWER KEY

1. (*d*)	**2.** (*b*)	**3.** (*b*)	**4.** (*d*)	**5.** (*a*)	**6.** (*c*)	**7.** (*a*, *b*)	**8.** (*a*)	**9.** (*a*, *c*)	**10.** (*a*,*c*)
11. (*b*, *d*)	**12.** Isobar	**13.** 1.66×10^{-24} kg		**14.** Neutrons	**15.** TRUE	**16.** (*b*)	**17.** (*d*)	**18.** (*c*)	**19.** (*d*)
20. (*b*)	**21.** (*b*)	**22.** [5]	**23.** [4]	**24.** Photons	**25.** FALSE	**29.** (*c*)	**30.** (*b*)	**31.** (*a*)	**32.** (*c*)
33. (*d*)	**34.** (*c*)	**35.** (*d*)	**36.** A→(r); B→(q); C→(p); D→(s)			**37.** [30]	**38.** [–5242.4192]		**39.** [1:16]
51. (*c*)	**52.** [30]	**53.** Heisenberg and De-Broglie			**55.** (*c*)	**56.** (*a*)	**57.** (*c*)	**58.** (*d*)	**59.** (*a*)
60. (*b*)	**61.** (*a*)	**62.** (*a*)	**63.** (*b*)	**64.** (*c*)	**65.** (*c*)	**66.** (*a*)	**67.** (*b*)	**68.** (*c*)	**69.** (*a*)
70. (*a*)	**71.** (*d*)	**72.** (*a*, c)	**73.** (*a*, *d*)	**74.** (*a*, *b*, *c*)	**75.** (*c*)	**76.** (*b*)	**77.** (*c*)	**78.** (*b*)	**79.** (*c*)
80. (*a*)	**81.** (*d*)	**82.** [3]	**83.** [6]	**84.** [9]	**85.** $[Ar]3d^54s^1$		**86.** Orbital	**87.** Orientation in space	
88. opposite	**89.** FALSE	**90.** TRUE	**91.** FALSE						

1 SOME BASIC CONCEPTS OF CHEMISTRY

1. (*a*) The molecular weight of oxalic acid dihydrate ($C_2H_2O_4 \cdot 2H_2O$) is g/mol. It is a dibasic acid.

Its equivalent weight is $\frac{126}{2} = 63$.

Its normality is

$$\frac{\text{weight}}{\text{equivalent weight}} \times \frac{1000}{\text{Volume in}} = \frac{6.3 \times 1000}{63 \times 250} = 0.4\text{N}$$

But $N_1V_1 = N_2V_2$,

Hence, $0.1\ V_1 = 0.4 \times 10$

Thus, the volume of 0.1 N NaOH required to completely neutralize 10 mL of this solution is 40 mL.

2. (*d*) From given question we have Molarity (M) = 0.3M and we know that the relation between normality (N) and molarity(M). Then, we have

Normality (N) = Molarity × basicity (basicity of H_3PO_3 is 2

So, N = 0.3 × 2 = 0.6N

3. (*d*) Molarity depends on temperature.

$$M\alpha\frac{1}{V}\alpha\frac{1}{T}$$

V = Volume, T = Temperature

Normality = Molarity $\times n_{factor}$.

So, it depends upon temperature.

Formality

$$\frac{\text{No. of gram formula masses dissolved}}{\text{Volumes (Litres)}}$$

So, Formality also depends on temperature.

$V \propto T$

Molality is the one which depends upon the mass of the solute and the solvent.

The mass is independent of temperature.

Thus, molality is independent of temperature.

4. (*b*) Volume strength of hydrogen peroxide is defined as the term which is used to express the concentration of H_2O_2 with respect to the volumes of oxygen gas based on its decomposition to form water and oxygen.

Normality (N) = 1.5

Equivalent weight of H_2O_2 is 17

Strength of H_2O_2 = (Normality) (Equivalent weight)

= 1.5 × 17 = 25.5

$2H_2O_2 \rightarrow 2H_2O + O_2$

(2) (34 g) (22.4 L)

Since 68 grams of H_2O_2 produces 22.4 liters of oxygen at NTP,

Therefore, 25.5 grams of H_2O_2 will produce = (22.4/68) 25.5 = 8.4 liter of oxygen

Thus, volume strength of given H_2O_2 solution is 8.4.

5. (*a*) According to molality (m) definition,

Molality is the number of moles of solute dissolved in 1000 grams of solvent. So 1 molal solution contains one mole of solute in 1000 grams of solvent.

Hence option (*a*) is correct.

6. (*d*) Chemical Reaction:

$3BaCl_2 + 2Na_3PO_4 \rightarrow Ba_3(PO_4)_2 + 6NaCl$

2 mol of $Na_3PO_4 \Rightarrow 3$ mol of $BaCl_2$

0.2 mol of $Na_3PO_4 \Rightarrow 0.3$ mol of $BaCl_2$

$\therefore$ Na_3PO_4 is the limiting reagent.

Thus, 2 mol of $Na_3PO_4 \Rightarrow 1$ mol of $Ba_3(PO_4)_2$

0.2 mol of $Na_3PO_4 \Rightarrow 0.1$ mol of $Ba_3(PO_4)_2$

7. (*a*) We know that, Atomic number = $n_p = n_e$

In case of carbon dioxide,

C has atomic number 6 so it has 6 electrons

oxygen has atomic no. 8, i.e., 16 electrons.

So total electrons present are in one mole of carbon dioxide (CO_2), 2 will be subscript of O = 16 + 6 = 22 electrons.

8. [6.15] Aluminium reacts with sulphuric acid to form aluminium sulphate and hydrogen.

$$\underset{\left(\frac{5.4}{27}=0.2\text{mol}\right)}{2Al} + \underset{\left(\frac{50\times5}{1000}=0.25\text{ mol}\right)}{3H_2SO_4} \rightarrow Al_2(SO_4)_3 + + 3H_2$$

H_2SO_4 is limiting reagent and moles of H_2(g) produced = 0.25 mol

Using ideal gas equation,

pV = nRT

$$\Rightarrow V = \frac{0.25 \times 0.082 \times 300}{1\text{atm}} \Rightarrow 6.15\text{ L}$$

9. [2.98 or 2.99]

$$X_{urea} = 0.05 = \frac{n}{n+50}$$

19n = 50

n = 2.6315

$$V_{sol} = \frac{(2.6315 \times 60 + 900)}{1.2} = 881.5789\text{ ml}$$

$$\text{Molarity} = \frac{2.6315 \times 1000}{881.5789} = 2.9849$$

Molarity = 2.98M

10. [9] Molecular weight of solute be = M_1

Molecular weight of solvent be M_2

Fraction of solute = 0.1

Let solution be litre

mass of solution = 2000 g

mass of solute = x mass of solvent = 2000 × x · g

$$\text{Molarity} = \frac{x}{M_1}/1\text{ litre} = \frac{x}{M_1}$$

$$\text{Molarity} = \frac{x}{M_1}/(2000 - x) \times 10^{-3}$$

$$= \frac{1000x}{(2000 - x)M_1}$$

Molarity = Molarity

$$\frac{x}{M_1} = \frac{1000x}{(2000 - x)M_1} = 2000 - x = 1000;\ x = 1000\text{ gM}$$

$$\frac{\frac{1000}{M_1}}{\frac{1000}{M_1} + \frac{1000}{M_2}} \Rightarrow \frac{M_2}{M_1 + M_2} = 0.1$$

$M_2 = 0.1M_1 + 0.1\ M_2$

$0.9\ M_2 = 0.1\ M_1$

$M_1/M_2 = 0.9/0.1 = 9$

11. [8] According to given question

$$M_{(H_2X)} = 80\,\text{gmol}^{-1}$$

$$d_{solvent} = 0.4\,\text{gmol}^{-1}$$

$$M = 3.2 = \frac{n_B}{V_{solution}}$$

$V_{solvent} = V_{solution} = 1000$ ml (given in question)

$W_{Solvent} = 0.4 \times 1000 = 400\text{g} = W_A$

3.2 moles of H_2X in 1000 ml of Solution

n_B = 3.2 moles

$$\text{molality} = \frac{n_B}{W_A} \times 1000 = \frac{3.2 \times 1000}{400} = 8\text{ m}$$

12. [8] Given data

100 g solution contains 29.2g HCl and molecular weight of HCl = 36.5 g/mol

$$\text{Volume of solution} = \frac{\text{Mass}}{\text{density}} = \frac{100}{1.25} = 80\text{ ml}$$

Molarity

$$= \frac{\text{Mass of solute}}{\text{Mol.wt. of solute} \times \text{Volume (in ml)}} \times 1000$$

$$= \frac{29.2}{36.5 \times 80} \times 1000 = 10\text{ M}$$

Let V ml of this HCl are used to prepare 200 ml of 0.4M HCl, then

milli-mole of conc. HCl = milli-mole of dil. HCl

(milli-mole does not change on dilution)

$V \times 10 = 200 \times 0.4 \Rightarrow V = 8$ ml

13. (0.4) The expression for the molality of the solution is

Molality (m)

$$= \frac{\text{mass of salt}}{\text{molar mass of salt}} \times \frac{1}{\text{mass of water}}$$

Substituting values in the above expression, we get kg

$$m = \frac{3}{30} \times \frac{1}{250} \times 1000 = 0.4\text{m}$$

The molality of the solution is 0.4 m.

14. (6.023×10^{24}) Number of electron in one molecule of H_2O is 2 + 8 = 10.

Density = 1 g/ml

$\therefore$ 18 ml means 18 g

$$\text{Moles} = \frac{18}{18} = 1$$

Electrons = $6.023 \times 10^{23} \times 10 = 6.023 \times 10^{24}$

15. Given that for absorbed N_2 on surface sites,

$P(N_2) = 0.001\,\text{atm}, V = 2.46\,\text{cm}^3 = 2.46 \times 10^{-3}\text{l}$, T = 298

$n_{N_2} = \frac{PV}{RT} = \frac{0.0001 \times 2.46 \times 10^{-3}}{0.0821 \times 298} = 1.0 \times 10^{-7}$

Molecules of absorbed $N_2 = 1.0 \times 10^{-7} \times 6.023 \times 10^{23} = 6.023 \times 10^{16}$

Total surface sites available = Number of sites per cm^2 × Area = $60.23 \times 10^{14} \times 1000 = 6.023 \times 10^{17}$

Surface sites on which N_2 is absorbed = 20% × Available sites

$= \frac{20}{100} \times 6.023 \times 10^{17} = 12.046 \times 10^{16}$

$\therefore$ Number of sites absorbed per molecule of $N_2 = \frac{12.046 \times 10^{16}}{6.023 \times 10^{16}} = 2$

16. The reaction is as follows:

$6CaO + P_4O_{10} \rightarrow 2Ca_3(PO_4)_2$

$\because$ 1 mole of P_4O_{10} requires 6 moles CaO

$\therefore \frac{852}{284}$ moles of P_4O_{10} require $\frac{6 \times 852}{284}$ moles

CaO = $\frac{6 \times 852}{284} \times 56$gCaO

Therefore, mass of CaO required =1008 g

17. Moles of CH_3COOH absorbed = Initial moles – Final moles.

$= 0.5 \times 100 \times 10^{-3} - 0.049 \times 100 \times 10^{-3}$

$= 0.05 - 0.049 = 0.001$ mole

No. of molecules of CH_3COOH absorbed $= 0.001 \times 6.02 \times 10^{23} = 6.02 \times 10^{20}$

Surface area = 3.01×10^2 m^2 (given)

Surface area of charcoal absorbed by in each molecule of CH_3COOH

$= \frac{3.01 \times 10^2}{6.02 \times 10^{20}} = 5 \times 10^{-19} m^2$.

18. We know,

1 litre of water =1 kg.

(Since, Density is 1000 kg/m^3

Thus, 1000ml of water = 1 kg.

(Since, 1 litre = 1000ml)

Now, Mass of Water =1 kg. =1000 g.

The molecular mass of the water molecules = 18 grams.

Using the formula,

No.of moles $= \frac{\text{mass}}{\text{molar mass}}$

$= \frac{1000}{18} = 55.56$ moles

For the Molarity,

Using the Formula,

$\text{Molarity} = \frac{\text{Number of moles}}{\text{volume in ml}} \times 1000 = \frac{55.56}{1000} \times 1000$

= 55.56M

19. The balanced chemical reaction is :

$CuCO_3 + H_2SO_4 \rightarrow CuSO_4 + H_2O + CO_2$

Millimol of $CuCO_3$ = (0.5 × 1000)/123.5 = 4.048

$\Rightarrow$ millimol of H_2SO_4 required = 4.048

$\because$ millimol = Molarity × Volume (in mL)

$\Rightarrow$ Vol = 4.048/0.50 = 8.1 mL

20. The reaction is as follows:

$KIO_3 + 5KI \rightarrow K_2O + 3I_2$

Moles of $KIO_3 = \frac{0.1}{214}$

Moles of iodine liberated $= 3 \times \frac{0.1}{214}$

$2Na_2S_2O_3 + I_2 \rightarrow 2NaI + Na_2S_4O_6$

Moles of $Na_2S_2O_3$ required $= 3 \times \frac{0.1}{214} \times 2$

Molarity

$= \frac{\text{Number of moles}}{\text{Volume}_{mL}} \times 1000$

$= 3 \times \frac{0.1}{214} \times 2 \times \frac{1}{45} \times 1000$

= 0.0623 M

Therefore, molarity of the sodium thiosulphate solution is 0.0623 M

21. Normality is a concentration measurement expressed in gram equivalent weight per litre of fluid. The reactive capacity of a molecule is measured in gram equivalent weight. The of the solution is determined by the solute's role in the reaction. The corresponding concentration of a solution is also known as normality.

Here given,

25ml H_2O_2 was reacted with excess of KI

Also 20 ml 0.3 N $Na_2S_2O_3$ was required to liberate I_2 The reaction involved in this liberation is

$2KI + H_2O_2 \rightarrow I_2 + 2KOH$

Let, Normality of 25ml H_2O_2 be xN

$\therefore$ From above titration

N_1= Normality of H_2O_2

V_1= Volume of H_2O_2

N_2= Normality of $Na_2S_2O_3$ or I_2

V_2= Volume of $Na_2S_2O_3$ or I_2

$\Rightarrow N_1V_1 = N_2V_2 \Rightarrow x \times 2\,5 = 0.3 \times 20$

$\Rightarrow x = \frac{0.3 \times 20}{25} = 0.24$

$\therefore$ Normality of H_2O_2 solution = 0.24 N

Now, We know Volume strength = Normality × 5.6

Equivalent weight of H_2O_2 in terms of oxygen = 5.6L

$\Rightarrow$ Volume strength = $0.24 \times 5.6 = 1.344 gL^{-1}$

The volume strength of H_2O_2 solution is $1.344 gL^{-1}$

22. Moles of iodine = $\frac{0.508}{254}$ moles

Now, $M_1V_1 = M_2V_2$

$M_1 \rightarrow$ Molarity of H_2O_2 solution

$\therefore V_1 \rightarrow$ Volume of H_2O_2

$M_2 \rightarrow$ Molarity of iodine

$V_2 \rightarrow 1000$ml $\therefore M_1 \times 5 = \frac{0.508}{254} \times 1000$

$\therefore M_1 = 0.4M$

The reaction can be given as,

$H_2O_2 + 2I^- + 2H^+ \rightarrow 2H_2O + I_2$

$\therefore$ n-factor for $H_2O_2 = 2$

$\therefore$ Normality of $H_2O_2 = 2 \times 0.4 = 0.8N$

$\therefore$ Volume strength of $H_2O_2 = 0.8 \times 5.6 = 4.48$ volumes

23. We know that the relations

(i) Density = Mass/Volume

(ii) Molarity = Moles of solute/Volume of solution in L

(iii) Molality = Moles of solute/Mass of solvent in kg

(iv) Mole fraction of solute = Moles of solute/Total moles

The formula of Glauber's salt is $Na_2SO_4 \cdot 10H_2O$

Molecular mass of $Na_2SO_4 \cdot 10H_2O$

$= [2 \times 23 + 32.1 + 4 \times 16] + 10(1.01 \times 2 + 16)$

$= 322.3$ g mol^{-1}

Weight of the Glauber's salt taken

= 80.575gm

Out of 80.575 g of salt, weight of anhydrous $Na_2SO_4 = 142.1/322.3 \times 80.575 = 35.525$ g

Number of moles of Na_2SO_4 per dm^3 of the solution = 35.525/142.1= 0.25

Density of solution =1077.2kgm^{-3}

$= 1077.2 \times 10^3 / 10^6$ gmcm = 1.0772 g cm^{-3}

Total weight of sol = V × d = 1dm^3 × d

= 1000 cm^3 × 1.0772 gcm^{-3} = 1077.2 g

Weight of water = 1077.2 – 35.525 = 1041.67 g

Molality of sol. 0.25/1041.67 g × 1000 g = 0.2399 = 0.24m

Number of moles of water in the solution = 1041.67/18 = 57.87

Mole fraction of Na_2SO_4

= No. of moles of Na_2SO_4/ Total number of moles = 0.25/0.25 + 57.87

$= 0.0043 = 4.3 \times 10^{-3}$.

24. $3Pb(NO_3)_2 + Cr_2(SO_4)_3 \rightarrow 3PbSO + 2Cr_2(NO_3)_3$

No. of moles of $Pb(NO_3)_2 = 45 \times 10^{-3} \times 0.25 = 11.25 \times 10^{-3}$ mole

No. of moles of $Cr_2(SO_4)_3 = 25 \times 10^{-3} \times 0.1 = 2.5 \times 10^{-3}$ mole

Thus, $Cr_2(SO_4)_3$ has limiting amount. It shall be consumed fully and the number of moles of lead sulphate produced will be $= 3 \times 2.5 \times 10^{-3} = 7.5 \times 10^{-3}$ mole

No. of mole of lead nitrate left = $11.25 \times 10^{-3} - 7.5 \times 10^{-3} = 3.75 \times 10^{-3}$ mole

Total volume = (45.0 + 25.0) = 70 mL or 70×10^{-3} litre

$\text{Molarity} = \frac{3.75 \times 10^{-2}}{70 \times 10^{-2}} = 0.0536M$

No. of moles of $Cr(NO_3)_3$ formed = $2 \times 2.5 \times 10^{-3} = 5 \times 10^{-3}$ mole

$Pb(NO_3)_2$ and $Cr(NO_3)_3$ will be present in solution in ionic form.

Thus, $[Pb^{2+}] = 0.0536M$

$[Cr^{3+}] = 0.0714M$, $[NO_3^-]$

$= (2 \times 0.0536) + (3 \times 0.0714) = 0.3214M$.

25. 93%H_2SO_4 w/v means 93 g of H_2SO_4 is present in 100ml of solution.

KEY FEATURES

- Chapter-wise & topic-wise solved papers of the past 47 years
- Exam Analysis based on different parameters
- Realtime Question-wise difficulty level analysis with Correct (C), Wrong(W) and Unattempted (UA) questions response tagging provided by IIT-JEE
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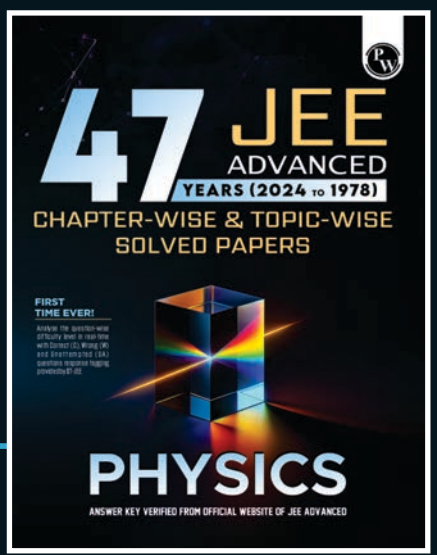

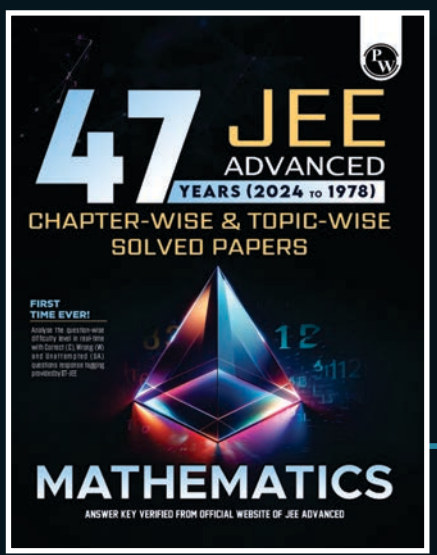

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