

JEE MAIN 2024 · QUESTION PAPER

8 Apr 2024 **Shift 1**

82 questions in exam order, with answer key

Subject	Section A multiple choice	Section B numerical value
• Physics	20 Q1 to Q20	8 Q21 to Q28
• Chemistry	15 Q29 to Q43	9 Q44 to Q52
• Mathematics	20 Q53 to Q72	10 Q73 to Q82
In this PDF	82 questions · answer key at the end	

- 1 Set a 3 hour timer and attempt the paper in one sitting, like the real exam.
- 2 In the 2021 to 2024 papers, Section B asked you to answer any 5 numerical questions per subject. Try each one here.
- 3 Check yourself against the answer key at the end. Every question names its chapter, so you can see where marks went.
- 4 Got one wrong? Tap “Step-by-step solution” at the top right of it for the full working, where available.

Attempt this paper online

The same questions in the same order, with instant answer checking and step-by-step solutions where available.

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Answers follow NTA's final answer keys. Typing errors are possible, so check doubtful answers against the official key. Spotted a mistake?
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Q1 Alternating Current

[Step-by-step solution](#) · [prepwiser.in/questions/bFO-ymPSkD](#)

A LCR circuit is at resonance for a capacitor C, inductance L and resistance R. Now the value of resistance is halved keeping all other parameters same. The current amplitude at resonance will be now:

- (A) halved (B) same (C) Zero (D) double

Q2 Nuclear Physics

[Step-by-step solution](#) · [prepwiser.in/questions/ZiZ3cBwpod](#)

Binding energy of a certain nucleus is $18 \times 10^8 \text{ J}$. How much is the difference between total mass of all the nucleons and nuclear mass of the given nucleus:

- (A) $20 \mu\text{g}$ (B) $2 \mu\text{g}$ (C) $10 \mu\text{g}$ (D) $0.2 \mu\text{g}$

Q3 Centre of Mass & Linear Momentum

[Step-by-step solution](#) · [prepwiser.in/questions/Q-iOf_jkGc](#)

A stationary particle breaks into two parts of masses m_A and m_B which move with velocities v_A and v_B respectively. The ratio of their kinetic energies ($K_B : K_A$) is:

- (A) $v_B : v_A$ (B) $1 : 1$ (C) $m_B v_B : m_A v_A$ (D) $m_B : m_A$

Q4 Circular Motion

[Step-by-step solution](#) · [prepwiser.in/questions/5vOND3awu8](#)

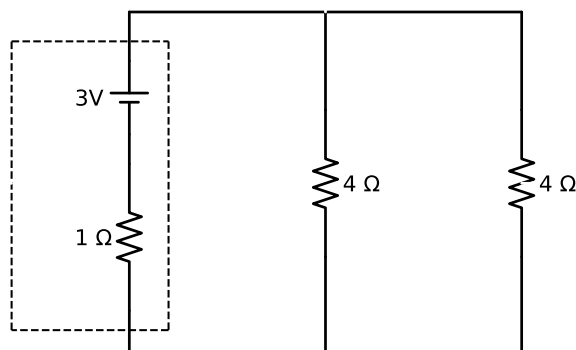
A clock has 75cm, 60cm long second hand and minute hand respectively. In 30 minutes duration the tip of second hand will travel x distance more than the tip of minute hand. The value of x in meter is nearly (Take $\pi = 3.14$):

- (A) 118.9 (B) 140.5 (C) 139.4 (D) 220.0

Q5 Current Electricity

[Step-by-step solution](#) · [prepwiser.in/questions/i3tSDiB0uG](#)

In the given circuit, the terminal potential difference of the cell is:



- (A) 3 V (B) 4 V (C) 2 V (D) 1.5 V

Q6 Dual Nature of Radiation & Matter

[Step-by-step solution](#) · [prepwiser.in/questions/IcnCUZcQ3W](#)

A proton and an electron are associated with same de-Broglie wavelength. The ratio of their kinetic energies is: (Assume $h = 6.63$

$$\times 10^{-34} \text{ Js, } m_e = 9.0 \times 10^{-31} \text{ kg}$$

and $m_p = 1836 \text{ times } m_e$)

- (A) $1 : \frac{1}{1836}$ (B) $1 : \sqrt{1836}$ (C) $1 : 1836$ (D) $1 : \frac{1}{\sqrt{1836}}$

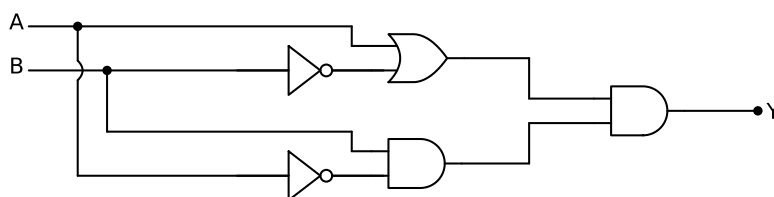
Q7 Electromagnetic Waves

[Step-by-step solution](#) · [prepwiser.in/questions/0j8fA2nB5B](#)

Average force exerted on a non-reflecting surface at normal incidence is $2.4 \times 10^{-4} \text{ N}$. If 360 W/cm^2 is the light energy flux during span of 1 hour 30 minutes, Then the area of the surface is:

- (A) 20 m^2 (B) 0.2 m^2 (C) 0.1 m^2 (D) 0.02 m^2

The output Y of following circuit for given inputs is:



- (A) $A \cdot B$ (B) $\bar{A} \cdot B$ (C) $A \cdot B(A + B)$ (D) 0

Two charged conducting spheres of radii a and b are connected to each other by a conducting wire. The ratio of charges of the two spheres respectively is:

- (A) ab (B) $\frac{b}{a}$ (C) $\frac{a}{b}$ (D) $\sqrt{ab}$

Critical angle of incidence for a pair of optical media is 45° . The refractive indices of first and second media are in the ratio:

- (A) 1 : 2 (B) $1 : \sqrt{2}$ (C) 2 : 1 (D) $\sqrt{2} : 1$

Two planets A and B having masses m_1 and m_2 move around the sun in circular orbits of r_1 and r_2 radii respectively. If angular momentum of A is L and that of B is $3L$, the ratio of time period $\left(\frac{T_A}{T_B}\right)$ is:

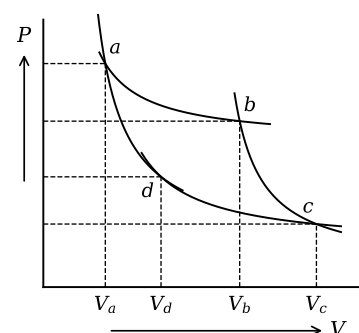
- (A) $\left(\frac{r_2}{r_1}\right)^{\frac{3}{2}}$ (B) $27 \left(\frac{m_1}{m_2}\right)^3$ (C) $\left(\frac{r_1}{r_2}\right)^3$ (D) $\frac{1}{27} \left(\frac{m_2}{m_1}\right)^3$

A mixture of one mole of monoatomic gas and one mole of a diatomic gas (rigid) are kept at room temperature (27°C). The ratio of specific heat of gases at constant volume respectively is:

- (A) $\frac{3}{2}$ (B) $\frac{3}{5}$ (C) $\frac{7}{5}$ (D) $\frac{5}{3}$

Two different adiabatic paths for the same gas intersect two isothermal curves as shown in P-V diagram. The relation between the ratio $\frac{V_a}{V_d}$ and the ratio $\frac{V_b}{V_c}$ is:

- (A) $\frac{V_a}{V_d} \neq \frac{V_b}{V_c}$ (B) $\frac{V_a}{V_d} = \left(\frac{V_b}{V_c}\right)^{-1}$
(C) $\frac{V_a}{V_d} = \frac{V_b}{V_c}$ (D) $\frac{V_a}{V_d} = \left(\frac{V_b}{V_c}\right)^2$



A player caught a cricket ball of mass 150g moving at a speed of 20m/s. If the catching process is completed in 0.1s, the magnitude of force exerted by the ball on the hand of the player is:

- (A) 150 N (B) 3 N (C) 30 N (D) 300 N

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Paramagnetic substances:

- A. align themselves along the directions of external magnetic field.
- B. attract strongly towards external magnetic field.
- C. has susceptibility little more than zero.
- D. move from a region of strong magnetic field to weak magnetic field.

Choose the most appropriate answer from the options given below:

- (A) A, B, C Only (B) A, C Only (C) A, B, C, D (D) B, D Only

Young's modulus is determined by the equation given by

$$Y = 49000 \frac{\text{m dyne}}{\text{l cm}^2}$$

where M is the mass and l is the extension of wire used in the experiment. Now error in Young modulus (Y) is estimated by taking data from $M - l$ plot in graph paper. The smallest scale divisions are 5g and 0.02cm along load axis and extension axis respectively. If the value of M and l are 500g and 2cm respectively then percentage error of Y is:

- (A) 2% (B) 0.02% (C) 0.5% (D) 0.2%

Correct Bernoulli's equation is (symbols have their usual meaning):

- (A) $P + \frac{1}{2}\rho gh + \frac{1}{2}\rho v^2 = \text{constant}$ (B) $P + mgh + \frac{1}{2}mv^2 = \text{constant}$
 (C) $P + \rho gh + \rho v^2 = \text{constant}$ (D) $P + \rho gh + \frac{1}{2}\rho v^2 = \text{constant}$

Three bodies A, B and C have equal kinetic energies and their masses are 400g, 1.2kg and 1.6kg respectively. The ratio of their linear momenta is:

- (A) $1 : \sqrt{3} : 2$ (B) $\sqrt{3} : \sqrt{2} : 1$ (C) $1 : \sqrt{3} : \sqrt{2}$ (D) $\sqrt{2} : \sqrt{3} : 1$

In an expression $a \times 10^b$:

- (A) a is order of magnitude for $b \leq 5$ (B) b is order of magnitude for $a \leq 5$
 (C) b is order of magnitude for $a \geq 5$ (D) b is order of magnitude for $5 < a \leq 10$

The diameter of a sphere is measured using a vernier caliper whose 9 divisions of main scale are equal to 10 divisions of vernier scale. The shortest division on the main scale is equal to 1mm. The main scale reading is 2cm and second division of vernier scale coincides with a division on main scale. If mass of the sphere is 8.635 g, the density of the sphere is:

- (A) 2.2g/cm³ (B) 2.0g/cm³ (C) 1.7g/cm³ (D) 2.5g/cm³

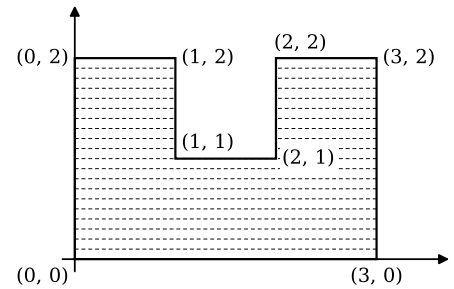
Physics Section B · Numerical value

Q21 to Q28

In an alpha particle scattering experiment distance of closest approach for the α particle is $4.5 \times 10^{-14}\text{m}$. If target nucleus has atomic number 80, then maximum velocity of α -particle is _____ $\times 10^5\text{m/s}$ approximately.
 ($\frac{1}{4\pi\epsilon_0} = 9 \times 10^9\text{SI unit}$, mass of α particle = $6.72 \times 10^{-27}\text{kg}$)

Q22 Centre of Mass & Linear Momentum **NUMERICAL**[Step-by-step solution](https://www.prepwisar.in/questions/kwEGUadUdR) > prepwisar.in/questions/kwEGUadUdR

A uniform thin metal plate of mass 10kg with dimensions is shown. The ratio of x and y coordinates of center of mass of plate in $\frac{n}{9}$. The value of n is _____.

**Q23** Current Electricity **NUMERICAL**[Step-by-step solution](https://www.prepwisar.in/questions/MPgAEf_ith) > prepwisar.in/questions/MPgAEf_ith

Resistance of a wire at 0°C , 100°C and $t^\circ\text{C}$ is found to be 10Ω , 10.2Ω and 10.95Ω respectively. The temperature t in Kelvin scale is _____.

Q24 Electrostatics I: Charges, Field & Gauss's Law **NUMERICAL**[Step-by-step solution](https://www.prepwisar.in/questions/PKRug7ygYe) > prepwisar.in/questions/PKRug7ygYe

An electric field, $\vec{E} = \frac{2\hat{i} + 6\hat{j} + 8\hat{k}}{\sqrt{6}}$ passes through the surface of 4m^2 area having unit vector $\hat{n} = \left(\frac{2\hat{i} + \hat{j} + \hat{k}}{\sqrt{6}}\right)$. The electric flux for that surface is _____ Vm.

Q25 Moving Charges & Magnetism **NUMERICAL**[Step-by-step solution](https://www.prepwisar.in/questions/Sl8b4wbcEX) > prepwisar.in/questions/Sl8b4wbcEX

An electron with kinetic energy 5eV enters a region of uniform magnetic field of $3\mu\text{T}$ perpendicular to its direction. An electric field E is applied perpendicular to the direction of velocity and magnetic field. The value of E , so that electron moves along the same path, is _____ NC^{-1} .

(Given, mass of electron = $9 \times 10^{-31}\text{kg}$, electric charge = $1.6 \times 10^{-19}\text{C}$)

Q26 Surface Tension **NUMERICAL**[Step-by-step solution](https://www.prepwisar.in/questions/8BQX85BVWH) > prepwisar.in/questions/8BQX85BVWH

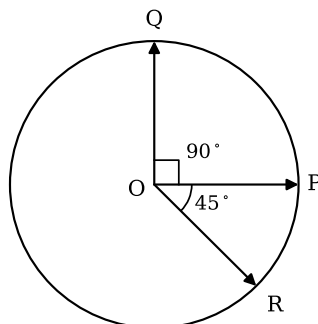
A liquid column of height 0.04cm balances excess pressure of a soap bubble of certain radius. If density of liquid is $8 \times 10^3\text{kgm}^{-3}$ and surface tension of soap solution is 0.28Nm^{-1} , then diameter of the soap bubble is _____ cm. (if $g = 10\text{ms}^{-2}$)

Q27 Mechanical Waves **NUMERICAL**[Step-by-step solution](https://www.prepwisar.in/questions/XNAon6tfEI) > prepwisar.in/questions/XNAon6tfEI

A closed and an open organ pipe have same lengths. If the ratio of frequencies of their seventh overtones is $\left(\frac{a-1}{a}\right)$ then the value of a is _____.

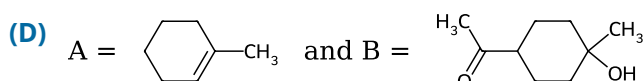
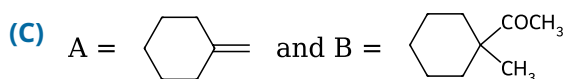
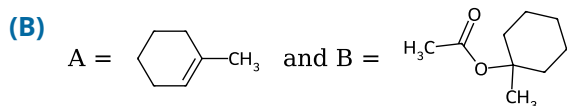
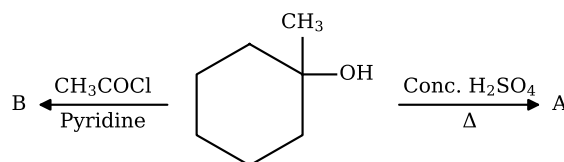
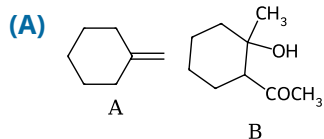
Q28 Vectors **NUMERICAL**[Step-by-step solution](https://www.prepwisar.in/questions/pzD0-JeO3c) > prepwisar.in/questions/pzD0-JeO3c

Three vectors $\vec{OP}$, $\vec{OQ}$ and $\vec{OR}$ each of magnitude A are acting as shown in figure. The resultant of the three vectors is $A\sqrt{x}$. The value of x is _____.



Q29 Alcohols, Phenols & Ethers[Step-by-step solution](https://www.prepwisar.in/questions/addwloSxNV)

Identify the major products A and B respectively in the following set of reactions.

**Q30** Chemical Bonding & Molecular Structure[Step-by-step solution](https://www.prepwisar.in/questions/2DWA8HfyXC)

Match List I with List II

	LIST I (Molecule)		LIST II (Shape)
A.	NH ₃	I.	Square pyramid
B.	BrF ₅	II.	Tetrahedral
C.	PCl ₅	III.	Trigonal pyramidal
D.	CH ₄	IV.	Trigonal bipyramidal

Choose the correct answer from the options given below:

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

Q31 Coordination Compounds[Step-by-step solution](https://www.prepwisar.in/questions/LgatBjxkJL)

Number of Complexes with even number of electrons in t_{2g} orbitals is -



- (A) 3 (B) 2 (C) 1 (D) 5

Q32 Coordination Compounds[Step-by-step solution](https://www.prepwisar.in/questions/pw9LERPVCS)

An octahedral complex with the formula $\text{CoCl}_3 \cdot n\text{NH}_3$ upon reaction with excess of AgNO_3 solution gives 2 moles of AgCl . Consider the oxidation state of Co in the complex is 'x'. The value of " $x + n$ " is _____.

- (A) 6 (B) 5 (C) 3 (D) 8

Q33 Coordination Compounds[Step-by-step solution](https://www.prepwisar.in/questions/DPY97MIh3)

Given below are two statements:

Statement I: $\text{N}(\text{CH}_3)_3$ and $\text{P}(\text{CH}_3)_3$ can act as ligands to form transition metal complexes.

Statement II: As N and P are from same group, the nature of bonding of $\text{N}(\text{CH}_3)_3$ and $\text{P}(\text{CH}_3)_3$ is always same with transition metals.

In the light of the above statements, choose the most appropriate answer from the options given below:

- (A) Both Statement I and Statement II are incorrect.
 (B) Both Statement I and Statement II are correct.
 (C) Statement I is incorrect but Statement II is correct.
 (D) Statement I is correct but Statement II is incorrect.

Match List I with List II

	LIST I (Compound)		LIST II (Colour)
A.	$\text{Fe}_4 [\text{Fe}(\text{CN})_6]_3 \cdot x\text{H}_2\text{O}$	I.	Violet
B.	$[\text{Fe}(\text{CN})_5\text{NOS}]^{4-}$	II.	Blood Red
C.	$[\text{Fe}(\text{SCN})]^{2+}$	III.	Prussian Blue
D.	$(\text{NH}_4)_3\text{PO}_4 \cdot 12\text{MoO}_3$	IV.	Yellow

Choose the correct answer from the options given below:

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

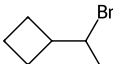
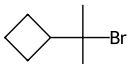
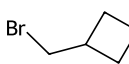
Iron (III) catalyses the reaction between iodide and persulphate ions, in which

- A. Fe^{3+} oxidises the iodide ion
 B. Fe^{3+} oxidises the persulphate ion
 C. Fe^{2+} reduces the iodide ion
 D. Fe^{2+} reduces the persulphate ion

Choose the most appropriate answer from the options given below:

- (A) B and C only (B) A only (C) A and D only (D) B only

Which among the following compounds will undergo fastest $\text{S}_\text{N}2$ reaction.

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

Give below are two statements: One is labelled as Assertion A and the other is labelled as Reason R:

Assertion A: The stability order of +1 oxidation state of Ga, In and Tl is $\text{Ga} < \text{In} < \text{Tl}$.

Reason R: The inert pair effect stabilizes the lower oxidation state down the group.

In the light of the above statements, choose the correct answer from the options given below:

- (A) A is true but R is false.
 (B) Both A and R are true but R is NOT the correct explanation of A.
 (C) A is false but R is true.
 (D) Both A and R are true and R is the correct explanation of A.

Among the following halogens

 F_2 , Cl_2 , Br_2 and I_2

Which can undergo disproportionation reactions?

- (A) F_2 and Cl_2 (B) Cl_2 , Br_2 and I_2 (C) Only I_2 (D) F_2 , Cl_2 and Br_2

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Match List I with List II

	LIST I (Elements)		LIST II (Properties in their respective groups)
A.	Cl, S	I.	Elements with highest electronegativity
B.	Ge, As	II.	Elements with largest atomic size
C.	Fr, Ra	III.	Elements which show properties of both metals and non-metal
D.	F, O	IV.	Elements with highest negative electron gain enthalpy

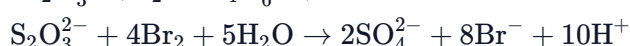
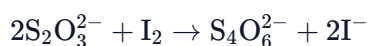
Choose the correct answer from the options given below:

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

Q40 Redox Reactions

[Step-by-step solution](#) > [prepwisar.in/questions/mE5aXPfBKx](https://www.prepwisar.in/questions/mE5aXPfBKx)

Thiosulphate reacts differently with iodine and bromine in the reactions given below:



Which of the following statement justifies the above dual behaviour of thiosulphate?

- (A) Thiosulphate undergoes oxidation by bromine and reduction by iodine in these reactions
 (B) Bromine is a weaker oxidant than iodine
 (C) Bromine is a stronger oxidant than iodine
 (D) Bromine undergoes oxidation and iodine undergoes reduction in these reactions

Q41 Mole Concept & Stoichiometry

[Step-by-step solution](#) > [prepwisar.in/questions/a1LLD_AmWI](https://www.prepwisar.in/questions/a1LLD_AmWI)Combustion of glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) produces CO_2 and water. The amount of oxygen (in g) required for the complete combustion of 900g of glucose is:[Molar mass of glucose in $\text{g mol}^{-1} = 180$]

- (A) 32 (B) 480 (C) 800 (D) 960

Q42 Chemical Equilibrium

[Step-by-step solution](#) > [prepwisar.in/questions/VI0fB6UqQx](https://www.prepwisar.in/questions/VI0fB6UqQx)

For the given hypothetical reactions, the equilibrium constants are as follows:

The equilibrium constant for the reaction $\text{X} \rightleftharpoons \text{W}$ is

- (A) 12.0 (B) 8.0 (C) 6.0 (D) 7.0

Q43 Qualitative Analysis: Salt Analysis

[Step-by-step solution](#) > [prepwisar.in/questions/g_I8IMqvIn](https://www.prepwisar.in/questions/g_I8IMqvIn)

Match List I with List II

	LIST I (Name of the test)		LIST II (Reaction sequence involved) [M is metal]
A.	Borax bead test	I.	$\text{MCO}_3 \rightarrow \text{MO} \xrightarrow[\text{+}\Delta]{\text{Co}(\text{NO}_3)_2} \text{CoO} \cdot \text{MO}$
B.	Charcoal cavity test	II.	$\text{MCO}_3 \rightarrow \text{MCl}_2 \rightarrow \text{M}^{2+}$
C.	Cobalt nitrate test	III.	$\text{MSO}_4 \xrightarrow[\Delta]{\text{Na}_2\text{B}_4\text{O}_7} \text{M}(\text{BO}_2)_2 \rightarrow \text{MBO}_2 \rightarrow \text{M}$
D.	Flame test	IV.	$\text{MSO}_4 \xrightarrow[\Delta]{\text{Na}_2\text{CO}_3} \text{MCO}_3 \rightarrow \text{MO} \rightarrow \text{M}$

Choose the correct answer from the options given below:

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

Q44 Chemical Bonding & Molecular Structure **NUMERICAL**[Step-by-step solution](https://www.prepwisar.in/questions/uEj7o3aO6t) > prepwisar.in/questions/uEj7o3aO6t

Number of molecules from the following which are exceptions to octet rule is _____.

**Q45** Chemical Kinetics **NUMERICAL**[Step-by-step solution](https://www.prepwisar.in/questions/aPR5mvVGXZ) > prepwisar.in/questions/aPR5mvVGXZ

Consider the following reaction



The time taken for A to become $1/4^{\text{th}}$ of its initial concentration is twice the time taken to become $1/2$ of the same. Also, when the change of concentration of B is plotted against time, the resulting graph gives a straight line with a negative slope and a positive intercept on the concentration axis.

The overall order of the reaction is _____.

Q46 d & f Block Elements **NUMERICAL**[Step-by-step solution](https://www.prepwisar.in/questions/rYUqD9N_h_) > prepwisar.in/questions/rYUqD9N_h_

The 'spin only' magnetic moment value of MO_4^{2-} is _____ BM. (Where M is a metal having least metallic radii. among Sc, Ti, V, Cr, Mn and Zn).

(Given atomic number: Sc = 21, Ti = 22, V = 23, Cr = 24, Mn = 25 and Zn = 30)

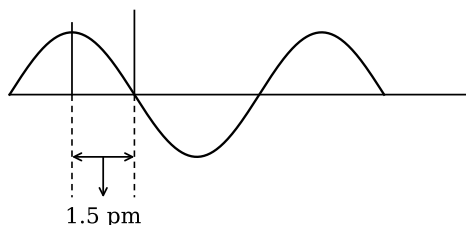
Q47 Solutions & Colligative Properties **NUMERICAL**[Step-by-step solution](https://www.prepwisar.in/questions/X48QWUcQa_) > prepwisar.in/questions/X48QWUcQa_

A solution containing 10g of an electrolyte AB_2 in 100g of water boils at 100.52°C . The degree of ionization of the electrolyte (α) is _____ $\times 10^{-1}$. (nearest integer)

[Given : Molar mass of $\text{AB}_2 = 200\text{g mol}^{-1}$, K_b (molal boiling point elevation const. of water) = 0.52K kg mol^{-1} , boiling point of water = 100°C ; AB_2 ionises as $\text{AB}_2 \rightarrow \text{A}^{2+} + 2\text{B}^-$]

Q48 Atomic Structure **NUMERICAL**[Step-by-step solution](https://www.prepwisar.in/questions/9N07euQl5m) > prepwisar.in/questions/9N07euQl5m

A hypothetical electromagnetic wave is show below.



The frequency of the wave is $x \times 10^{19}\text{Hz}$.

$x =$ _____ (nearest integer)

Q49 Chemical Thermodynamics **NUMERICAL**[Step-by-step solution](https://www.prepwisar.in/questions/gyUexY-uGe) > prepwisar.in/questions/gyUexY-uGe

Consider the figure provided.

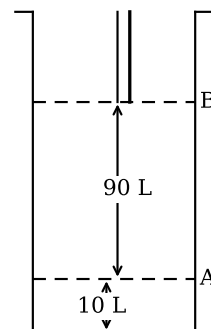
1mol of an ideal gas is kept in a cylinder, fitted with a piston, at the position A, at 18°C . If the piston is moved to position B, keeping the temperature unchanged, then 'x' L atm work is done in this reversible process.

$x =$ _____ L atm. (nearest integer)

[Given : Absolute temperature

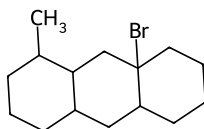
$$= ^\circ\text{C} + 273.15, R = 0.08206\text{Latmmol}^{-1}\text{K}^{-1}$$

]



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The number of optical isomers in following compound is : _____.



Q51 Mole Concept & Stoichiometry **NUMERICAL**

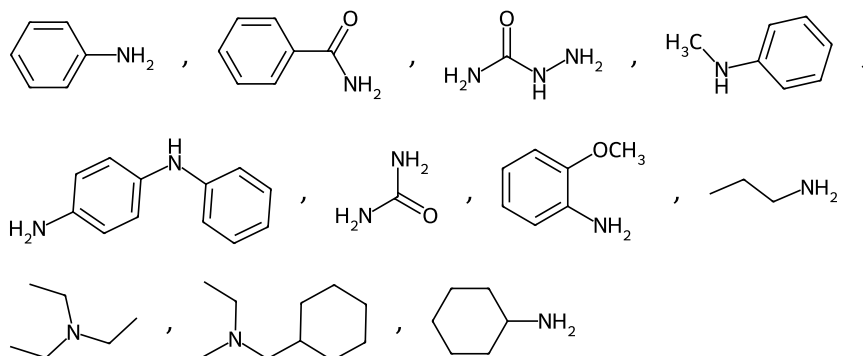
[Step-by-step solution](#) › prepwiser.in/questions/5rR4KYW6ky

If 279g of aniline is reacted with one equivalent of benzenediazonium chloride, the maximum amount of aniline yellow formed will be _____ g. (nearest integer)
(consider complete conversion).

Q52 Amines & Diazonium Salts **NUMERICAL**

[Step-by-step solution](#) › prepwiser.in/questions/6ZGW-dXdZ0

Number of amine compounds from the following giving solids which are soluble in NaOH upon reaction with Hinsberg's reagent is _____.



Mathematics Section A · Multiple choice

Q53 to Q72

Q53 Three Dimensional Geometry

[Step-by-step solution](#) › prepwiser.in/questions/36JNtB1hS6

Let $P(x, y, z)$ be a point in the first octant, whose projection in the xy -plane is the point Q . Let $OP = \gamma$; the angle between OQ and the positive x -axis be θ ; and the angle between OP and the positive z -axis be ϕ , where O is the origin. Then the distance of P from the x -axis is

- (A) $\gamma\sqrt{1 - \sin^2 \phi \cos^2 \theta}$ (B) $\gamma\sqrt{1 + \cos^2 \theta \sin^2 \phi}$ (C) $\gamma\sqrt{1 + \cos^2 \phi \sin^2 \theta}$ (D) $\gamma\sqrt{1 - \sin^2 \theta \cos^2 \phi}$

Q54 Three Dimensional Geometry

[Step-by-step solution](#) › prepwiser.in/questions/u1-59va7BE

If the shortest distance between the lines

$$L_1 : \vec{r} = (2 + \lambda)\hat{i} + (1 - 3\lambda)\hat{j} + (3 + 4\lambda)\hat{k}, \quad \lambda \in \mathbb{R}$$

$$L_2 : \vec{r} = 2(1 + \mu)\hat{i} + 3(1 + \mu)\hat{j} + (5 + \mu)\hat{k}, \quad \mu \in \mathbb{R}$$

is $\frac{m}{\sqrt{n}}$, where $\gcd(m, n) = 1$, then the value of $m + n$ equals

- (A) 384 (B) 387 (C) 390 (D) 377

Q55 Applications of Derivatives

[Step-by-step solution](#) › prepwiser.in/questions/mxSGy-jnxn

Let $f(x) = 4\cos^3 x + 3\sqrt{3}\cos^2 x - 10$. The number of points of local maxima of f in interval $(0, 2\pi)$ is

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

Q56 Applications of Derivatives

[Step-by-step solution](#) › prepwiser.in/questions/LIuJ-ix1Yg

The number of critical points of the function $f(x) = (x - 2)^{2/3}(2x + 1)$ is

- (A) 2 (B) 1 (C) 0 (D) 3

Q57 Applications of Derivatives[Step-by-step solution](#) › [prepwisar.in/questions/jznK1BVO8i](https://www.prepwisar.in/questions/jznK1BVO8i)

For the function $f(x) = (\cos x) - x + 1, x \in \mathbb{R}$, between the following two statements

(S1) $f(x) = 0$ for only one value of x in $[0, \pi]$.

(S2) $f(x)$ is decreasing in $[0, \frac{\pi}{2}]$ and increasing in $[\frac{\pi}{2}, \pi]$.

(A) Both (S1) and (S2) are incorrect.

(B) Only (S1) is correct.

(C) Only (S2) is correct.

(D) Both (S1) and (S2) are correct.

Q58 Circles[Step-by-step solution](#) › [prepwisar.in/questions/7ba2jxvD1z](https://www.prepwisar.in/questions/7ba2jxvD1z)

Let the circles $C_1 : (x - \alpha)^2 + (y - \beta)^2 = r_1^2$ and $C_2 : (x - 8)^2 + (y - \frac{15}{2})^2 = r_2^2$ touch each other externally at the point $(6, 6)$. If the point $(6, 6)$ divides the line segment joining the centres of the circles C_1 and C_2 internally in the ratio $2 : 1$, then $(\alpha + \beta) + 4(r_1^2 + r_2^2)$ equals

(A) 130

(B) 110

(C) 145

(D) 125

Q59 Complex Numbers[Step-by-step solution](#) › [prepwisar.in/questions/nTQyatp9uM](https://www.prepwisar.in/questions/nTQyatp9uM)

Let z be a complex number such that $|z + 2| = 1$ and $\operatorname{Im} \left(\frac{z+1}{z+2} \right) = \frac{1}{5}$. Then the value of $|\operatorname{Re}(\overline{z+2})|$ is

(A) $\frac{2\sqrt{6}}{5}$

(B) $\frac{24}{5}$

(C) $\frac{\sqrt{6}}{5}$

(D) $\frac{1 + \sqrt{6}}{5}$

Q60 Complex Numbers[Step-by-step solution](#) › [prepwisar.in/questions/BYIkISOIve](https://www.prepwisar.in/questions/BYIkISOIve)

If the set $R = \{(a, b) : a + 5b = 42, a, b \in \mathbb{N}\}$ has m elements and $\sum_{n=1}^m (1 - i^{n!}) = x + iy$, where $i = \sqrt{-1}$, then the value of $m + x + y$ is

(A) 12

(B) 4

(C) 8

(D) 5

Q61 Definite Integration[Step-by-step solution](#) › [prepwisar.in/questions/y4ooZRYnvs](https://www.prepwisar.in/questions/y4ooZRYnvs)

The value of $k \in \mathbb{N}$ for which the integral $I_n = \int_0^1 (1 - x^k)^n dx, n \in \mathbb{N}$, satisfies $147I_{20} = 148I_{21}$ is

(A) 8

(B) 14

(C) 7

(D) 10

Q62 Differential Equations[Step-by-step solution](#) › [prepwisar.in/questions/FqI1wPW7ud](https://www.prepwisar.in/questions/FqI1wPW7ud)

Let $f(x)$ be a positive function such that the area bounded by $y = f(x), y = 0$ from $x = 0$ to $x = a > 0$ is $e^{-a} + 4a^2 + a - 1$. Then the differential equation, whose general solution is $y = c_1 f(x) + c_2$, where c_1 and c_2 are arbitrary constants, is

(A) $(8e^x + 1) \frac{d^2 y}{dx^2} - \frac{dy}{dx} = 0$

(B) $(8e^x + 1) \frac{d^2 y}{dx^2} + \frac{dy}{dx} = 0$

(C) $(8e^x - 1) \frac{d^2 y}{dx^2} - \frac{dy}{dx} = 0$

(D) $(8e^x - 1) \frac{d^2 y}{dx^2} + \frac{dy}{dx} = 0$

Q63 Differential Equations[Step-by-step solution](#) › [prepwisar.in/questions/jyHOH0bm44](https://www.prepwisar.in/questions/jyHOH0bm44)

Let $y = y(x)$ be the solution of the differential equation $(1 + y^2)e^{\tan x} dx + \cos^2 x (1 + e^{2 \tan x}) dy = 0, y(0) = 1$. Then $y\left(\frac{\pi}{4}\right)$ is equal to

(A) $\frac{1}{e^2}$

(B) $\frac{2}{e^2}$

(C) $\frac{2}{e}$

(D) $\frac{1}{e}$

Q64 Hyperbola[Step-by-step solution](#) › [prepwisar.in/questions/-x6uyGb4Jp](https://www.prepwisar.in/questions/-x6uyGb4Jp)

Let $H : \frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ be the hyperbola, whose eccentricity is $\sqrt{3}$ and the length of the latus rectum is $4\sqrt{3}$. Suppose the point $(\alpha, 6), \alpha > 0$ lies on H . If β is the product of the focal distances of the point $(\alpha, 6)$, then $\alpha^2 + \beta$ is equal to

(A) 170

(B) 171

(C) 169

(D) 172

Let

$$A = \begin{bmatrix} 2 & a & 0 \\ 1 & 3 & 1 \\ 0 & 5 & b \end{bmatrix}$$

If $A^3 = 4A^2 - A - 21I$, where I is the identity matrix of order 3×3 , then $2a + 3b$ is equal to

- (A) -10 (B) -12 (C) -13 (D) -9

Q66 Relations & Functions (Basic)

Step-by-step solution › prepwiser.in/questions/K9NZTFKN3p

Let $[t]$ be the greatest integer less than or equal to t . Let A be the set of all prime factors of 2310 and $f : A \rightarrow \mathbb{Z}$ be the function $f(x) = \left[\log_2 \left(x^2 + \left[\frac{x^3}{5} \right] \right) \right]$. The number of one-to-one functions from A to the range of f is

- (A) 20 (B) 120 (C) 25 (D) 24

Q67 Probability: Basic

Step-by-step solution › prepwiser.in/questions/c0vILU4xnZ

Let the sum of two positive integers be 24. If the probability, that their product is not less than $\frac{3}{4}$ times their greatest possible product, is $\frac{m}{n}$, where $\gcd(m, n) = 1$, then $n-m$ equals

- (A) 10 (B) 11 (C) 9 (D) 8

Q68 Quadratic Equations & Polynomial Inequalities

Step-by-step solution › prepwiser.in/questions/G2Zqcx949f

The sum of all the solutions of the equation $(8)^{2x} - 16 \cdot (8)^x + 48 = 0$ is:

- (A) $1 + \log_8(6)$ (B) $1 + \log_6(8)$ (C) $\log_8(6)$ (D) $\log_8(4)$

Q69 Vectors

Step-by-step solution › prepwiser.in/questions/2YINuTlrg-

The set of all α , for which the vectors $\vec{a} = \alpha \hat{i} + 6\hat{j} - 3\hat{k}$ and $\vec{b} = t\hat{i} - 2\hat{j} - 2\alpha t\hat{k}$ are inclined at an obtuse angle for all $t \in \mathbb{R}$, is

- (A) $[0, 1]$ (B) $\left(-\frac{4}{3}, 0\right]$ (C) $(-2, 0]$ (D) $\left(-\frac{4}{3}, 1\right)$

Q70 Straight Lines

Step-by-step solution › prepwiser.in/questions/IqPSKtdCTF

The equations of two sides AB and AC of a triangle ABC are $4x + y = 14$ and $3x - 2y = 5$, respectively. The point $\left(2, -\frac{4}{3}\right)$ divides the third side BC internally in the ratio 2 : 1, the equation of the side BC is

- (A) $x + 6y + 6 = 0$ (B) $x - 3y - 6 = 0$ (C) $x + 3y + 2 = 0$ (D) $x - 6y - 10 = 0$

Q71 Indefinite Integration

Step-by-step solution › prepwiser.in/questions/q6PwZhfmgS

Let $I(x) = \int \frac{6}{\sin^2 x (1 - \cot x)^2} dx$. If $I(0) = 3$, then $I\left(\frac{\pi}{12}\right)$ is equal to

- (A) $\sqrt{3}$ (B) $2\sqrt{3}$ (C) $6\sqrt{3}$ (D) $3\sqrt{3}$

Q72 Trigonometric Ratios & Identities

Step-by-step solution › prepwiser.in/questions/3OsVuj5cBu

If $\sin x = -\frac{3}{5}$, where $\pi < x < \frac{3\pi}{2}$, then $80(\tan^2 x - \cos x)$ is equal to

- (A) 109 (B) 108 (C) 19 (D) 18

Mathematics Section B · Numerical value

Q73 to Q82

Q73 Trigonometric Ratios & Identities NUMERICAL

Step-by-step solution › prepwiser.in/questions/iuyi1Fqh6m

If the range of

$$f(\theta) = \frac{\sin^4 \theta + 3 \cos^2 \theta}{\sin^4 \theta + \cos^2 \theta}, \theta \in \mathbb{R}$$

is $[\alpha, \beta]$, then the sum of the infinite G.P., whose first term is 64 and the common ratio is $\frac{\alpha}{\beta}$, is equal to _____.

The value of

$$\lim_{x \rightarrow 0} 2 \left(\frac{1 - \cos x \sqrt{\cos 2x} \sqrt[3]{\cos 3x} \dots \sqrt[10]{\cos 10x}}{x^2} \right)$$

is _____.

Let

$$A = \begin{bmatrix} 2 & -1 \\ 1 & 1 \end{bmatrix}$$

. If the sum of the diagonal elements of A^{13} is 3^n , then n is equal to _____.

The number of 3-digit numbers, formed using the digits 2, 3, 4, 5 and 7, when the repetition of digits is not allowed, and which are not divisible by 3, is equal to _____.

Three balls are drawn at random from a bag containing 5 blue and 4 yellow balls. Let the random variables X and Y respectively denote the number of blue and yellow balls. If $\bar{X}$ and $\bar{Y}$ are the means of X and Y respectively, then $7\bar{X} + 4\bar{Y}$ is equal to _____.

Let the positive integers be written in the form:

$$\begin{array}{ccccccc} & & & & 1 & & \\ & & & & & & \\ & & & 2 & & 3 & \\ & & 4 & & 5 & & 6 \\ & 7 & & 8 & & 9 & & 10 \\ & \ddots & & & & & & \ddots \end{array}$$

If the k^{th} row contains exactly k numbers for every natural number k , then the row in which the number 5310 will be, is _____.

Let $\alpha = \sum_{r=0}^n (4r^2 + 2r + 1) {}^nC_r$ and $\beta = \left(\sum_{r=0}^n \frac{{}^nC_r}{r+1} \right) + \frac{1}{n+1}$. If $140 < \frac{2\alpha}{\beta} < 281$, then the value of n is _____.

Let $\vec{a} = 9\hat{i} - 13\hat{j} + 25\hat{k}$, $\vec{b} = 3\hat{i} + 7\hat{j} - 13\hat{k}$ and $\vec{c} = 17\hat{i} - 2\hat{j} + \hat{k}$ be three given vectors. If $\vec{r}$ is a vector such that $\vec{r} \times \vec{a} = (\vec{b} + \vec{c}) \times \vec{a}$ and $\vec{r} \cdot (\vec{b} - \vec{c}) = 0$, then $\frac{593\vec{r} + 67\vec{a}}{(593)^2}$ is equal to _____.

Let the area of the region enclosed by the curve $y = \min\{\sin x, \cos x\}$ and the x axis between $x = -\pi$ to $x = \pi$ be A . Then A^2 is equal to _____.

If the orthocentre of the triangle formed by the lines $2x + 3y - 1 = 0$, $x + 2y - 1 = 0$ and $ax + by - 1 = 0$, is the centroid of another triangle, whose circumcentre and orthocentre respectively are $(3, 4)$ and $(-6, -8)$, then the value of $|a - b|$ is _____.

Answer key: JEE Main 2024 · 8 Apr · Shift 1

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Physics

1.	D	2.	A	3.	A	4.	C	5.	C	6.	C	7.	D	8.	D	9.	C	10.	D
11.	D	12.	B	13.	C	14.	C	15.	B	16.	A	17.	D	18.	A	19.	B	20.	B
21.	156	22.	15	23.	748	24.	12	25.	4	26.	7	27.	16	28.	3				

Chemistry

29.	B	30.	B	31.	A	32.	D	33.	D	34.	D	35.	C	36.	C	37.	D	38.	B
39.	D	40.	C	41.	D	42.	B	43.	B	44.	6	45.	1	46.	0	47.	5	48.	5
49.	55	50.	32	51.	591	52.	5												

Mathematics

53.	A	54.	B	55.	D	56.	A	57.	B	58.	A	59.	A	60.	A	61.	C	62.	B
63.	D	64.	B	65.	C	66.	B	67.	A	68.	A	69.	B	70.	C	71.	D	72.	A
73.	96	74.	55	75.	7	76.	36	77.	17	78.	103	79.	5	80.	569	81.	16	82.	16

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