

JEE MAIN 2024 · QUESTION PAPER

30 Jan 2024 Shift 2

86 questions in exam order, with answer key

Subject	Section A multiple choice	Section B numerical value
● Physics	18 Q1 to Q18	10 Q19 to Q28
● Chemistry	19 Q29 to Q47	10 Q48 to Q57
● Mathematics	19 Q58 to Q76	10 Q77 to Q86
In this PDF	86 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? prepwiser.in/feedback · Terms: prepwiser.in/terms

Q1 Alternating Current

[Step-by-step solution](#) · [prepwisar.in/questions/sX4F4Bs_x-](#)

An alternating voltage $V(t) = 220 \sin 100\pi t$ volt is applied to a purely resistive load of 50Ω . The time taken for the current to rise from half of the peak value to the peak value is:

- (A) 7.2 ms (B) 3.3 ms (C) 5 ms (D) 2.2 ms

Q2 Atomic Physics

[Step-by-step solution](#) · [prepwisar.in/questions/V7Zlaa-kpT](#)

An electron revolving in n^{th} Bohr orbit has magnetic moment μ_n . If $\mu_n \propto n^x$, the value of x is

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

Q3 Nuclear Physics

[Step-by-step solution](#) · [prepwisar.in/questions/fWO_GnOfRW](#)

In a nuclear fission reaction of an isotope of mass M , three similar daughter nuclei of same mass are formed. The speed of a daughter nuclei in terms of mass defect ΔM will be:

- (A) $c\sqrt{\frac{3\Delta M}{M}}$ (B) $\frac{\Delta M c^2}{3}$ (C) $c\sqrt{\frac{2\Delta M}{M}}$ (D) $\sqrt{\frac{2c\Delta M}{M}}$

Q4 Current Electricity

[Step-by-step solution](#) · [prepwisar.in/questions/piB9CV9QK5](#)

When a potential difference V is applied across a wire of resistance R , it dissipates energy at a rate W . If the wire is cut into two halves and these halves are connected mutually parallel across the same supply, the energy dissipation rate will become:

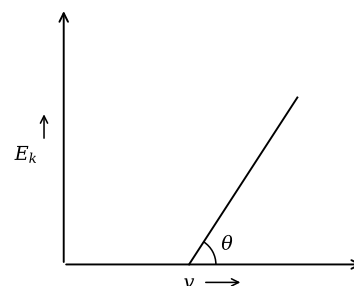
- (A) $1/2W$ (B) $4W$ (C) $1/4W$ (D) $2W$

Q5 Dual Nature of Radiation & Matter

[Step-by-step solution](#) · [prepwisar.in/questions/WaFWA1S9_J](#)

For the photoelectric effect, the maximum kinetic energy (E_k) of the photoelectrons is plotted against the frequency (ν) of the incident photons as shown in figure. The slope of the graph gives

- (A) Planck's constant
(B) Work function of the metal
(C) Charge of electron
(D) Ratio of Planck's constant to electric charge



Q6 Electromagnetic Waves

[Step-by-step solution](#) · [prepwisar.in/questions/qoVn3FytBW](#)

If the total energy transferred to a surface in time t is $6.48 \times 10^5 \text{ J}$, then the magnitude of the total momentum delivered to this surface for complete absorption will be:

- (A) $2.16 \times 10^{-3} \text{ kgm/s}$ (B) $2.46 \times 10^{-3} \text{ kgm/s}$ (C) $1.58 \times 10^{-3} \text{ kgm/s}$ (D) $4.32 \times 10^{-3} \text{ kgm/s}$

Q7 Electromagnetic Waves

[Step-by-step solution](#) · [prepwisar.in/questions/kQahzTgbJx](#)

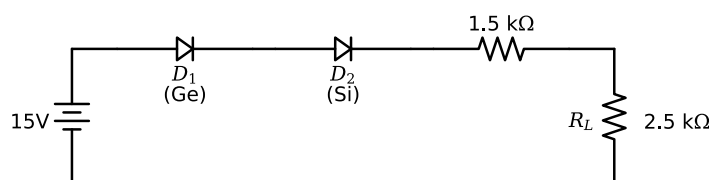
Match List I with List II

	List I		List II
(A)	Gauss's law of magnetostatics	(I)	$\oint \vec{E} \cdot d\vec{a} = \frac{1}{\epsilon_0} \int \rho dV$
(B)	Faraday's law of electro magnetic induction	(II)	$\oint \vec{B} \cdot d\vec{a} = 0$
(C)	Ampere's law	(III)	$\int \vec{E} \cdot d\vec{l} = -\frac{d}{dt} \int \vec{B} \cdot d\vec{a}$
(D)	Gauss's law of electrostatics	(IV)	$\oint \vec{B} \cdot d\vec{l} = \mu_0 I$

Choose the correct answer from the options given below:

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

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In the given circuit, the voltage across load resistance (R_L) is:

- (A) 8.75 V (B) 9.00 V (C) 8.50 V (D) 14.00 V

Q9 Electrostatics I: Charges, Field & Gauss's Law

A particle of charge ' $-q$ ' and mass ' m ' moves in a circle of radius ' r ' around an infinitely long line charge of linear charge density ' $+\lambda$ '. Then time period will be given as:

(Consider k as Coulomb's constant)

- (A) $T^2 = \frac{4\pi^2 m}{2k\lambda q} r^3$ (B) $T = \frac{1}{2\pi r} \sqrt{\frac{m}{2k\lambda q}}$ (C) $T = \frac{1}{2\pi} \sqrt{\frac{2k\lambda q}{m}}$ (D) $T = 2\pi r \sqrt{\frac{m}{2k\lambda q}}$

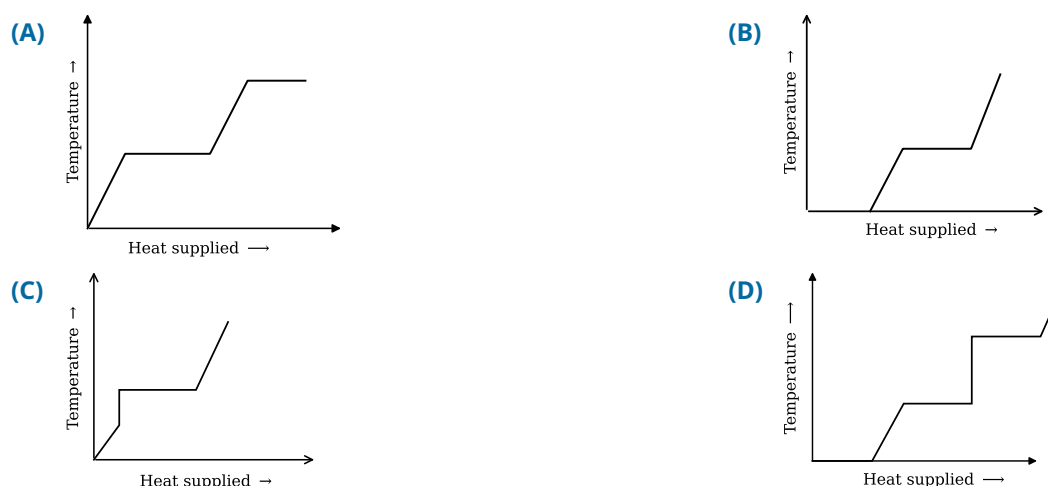
Q10 Gravitation

Escape velocity of a body from earth is 11.2 km/s. If the radius of a planet be one-third the radius of earth and mass be one-sixth that of earth, the escape velocity from the planet is:

- (A) 7.9 km/s (B) 8.4 km/s (C) 4.2 km/s (D) 11.2 km/s

Q11 Thermometry & Calorimetry

A block of ice at -10°C is slowly heated and converted to steam at 100°C . Which of the following curves represent the phenomenon qualitatively:



Q12 Kinetic Theory of Gases

If three moles of monoatomic gas ($\gamma = \frac{5}{3}$) is mixed with two moles of a diatomic gas ($\gamma = \frac{7}{5}$), the value of adiabatic exponent γ for the mixture is

- (A) 1.35 (B) 1.52 (C) 1.40 (D) 1.75

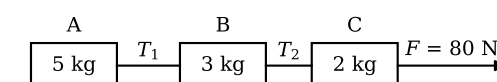
Q13 Friction

A block of mass m is placed on a surface having vertical cross-section given by $y = x^2/4$. If coefficient of friction is 0.5, the maximum height above the ground at which block can be placed without slipping is:

- (A) 1/2 m (B) 1/3 m (C) 1/6 m (D) 1/4 m

Q14 Newton's Laws of Motion

Three blocks A, B and C are pulled on a horizontal smooth surface by a force of 80 N as shown in figure



The tensions T_1 and T_2 in the string are respectively:

- (A) 40 N, 64 N (B) 60 N, 80 N (C) 80 N, 100 N (D) 88 N, 96 N

Q15 Wave Optics[Step-by-step solution](#) > prepwiser.in/questions/cZ4tFENiZh

A beam of unpolarised light of intensity I_0 is passed through a polaroid A and then through another polaroid B which is oriented so that its principal plane makes an angle of 45° relative to that of A . The intensity of emergent light is:

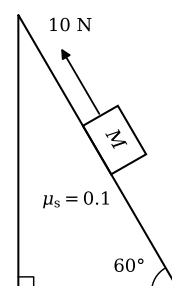
- (A) $I_0/2$ (B) $I_0/8$ (C) $I_0/4$ (D) I_0

Q16 Friction[Step-by-step solution](#) > prepwiser.in/questions/sEh4j9ZxDo

A block of mass 1kg is pushed up a surface inclined to horizontal at an angle of 60° by a force of 10N parallel to the inclined surface as shown in figure. When the block is pushed up by 10m along inclined surface, the work done against frictional force is:

$$[g = 10\text{m/s}^2]$$

- (A) $5\sqrt{3}\text{J}$ (B) 5J (C) $5 \times 10^3\text{J}$ (D) 10J

**Q17** Experimental Skills[Step-by-step solution](#) > prepwiser.in/questions/mh4NRjXrAc

If 50 Vernier divisions are equal to 49 main scale divisions of a traveling microscope and one smallest reading of main scale is 0.5mm , the Vernier constant of traveling microscope is

- (A) 0.01 mm (B) 0.01 cm (C) 0.1 mm (D) 0.1 cm

Q18 Units, Dimensions & Errors[Step-by-step solution](#) > prepwiser.in/questions/9_K2TSi_y4

If mass is written as $m = kc^P G^{-1/2} h^{1/2}$ then the value of P will be : (Constants have their usual meaning with k a dimensionless constant)

- (A) $1/3$ (B) $-1/3$ (C) $1/2$ (D) 2

Physics Section B · Numerical value

Q19 to Q28

Q19 Alternating Current **NUMERICAL**[Step-by-step solution](#) > prepwiser.in/questions/-1KK9A2JLn

A power transmission line feeds input power at 2.3kV to a step down transformer with its primary winding having 3000 turns. The output power is delivered at 230V by the transformer. The current in the primary of the transformer is 5A and its efficiency is 90% . The winding of transformer is made of copper. The output current of transformer is _____ A.

Q20 Current Electricity **NUMERICAL**[Step-by-step solution](#) > prepwiser.in/questions/Y1nkziwXTv

Two resistance of 100Ω and 200Ω are connected in series with a battery of 4V and negligible internal resistance. A voltmeter is used to measure voltage across 100Ω resistance, which gives reading as 1V . The resistance of voltmeter must be _____ Ω .

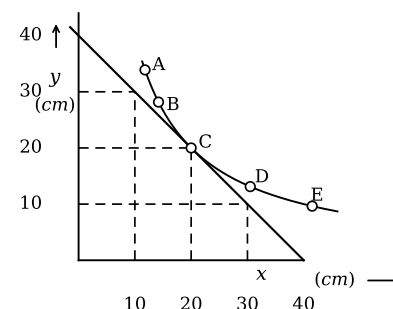
Q21 Electrostatics I: Charges, Field & Gauss's Law **NUMERICAL**[Step-by-step solution](#) > prepwiser.in/questions/khRiwra0h2

Two identical charged spheres are suspended by strings of equal lengths. The strings make an angle of 37° with each other. When suspended in a liquid of density 0.7g/cm^3 , the angle remains same. If density of material of the sphere is 1.4g/cm^3 , the dielectric constant of the liquid is _____ ($\tan 37^\circ = \frac{3}{4}$)

Q22 Experimental Skills **NUMERICAL**[Step-by-step solution](#) > prepwiser.in/questions/mP11TasMaA

In an experiment to measure the focal length (f) of a convex lens, the magnitude of object distance (x) and the image distance (y) are measured with reference to the focal point of the lens. The y - x plot is shown in figure.

The focal length of the lens is _____ cm.



Q23 Gravitation **NUMERICAL**[Step-by-step solution](#) > prepwiser.in/questions/tjsjWqZSN7

A simple pendulum is placed at a place where its distance from the earth's surface is equal to the radius of the earth. If the length of the string is $4m$, then the time period of small oscillations will be _____ s. [take $g = \pi^2 ms^{-2}$]

Q24 Moving Charges & Magnetism **NUMERICAL**[Step-by-step solution](#) > prepwiser.in/questions/5itRqo1xL9

The current of $5A$ flows in a square loop of sides $1m$ is placed in air. The magnetic field at the centre of the loop is $X\sqrt{2} \times 10^{-7}T$. The value of X is _____.

Q25 Surface Tension **NUMERICAL**[Step-by-step solution](#) > prepwiser.in/questions/f-ZDNbULxZ

A big drop is formed by coalescing 1000 small identical drops of water. If E_1 be the total surface energy of 1000 small drops of water and E_2 be the surface energy of single big drop of water, then $E_1 : E_2$ is $x : 1$ where $x =$ _____.

Q26 Rotational Motion **NUMERICAL**[Step-by-step solution](#) > prepwiser.in/questions/Opo9UgyKos

Two discs of moment of inertia $I_1 = 4kgm^2$ and $I_2 = 2kgm^2$, about their central axes & normal to their planes, rotating with angular speeds $10rad/s$ & $4rad/s$ respectively are brought into contact face to face with their axes of rotation coincident. The loss in kinetic energy of the system in the process is _____ J.

Q27 Sound Waves **NUMERICAL**[Step-by-step solution](#) > prepwiser.in/questions/Yvr6e-xapH

A point source is emitting sound waves of intensity $16 \times 10^{-8}Wm^{-2}$ at the origin. The difference in intensity (magnitude only) at two points located at a distances of $2m$ and $4m$ from the origin respectively will be _____ $\times 10^{-8}Wm^{-2}$.

Q28 Vectors **NUMERICAL**[Step-by-step solution](#) > prepwiser.in/questions/yJezynBdev

A vector has magnitude same as that of $\vec{A} = 3\hat{i} + 4\hat{j}$ and is parallel to $\vec{B} = 4\hat{i} + 3\hat{j}$. The x and y components of this vector in first quadrant are x and 3 respectively where $x =$ _____.

Chemistry Section A · Multiple choice

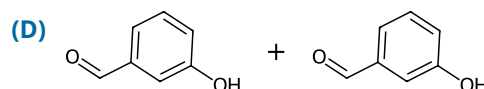
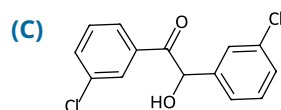
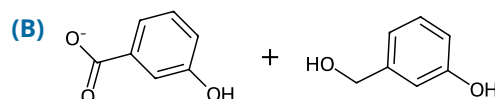
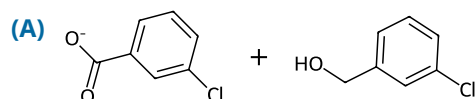
Q29 to Q47

Q29 Alcohols, Phenols & Ethers[Step-by-step solution](#) > prepwiser.in/questions/5_vrKREZ4g

Salicylaldehyde is synthesized from phenol, when reacted with

(A) $HCCl_3, NaOH$ **(B)** $CO_2, NaOH$ **(C)** $H - \overset{\overset{O}{\parallel}}{C} - Cl, NaOH$ **(D)** $CCl_4, NaOH$ **Q30** Aldehydes & Ketones[Step-by-step solution](#) > prepwiser.in/questions/ZxB3PVPKf7

m-chlorobenzaldehyde on treatment with 50% KOH solution yields:

**Q31** Chemical Bonding & Molecular Structure[Step-by-step solution](#) > prepwiser.in/questions/_Hb_MJAXjE

Given below are two statements:

Statement - I: Since Fluorine is more electronegative than nitrogen, the net dipole moment of NF_3 is greater than NH_3 .

Statement - II: In NH_3 , the orbital dipole due to lone pair and the dipole moment of NH bonds are in opposite direction, but in NF_3 the orbital dipole due to lone pair and dipole moments of $N-F$ bonds are in same direction.

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

(A) Statement I is true but Statement II is false.**(B)** Both Statement I and Statement II are true.**(C)** Both Statement I and Statement II are false.**(D)** Statement I is false but Statement II is true.**Q32** Chemical Bonding & Molecular Structure[Step-by-step solution](#) > prepwiser.in/questions/F762EvXNAt

The molecule / ion with square pyramidal shape is

(A) PCl_5 **(B)** $[Ni(CN)_4]^{2-}$ **(C)** PF_5 **(D)** BrF_5

The coordination geometry around the manganese in decacarbonyldimanganese (0) is

- (A) Trigonal bipyramidal (B) Square pyramidal
(C) Square planar (D) Octahedral

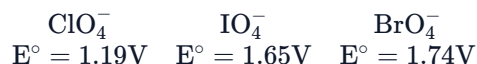
The orange colour of $K_2Cr_2O_7$ and purple colour of $KMnO_4$ is due to

- (A) Charge transfer transition in both.
(B) $d \rightarrow d$ transitions in $KMnO_4$ and charge transfer transitions in $K_2Cr_2O_7$.
(C) $d \rightarrow d$ transitions in both
(D) $d \rightarrow d$ transitions in $K_2Cr_2O_7$ and charge transfer transitions in $KMnO_4$.

Alkaline oxidative fusion of MnO_2 gives "A" which on electrolytic oxidation in alkaline solution produces B. A and B respectively are

- (A) Mn_2O_3 and MnO_4^{2-} (B) Mn_2O_7 and MnO_4^-
(C) MnO_4^{2-} and MnO_4^- (D) MnO_4^{2-} and Mn_2O_7

Reduction potential of ions are given below:



The correct order of their oxidising power is:

- (A) $\text{IO}_4^- > \text{BrO}_4^- > \text{ClO}_4^-$ (B) $\text{BrO}_4^- > \text{ClO}_4^- > \text{IO}_4^-$
(C) $\text{ClO}_4^- > \text{IO}_4^- > \text{BrO}_4^-$ (D) $\text{BrO}_4^- > \text{IO}_4^- > \text{ClO}_4^-$

Given below are two statements:

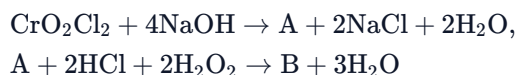
Statement - I: High concentration of strong nucleophilic reagent with secondary alkyl halides which do not have bulky substituents will follow S_N^2 mechanism.

Statement - II: A secondary alkyl halide when treated with a large excess of ethanol follows S_N^1 mechanism.

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

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

A and B formed in the following reactions are:



- (A) $\text{A} = \text{Na}_2\text{Cr}_2\text{O}_7$, $\text{B} = \text{CrO}_5$ (B) $\text{A} = \text{Na}_2\text{CrO}_4$, $\text{B} = \text{CrO}_5$
(C) $\text{A} = \text{Na}_2\text{Cr}_2\text{O}_4$, $\text{B} = \text{CrO}_4$ (D) $\text{A} = \text{Na}_2\text{Cr}_2\text{O}_7$, $\text{B} = \text{CrO}_3$

Choose the correct statements about the hydrides of group 15 elements.

- A. The stability of the hydrides decreases in the order $\text{NH}_3 > \text{PH}_3 > \text{AsH}_3 > \text{SbH}_3 > \text{BiH}_3$.
B. The reducing ability of the hydride increases in the order $\text{NH}_3 < \text{PH}_3 < \text{AsH}_3 < \text{SbH}_3 < \text{BiH}_3$.
C. Among the hydrides, NH_3 is strong reducing agent while BiH_3 is mild reducing agent.
D. The basicity of the hydrides increases in the order $\text{NH}_3 < \text{PH}_3 < \text{AsH}_3 < \text{SbH}_3 < \text{BiH}_3$.

Choose the most appropriate from the options given below:

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

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

Assertion A: H_2Te is more acidic than H_2S .

Reason R: Bond dissociation enthalpy of H_2Te is lower than H_2S .

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

- (A) Both A and R are true and R is the correct explanation of A.
 (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) A is true but R is false.

Given below are two statements:

Statement - I: Along the period, the chemical reactivity of the elements gradually increases from group 1 to group 18.

Statement - II: The nature of oxides formed by group 1 elements is basic while that of group 17 elements is acidic.

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

- (A) Statement I is False but Statement II is true
 (B) Both Statement I and Statement II are False
 (C) Statement I is True But Statement II is False
 (D) Both Statement I and Statement II are True

The solution from the following with highest depression in freezing point/lowest freezing point is

- (A) 180g of acetic acid dissolved in benzene
 (B) 180g of acetic acid dissolved in water
 (C) 180g of benzoic acid dissolved in benzene
 (D) 180g of glucose dissolved in water

If a substance 'A' dissolves in solution of a mixture of 'B' and 'C' with their respective number of moles as n_A , n_B and n_C . Mole fraction of C in the solution is

- (A) $\frac{n_C}{n_A \times n_B \times n_C}$
 (B) $\frac{n_B}{n_A + n_B}$
 (C) $\frac{n_C}{n_A + n_B + n_C}$
 (D) $\frac{n_C}{n_A - n_B - n_C}$

The correct stability order of carbocations is

- (A) $(\text{CH}_3)_3\text{C}^+ > \text{CH}_3 - \overset{+}{\text{CH}}_2 > (\text{CH}_3)_2\overset{+}{\text{CH}} > \overset{+}{\text{CH}}_3$
 (B) $(\text{CH}_3)_3\overset{+}{\text{C}} > (\text{CH}_3)_2\overset{+}{\text{CH}} > \text{CH}_3 - \overset{+}{\text{CH}}_2 > \overset{+}{\text{CH}}_3$
 (C) $\overset{+}{\text{CH}}_3 > \text{CH}_3 - \overset{+}{\text{CH}}_2 > \text{CH}_3 - \overset{+}{\underset{\text{CH}_3}{\text{C}}} \text{H} > (\text{CH}_3)_3\text{C}^+$
 (D) $\overset{+}{\text{CH}}_3 > (\text{CH}_3)_2\overset{+}{\text{CH}} > \text{CH}_3 - \overset{+}{\text{CH}}_2 > (\text{CH}_3)_3\overset{+}{\text{C}}$

Which among the following purification methods is based on the principle of "Solubility" in two different solvents?

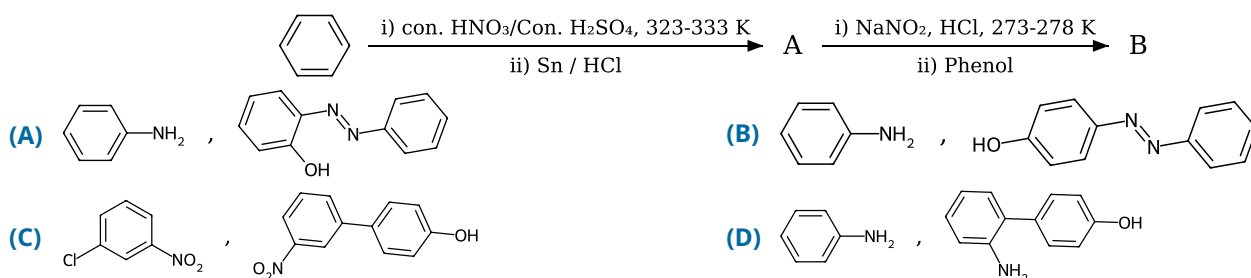
- (A) Distillation
 (B) Sublimation
 (C) Column Chromatography
 (D) Differential Extraction

IUPAC name of following compound is:



- (A) 2-Aminobutanenitrile
 (B) 3-Aminopropanenitrile
 (C) 2-Aminopentanenitrile
 (D) 3-Aminobutanenitrile

The products A and B formed in the following reaction scheme are respectively



Chemistry Section B · Numerical value

Q48 to Q57

The total number of correct statements, regarding the nucleic acids is _____.

- A. RNA is regarded as the reserve of genetic information
- B. DNA molecule self-duplicates during cell division
- C. DNA synthesizes proteins in the cell
- D. The message for the synthesis of particular proteins is present in DNA
- E. Identical DNA strands are transferred to daughter cells.

NO_2 required for a reaction is produced by decomposition of N_2O_5 in CCl_4 as by equation



The initial concentration of N_2O_5 is 3molL^{-1} and it is 2.75molL^{-1} after 30 minutes.

The rate of formation of NO_2 is $x \times 10^{-3}\text{molL}^{-1}\text{min}^{-1}$, value of x is _____. (nearest integer)

Number of complexes which show optical isomerism among the following is _____.

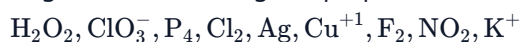


2-chlorobutane + $\text{Cl}_2 \rightarrow \text{C}_4\text{H}_8\text{Cl}_2$ (isomers)

Total number of optically active isomers shown by $\text{C}_4\text{H}_8\text{Cl}_2$, obtained in the above reaction is _____.

The pH of an aqueous solution containing 1M benzoic acid ($\text{pK}_a = 4.20$) and 1M sodium benzoate is 4.5. The volume of benzoic acid solution in 300mL of this buffer solution is _____ mL. (given: $\log 2 = 0.3$)

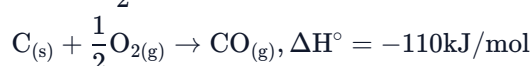
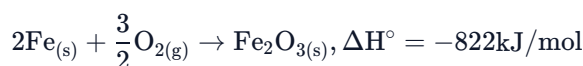
Total number of species from the following which can undergo disproportionation reaction is _____.



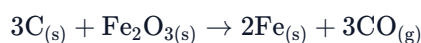
Number of spectral lines obtained in He^+ spectra, when an electron makes transition from fifth excited state to first excited state will be

Attempt this paper online with instant answer checking > prepwiser.in/pyqs/paper/2024-01-30-evening

Two reactions are given below:

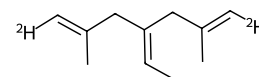


Then enthalpy change for following reaction



is _____ kJ/mol.

Number of geometrical isomers possible for the given structure is/are _____.



Number of metal ions characterized by flame test among the following is _____.



Mathematics Section A · Multiple choice

Q58 to Q76

Let

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

,

$$L_2 : \vec{r} = (\hat{j} - \hat{k}) + \mu(3\hat{i} + \hat{j} + p\hat{k}), \mu \in \mathbb{R}, \text{ and } L_3 : \vec{r} = \delta(\ell\hat{i} + m\hat{j} + n\hat{k}), \delta \in \mathbb{R}$$

be three lines such that L_1 is perpendicular to L_2 and L_3 is perpendicular to both L_1 and L_2 . Then, the point which lies on L_3 is

- (A) $(1, 7, -4)$ (B) $(1, -7, 4)$ (C) $(-1, 7, 4)$ (D) $(-1, -7, 4)$

Let $f(x) = (x+3)^2(x-2)^3$, $x \in [-4, 4]$. If M and m are the maximum and minimum values of f , respectively in $[-4, 4]$, then the value of $M - m$ is

- (A) 108 (B) 392 (C) 608 (D) 600

If z is a complex number, then the number of common roots of the equations $z^{1985} + z^{100} + 1 = 0$ and $z^3 + 2z^2 + 2z + 1 = 0$, is equal to

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

Let $f : \mathbb{R} \rightarrow \mathbb{R}$ be a function defined by $f(x) = \frac{x}{(1+x^4)^{1/4}}$, and $g(x) = f(f(f(f(x))))$. Then, $18 \int_0^{\sqrt{2\sqrt{5}}} x^2 g(x) dx$ is equal to

- (A) 36 (B) 33 (C) 39 (D) 42

Let $y = f(x)$ be a thrice differentiable function in $(-5, 5)$. Let the tangents to the curve $y = f(x)$ at $(1, f(1))$ and $(3, f(3))$ make angles $\pi/6$ and $\pi/4$, respectively with positive x -axis. If

$$27 \int_1^3 \left((f'(t))^2 + 1 \right) f''(t) dt = \alpha + \beta\sqrt{3}$$

where α, β are integers, then the value of $\alpha + \beta$ equals

- (A) 26 (B) -16 (C) 36 (D) -14

Let a and b be real constants such that the function f defined by

$$f(x) = \begin{cases} x^2 + 3x + a & , x \leq 1 \\ bx + 2 & , x > 1 \end{cases}$$

be differentiable on $\mathbb{R}$. Then, the value of $\int_{-2}^2 f(x) dx$ equals

- (A) 21 (B) 19/6 (C) 17 (D) 15/6

Let $f : \mathbb{R} \rightarrow \mathbb{R}$ be defined as $f(x) = ae^{2x} + be^x + cx$. If $f(0) = -1$, $f'(\log_e 2) = 21$ and $\int_0^{\log_e 4} (f(x) - cx) dx = \frac{39}{2}$, then the value of $|a + b + c|$ equals

- (A) 16 (B) 12 (C) 8 (D) 10

Let $f : \mathbb{R} - \{0\} \rightarrow \mathbb{R}$ be a function satisfying $f\left(\frac{x}{y}\right) = \frac{f(x)}{f(y)}$ for all $x, y, f(y) \neq 0$. If $f'(1) = 2024$, then

- (A) $xf'(x) + 2024f(x) = 0$ (B) $xf'(x) - 2023f(x) = 0$
(C) $xf'(x) - 2024f(x) = 0$ (D) $xf'(x) + f(x) = 2024$

Let $A(\alpha, 0)$ and $B(0, \beta)$ be the points on the line $5x + 7y = 50$. Let the point P divide the line segment AB internally in the ratio $7 : 3$. Let $3x - 25 = 0$ be a directrix of the ellipse $E : \frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ and the corresponding focus be S . If from S , the perpendicular on the x -axis passes through P , then the length of the latus rectum of E is equal to,

- (A) $\frac{25}{3}$ (B) $\frac{25}{9}$ (C) $\frac{32}{5}$ (D) $\frac{32}{9}$

If the domain of the function

$$f(x) = \log_e \left(\frac{2x+3}{4x^2+x-3} \right) + \cos^{-1} \left(\frac{2x-1}{x+2} \right)$$

is $(\alpha, \beta]$, then the value of $5\beta - 4\alpha$ is equal to

- (A) 9 (B) 12 (C) 11 (D) 10

Let P be a point on the hyperbola $H : \frac{x^2}{9} - \frac{y^2}{4} = 1$, in the first quadrant such that the area of triangle formed by P and the two foci of H is $2\sqrt{13}$. Then, the square of the distance of P from the origin is

- (A) 26 (B) 22 (C) 20 (D) 18

Let

$$R = \begin{pmatrix} x & 0 & 0 \\ 0 & y & 0 \\ 0 & 0 & z \end{pmatrix}$$

be a non-zero 3×3 matrix, where

$$x \sin \theta = y \sin \left(\theta + \frac{2\pi}{3} \right) = z \sin \left(\theta + \frac{4\pi}{3} \right) \neq 0, \theta \in (0, 2\pi)$$

. For a square matrix M , let $\text{trace}(M)$ denote the sum of all the diagonal entries of M . Then, among the statements:

- (I) $\text{Trace}(R) = 0$
(II) If $\text{trace}(\text{adj}(\text{adj}(R))) = 0$, then R has exactly one non-zero entry.

- (A) Only (I) is true (B) Only (II) is true
(C) Both (I) and (II) are true (D) Neither (I) nor (II) is true

Q70 Determinants[Step-by-step solution](#) › prepwiser.in/questions/IPNtUKmGue

Consider the system of linear equations $x + y + z = 5$, $x + 2y + \lambda^2 z = 9$, $x + 3y + \lambda z = \mu$, where $\lambda, \mu \in \mathbb{R}$. Then, which of the following statement is NOT correct?

- (A) System is consistent if $\lambda \neq 1$ and $\mu = 13$
 (B) System is inconsistent if $\lambda = 1$ and $\mu \neq 13$
 (C) System has unique solution if $\lambda \neq 1$ and $\mu \neq 13$
 (D) System has infinite number of solutions if $\lambda = 1$ and $\mu = 13$

Q71 Probability: Advanced[Step-by-step solution](#) › prepwiser.in/questions/cjpAy3khkR

Bag A contains 3 white, 7 red balls and Bag B contains 3 white, 2 red balls. One bag is selected at random and a ball is drawn from it. The probability of drawing the ball from the bag A, if the ball drawn is white, is

- (A) $1/4$ (B) $1/3$ (C) $3/10$ (D) $1/9$

Q72 Sequences & Series[Step-by-step solution](#) › prepwiser.in/questions/8fhp19d9T5

Let a and b be two distinct positive real numbers. Let 11^{th} term of a GP, whose first term is a and third term is b , is equal to p^{th} term of another GP, whose first term is a and fifth term is b . Then p is equal to

- (A) 20 (B) 24 (C) 21 (D) 25

Q73 Vectors[Step-by-step solution](#) › prepwiser.in/questions/NZZ9jPCrTc

Let $\vec{a} = \hat{i} + \alpha\hat{j} + \beta\hat{k}$, $\alpha, \beta \in \mathbb{R}$. Let a vector $\vec{b}$ be such that the angle between $\vec{a}$ and $\vec{b}$ is $\frac{\pi}{4}$ and $|\vec{b}|^2 = 6$. If $\vec{a} \cdot \vec{b} = 3\sqrt{2}$, then the value of $(\alpha^2 + \beta^2) |\vec{a} \times \vec{b}|^2$ is equal to

- (A) 85 (B) 90 (C) 75 (D) 95

Q74 Vectors[Step-by-step solution](#) › prepwiser.in/questions/2crz9aiQ68

Let $\vec{a}$ and $\vec{b}$ be two vectors such that $|\vec{b}| = 1$ and $|\vec{b} \times \vec{a}| = 2$. Then $|(\vec{b} \times \vec{a}) - \vec{b}|^2$ is equal to

- (A) 1 (B) 3 (C) 5 (D) 4

Q75 Straight Lines[Step-by-step solution](#) › prepwiser.in/questions/ODBq-hJTjG

If $x^2 - y^2 + 2hxy + 2gx + 2fy + c = 0$ is the locus of a point, which moves such that it is always equidistant from the lines $x + 2y + 7 = 0$ and $2x - y + 8 = 0$, then the value of $g + c + h - f$ equals

- (A) 8 (B) 14 (C) 29 (D) 6

Q76 Trigonometric Ratios & Identities[Step-by-step solution](#) › prepwiser.in/questions/hIXz-cP2RU

For $\alpha, \beta \in (0, \pi/2)$, let $3 \sin(\alpha + \beta) = 2 \sin(\alpha - \beta)$ and a real number k be such that $\tan \alpha = k \tan \beta$. Then, the value of k is equal to

- (A) 5 (B) $-2/3$ (C) -5 (D) $2/3$

Mathematics Section B · Numerical value

Q77 to Q86

Q77 Three Dimensional Geometry **NUMERICAL**[Step-by-step solution](#) › prepwiser.in/questions/bIQL3OIhF

Let a line passing through the point $(-1, 2, 3)$ intersect the lines $L_1 : \frac{x-1}{3} = \frac{y-2}{2} = \frac{z+1}{-2}$ at $M(\alpha, \beta, \gamma)$ and $L_2 : \frac{x+2}{-3} = \frac{y-2}{4} = \frac{z-1}{4}$ at $N(a, b, c)$. Then, the value of $\frac{(\alpha+\beta+\gamma)^2}{(a+b+c)^2}$ equals _____.

Q78 Binomial Theorem **NUMERICAL**[Step-by-step solution](#) › prepwiser.in/questions/cFgT9r_Qlr

Let $\alpha = \sum_{k=0}^n \binom{n C_k}{k+1}$ and $\beta = \sum_{k=0}^{n-1} \binom{n C_k}{k+2}$. If $5\alpha = 6\beta$, then n equals _____.

Q79 Circles **NUMERICAL**[Step-by-step solution](#) › prepwiser.in/questions/MtkOW4nPCK

Consider two circles $C_1 : x^2 + y^2 = 25$ and $C_2 : (x - \alpha)^2 + y^2 = 16$, where $\alpha \in (5, 9)$. Let the angle between the two radii (one to each circle) drawn from one of the intersection points of C_1 and C_2 be $\sin^{-1} \left(\frac{\sqrt{63}}{8} \right)$. If the length of common chord of C_1 and C_2 is β , then the value of $(\alpha\beta)^2$ equals _____.

Q80 Differential Equations **NUMERICAL**[Step-by-step solution](#) › prepwiser.in/questions/nt3HllpMjU

Let $Y = Y(X)$ be a curve lying in the first quadrant such that the area enclosed by the line $Y - y = Y'(x)(X - x)$ and the co-ordinate axes, where (x, y) is any point on the curve, is always $\frac{-y^2}{2Y'(x)} + 1$, $Y'(x) \neq 0$. If $Y(1) = 1$, then $12Y(2)$ equals _____.

Q81 Permutations & Combinations **NUMERICAL**[Step-by-step solution](#) › prepwiser.in/questions/SHKRmgc8gK

In an examination of Mathematics paper, there are 20 questions of equal marks and the question paper is divided into three sections: A , B and C . A student is required to attempt total 15 questions taking at least 4 questions from each section. If section A has 8 questions, section B has 6 questions and section C has 6 questions, then the total number of ways a student can select 15 questions is _____.

Q82 Quadratic Equations & Polynomial Inequalities **NUMERICAL**[Step-by-step solution](#) › prepwiser.in/questions/zNaV-VgqvV

The number of real solutions of the equation $x(x^2 + 3|x| + 5|x - 1| + 6|x - 2|) = 0$ is _____.

Q83 Sequences & Series **NUMERICAL**[Step-by-step solution](#) › prepwiser.in/questions/XCmfVT2VnY

Let S_n be the sum to n -terms of an arithmetic progression 3, 7, 11, If $40 < \left(\frac{6}{n(n+1)} \sum_{k=1}^n S_k \right) < 42$, then n equals _____.

Q84 Relations & Functions (Basic) **NUMERICAL**[Step-by-step solution](#) › prepwiser.in/questions/47_ypxTsxK

The number of symmetric relations defined on the set $\{1, 2, 3, 4\}$ which are not reflexive is _____.

Q85 Statistics **NUMERICAL**[Step-by-step solution](#) › prepwiser.in/questions/XGB0TA9vrH

The variance σ^2 of the data

x_i	0	1	5	6	10	12	17
f_i	3	2	3	2	6	3	3

is _____.

Q86 Area Under Curves **NUMERICAL**[Step-by-step solution](#) › prepwiser.in/questions/z0b8Nr2yZY

The area of the region enclosed by the parabola $(y - 2)^2 = x - 1$, the line $x - 2y + 4 = 0$ and the positive coordinate axes is _____.

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1. B	2. D	3. C	4. B	5. A	6. A	7. C	8. A
9. D	10. A	11. A	12. B	13. D	14. A	15. C	16. B
17. A	18. C	19. 45	20. 200	21. 2	22. 20	23. 8	24. 40
25. 10	26. 24	27. 3	28. 4				

Chemistry

29. A	30. A	31. C	32. D	33. D	34. A	35. C	36. D
37. A	38. B	39. C	40. A	41. A	42. B	43. C	44. B
45. D	46. D	47. B	48. 3	49. 17	50. 4	51. 6	52. 100
53. 6	54. 10	55. 492	56. 4	57. 4			

Mathematics

58. C	59. C	60. B	61. C	62. A	63. C	64. C	65. C
66. C	67. B	68. B	69. D	70. C	71. B	72. C	73. B
74. C	75. B	76. C	77. 196	78. 10	79. 1575	80. 20	81. 11376
82. 1	83. 9	84. 960	85. 29	86. 5			

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