

JEE MAIN 2021 · QUESTION PAPER

25 Jul 2021 **Shift 2**

83 questions in exam order, with answer key

Subject	Section A multiple choice	Section B numerical value
● Physics	20 Q1 to Q20	9 Q21 to Q29
● Chemistry	18 Q30 to Q47	9 Q48 to Q56
● Mathematics	18 Q57 to Q74	9 Q75 to Q83
In this PDF	83 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.

prepwise.in/pyqs/paper/2021-07-25-evening · Free, no signup needed to start

Answers follow NTA's final answer keys. Typing errors are possible, so check doubtful answers against the official key. Spotted a mistake? prepwise.in/feedback · Terms: prepwise.in/terms

Q1 Alternating Current

[Step-by-step solution](#) › [prepwisar.in/questions/1iq6zUc1na](https://www.prepwisar.in/questions/1iq6zUc1na)

A $10\ \Omega$ resistance is connected across 220V – 50 Hz AC supply. The time taken by the current to change from its maximum value to the rms value is:

- (A) 2.5 ms (B) 1.5 ms (C) 3.0 ms (D) 4.5 ms

Q2 Electrostatics II: Potential & Capacitance

[Step-by-step solution](#) › [prepwisar.in/questions/3cLlftcAuU](https://www.prepwisar.in/questions/3cLlftcAuU)

If q_f is the free charge on the capacitor plates and q_b is the bound charge on the dielectric slab of dielectric constant k placed between the capacitor plates, then bound charge q_b can be expressed as:

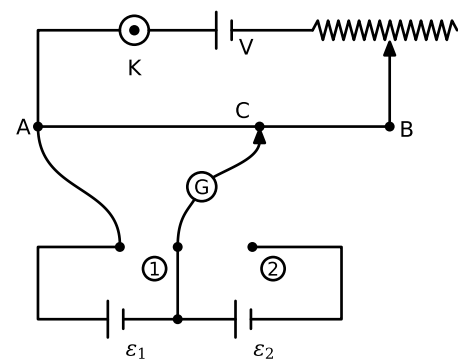
- (A) $q_b = q_f \left(1 - \frac{1}{\sqrt{k}}\right)$ (B) $q_b = q_f \left(1 - \frac{1}{k}\right)$ (C) $q_b = q_f \left(1 + \frac{1}{\sqrt{k}}\right)$ (D) $q_b = q_f \left(1 + \frac{1}{k}\right)$

Q3 Current Electricity

[Step-by-step solution](#) › [prepwisar.in/questions/TtNXQ-rhdK](https://www.prepwisar.in/questions/TtNXQ-rhdK)

In the given potentiometer circuit arrangement, the balancing length AC is measured to be 250 cm. When the galvanometer connection is shifted from point (1) to point (2) in the given diagram, the balancing length becomes 400 cm. The ratio of the emf of two cells, $\frac{\varepsilon_1}{\varepsilon_2}$ is:

- (A) $\frac{5}{3}$ (B) $\frac{8}{5}$ (C) $\frac{4}{3}$ (D) $\frac{3}{2}$

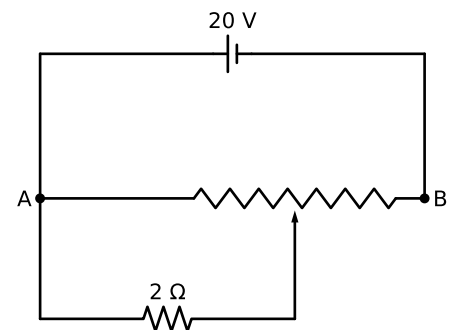


Q4 Current Electricity

[Step-by-step solution](#) › [prepwisar.in/questions/6fe5UbG_ww](https://www.prepwisar.in/questions/6fe5UbG_ww)

The given potentiometer has its wire of resistance $10\ \Omega$. When the sliding contact is in the middle of the potentiometer wire, the potential drop across $2\ \Omega$ resistor is:

- (A) 10 V (B) 5 V (C) $\frac{40}{9}$ V (D) $\frac{40}{11}$ V



Q5 Dual Nature of Radiation & Matter

[Step-by-step solution](#) › [prepwisar.in/questions/9kDuHxfyle](https://www.prepwisar.in/questions/9kDuHxfyle)

An electron moving with speed v and a photon moving with speed c , have same De-Broglie wavelength. The ratio of kinetic energy of electron to that of photon is:

- (A) $\frac{3c}{v}$ (B) $\frac{v}{3c}$ (C) $\frac{v}{2c}$ (D) $\frac{2c}{v}$

Q6 Dual Nature of Radiation & Matter

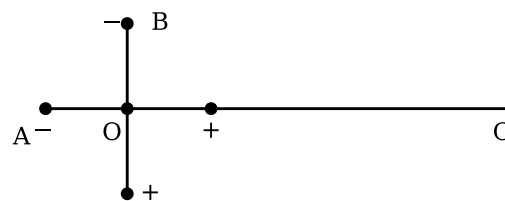
[Step-by-step solution](#) › [prepwisar.in/questions/LSJFWdZK6-](https://www.prepwisar.in/questions/LSJFWdZK6-)

When radiation of wavelength λ is incident on a metallic surface, the stopping potential of ejected photoelectrons is 4.8 V. If the same surface is illuminated by radiation of double the previous wavelength, then the stopping potential becomes 1.6 V. The threshold wavelength of the metal is:

- (A) 2λ (B) 4λ (C) 8λ (D) 6λ

Q7 Electrostatics I: Charges, Field & Gauss's Law[Step-by-step solution > prepwiser.in/questions/sloR_pfBmV](https://www.prepwiser.in/questions/sloR_pfBmV)

Two ideal electric dipoles A and B, having their dipole moment p_1 and p_2 respectively are placed on a plane with their centres at O as shown in the figure. At point C on the axis of dipole A, the resultant electric field is making an angle of 37° with the axis. The ratio of the dipole moment of A and B, $\frac{p_1}{p_2}$ is : (take $\sin 37^\circ = \frac{3}{5}$)



- (A) $\frac{3}{8}$ (B) $\frac{3}{2}$ (C) $\frac{2}{3}$ (D) $\frac{4}{3}$

Q8 Ray Optics[Step-by-step solution > prepwiser.in/questions/Qetn7Oufst](https://www.prepwiser.in/questions/Qetn7Oufst)

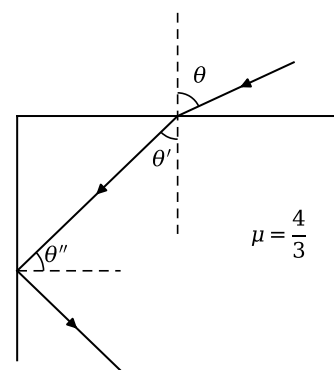
A prism of refractive index μ and angle of prism A is placed in the position of minimum angle of deviation. If minimum angle of deviation is also A, then in terms of refractive index

- (A) $2\cos^{-1}\left(\frac{\mu}{2}\right)$ (B) $\sin^{-1}\left(\frac{\mu}{2}\right)$ (C) $\sin^{-1}\left(\sqrt{\frac{\mu-1}{2}}\right)$ (D) $\cos^{-1}\left(\frac{\mu}{2}\right)$

Q9 Ray Optics[Step-by-step solution > prepwiser.in/questions/k2bL-gXgre](https://www.prepwiser.in/questions/k2bL-gXgre)

A ray of light entering from air into a denser medium of refractive index $\frac{4}{3}$, as shown in figure. The light ray suffers total internal reflection at the adjacent surface as shown. The maximum value of angle θ should be equal to:

- (A) $\sin^{-1}\frac{\sqrt{7}}{3}$ (B) $\sin^{-1}\frac{\sqrt{5}}{4}$ (C) $\sin^{-1}\frac{\sqrt{7}}{4}$ (D) $\sin^{-1}\frac{\sqrt{5}}{3}$

**Q10** Gravitation[Step-by-step solution > prepwiser.in/questions/zACRfKnIr2](https://www.prepwiser.in/questions/zACRfKnIr2)

Consider a planet in some solar system which has a mass double the mass of earth and density equal to the average density of earth. If the weight of an object on earth is W, the weight of the same object on that planet will be:

- (A) $2W$ (B) W (C) $2^{\frac{1}{3}}W$ (D) $\sqrt{2}W$

Q11 Thermodynamics[Step-by-step solution > prepwiser.in/questions/-O2ojzmRb1](https://www.prepwiser.in/questions/-O2ojzmRb1)

A heat engine has an efficiency of $\frac{1}{6}$. When the temperature of sink is reduced by 62°C , its efficiency get doubled. The temperature of the source is:

- (A) 124°C (B) 37°C (C) 62°C (D) 99°C

Q12 Newton's Laws of Motion[Step-by-step solution > prepwiser.in/questions/JWZv1uhlc7](https://www.prepwiser.in/questions/JWZv1uhlc7)

A force $\vec{F} = (40\hat{i} + 10\hat{j})\text{N}$ acts on a body of mass 5 kg. If the body starts from rest, its position vector $\vec{r}$ at time $t = 10\text{ s}$, will be:

- (A) $(100\hat{i} + 400\hat{j})\text{m}$ (B) $(100\hat{i} + 100\hat{j})\text{m}$ (C) $(400\hat{i} + 100\hat{j})\text{m}$ (D) $(400\hat{i} + 400\hat{j})\text{m}$

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Q13 Moving Charges & Magnetism[Step-by-step solution](https://www.prepwiser.in/questions/4VcA1MVfZO) > prepwiser.in/questions/4VcA1MVfZO

Two ions having same mass have charges in the ratio 1 : 2. They are projected normally in a uniform magnetic field with their speeds in the ratio 2 : 3. The ratio of the radii of their circular trajectories is:

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

Q14 Rectilinear Motion[Step-by-step solution](https://www.prepwiser.in/questions/DAYszyq01q) > prepwiser.in/questions/DAYszyq01q

The relation between time t and distance x for a moving body is given as $t = mx^2 + nx$, where m and n are constants. The retardation of the motion is : (When v stands for velocity)

- (A) $2mv^3$ (B) $2mnv^3$ (C) $2nv^3$ (D) $2n^2v^3$

Q15 Rectilinear Motion[Step-by-step solution](https://www.prepwiser.in/questions/GIRJ3UQh5l) > prepwiser.in/questions/GIRJ3UQh5l

A balloon was moving upwards with a uniform velocity of 10 m/s. An object of finite mass is dropped from the balloon when it was at a height of 75 m from the ground level. The height of the balloon from the ground when object strikes the ground was around:
(takes the value of g as 10 m/s^2)

- (A) 300 m (B) 200 m (C) 125 m (D) 250 m

Q16 Rectilinear Motion[Step-by-step solution](https://www.prepwiser.in/questions/MZD6y6knQ2) > prepwiser.in/questions/MZD6y6knQ2

The instantaneous velocity of a particle moving in a straight line is given as $V = \alpha t + \beta t^2$, where α and β are constants. The distance travelled by the particle between 1s and 2s is:

- (A) $3\alpha + 7\beta$ (B) $\frac{3}{2}\alpha + \frac{7}{3}\beta$ (C) $\frac{\alpha}{2} + \frac{\beta}{3}$ (D) $\frac{3}{2}\alpha + \frac{7}{2}\beta$

Q17 Surface Tension[Step-by-step solution](https://www.prepwiser.in/questions/J2bF6FE0se) > prepwiser.in/questions/J2bF6FE0se

Two spherical soap bubbles of radii r_1 and r_2 in vacuum combine under isothermal conditions. The resulting bubble has a radius equal to:

- (A) $\frac{r_1 r_2}{r_1 + r_2}$ (B) $\sqrt{r_1 r_2}$ (C) $\sqrt{r_1^2 + r_2^2}$ (D) $\frac{r_1 + r_2}{2}$

Q18 Simple Harmonic Motion[Step-by-step solution](https://www.prepwiser.in/questions/nB3pL0AyBD) > prepwiser.in/questions/nB3pL0AyBD

In a simple harmonic oscillation, what fraction of total mechanical energy is in the form of kinetic energy, when the particle is midway between mean and extreme position.

- (A) $\frac{1}{2}$ (B) $\frac{3}{4}$ (C) $\frac{1}{3}$ (D) $\frac{1}{4}$

Q19 Units, Dimensions & Errors[Step-by-step solution](https://www.prepwiser.in/questions/S_-vqVp5l_) > prepwiser.in/questions/S_-vqVp5l_

The force is given in terms of time t and displacement x by the equation

$$F = A \cos Bx + C \sin Dt$$

The dimensional formula of $\frac{AD}{B}$ is:

- (A) $[M^0 L T^{-1}]$ (B) $[M L^2 T^{-3}]$ (C) $[M^1 L^1 T^{-2}]$ (D) $[M^2 L^2 T^{-3}]$

Q20 Vectors[Step-by-step solution](https://www.prepwiser.in/questions/0w6h8Ez_39) > prepwiser.in/questions/0w6h8Ez_39

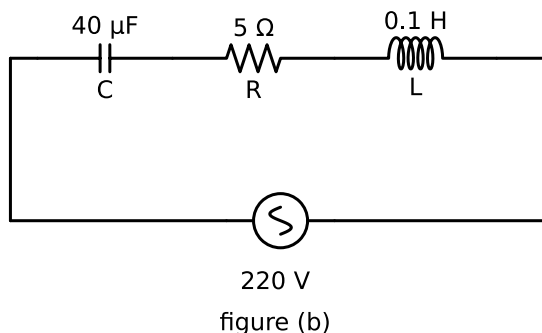
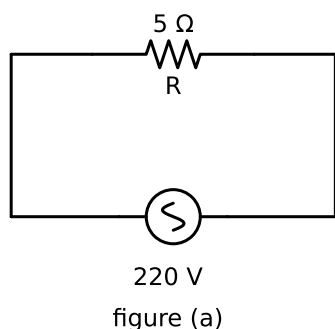
Two vectors $\vec{X}$ and $\vec{Y}$ have equal magnitude. The magnitude of $(\vec{X} - \vec{Y})$ is n times the magnitude of $(\vec{X} + \vec{Y})$. The angle between $\vec{X}$ and $\vec{Y}$ is:

- (A) $\cos^{-1} \left(\frac{-n^2 - 1}{n^2 - 1} \right)$ (B) $\cos^{-1} \left(\frac{n^2 - 1}{-n^2 - 1} \right)$ (C) $\cos^{-1} \left(\frac{n^2 + 1}{-n^2 - 1} \right)$ (D) $\cos^{-1} \left(\frac{n^2 + 1}{n^2 - 1} \right)$

Q21 Alternating Current **NUMERICAL**

[Step-by-step solution](#) > [prepwise.in/questions/aRALLVZY5M](https://www.prepwise.in/questions/aRALLVZY5M)

Two circuits are shown in the figure (a) & (b). At a frequency of _____ rad/s the average power dissipated in one cycle will be same in both the circuits.



Q22 Nuclear Physics **NUMERICAL**

[Step-by-step solution](#) > [prepwise.in/questions/I05G9cH4Zi](https://www.prepwise.in/questions/I05G9cH4Zi)

From the given data, the amount of energy required to break the nucleus of aluminium ${}_{13}^{27}\text{Al}$ is _____ $\times 10^{-3}$ J.

Mass of neutron = 1.00866 u

Mass of proton = 1.00726 u

Mass of Aluminium nucleus = 27.18846 u

(Assume 1 u corresponds to x J of energy)

(Round off to the nearest integer)

Q23 Nuclear Physics **NUMERICAL**

[Step-by-step solution](#) > [prepwise.in/questions/2ml-q9N2G2](https://www.prepwise.in/questions/2ml-q9N2G2)

The nuclear activity of a radioactive element becomes $\left(\frac{1}{8}\right)^{\text{th}}$ of its initial value in 30 years. The half-life of radioactive element is _____ years.

Q24 Current Electricity **NUMERICAL**

[Step-by-step solution](#) > [prepwise.in/questions/wN64sE1KOk](https://www.prepwise.in/questions/wN64sE1KOk)

A $16\ \Omega$ wire is bent to form a square loop. A 9V supply having internal resistance of $1\ \Omega$ is connected across one of its sides. The potential drop across the diagonals of the square loop is _____ $\times 10^{-1}$ V

Q25 Dual Nature of Radiation & Matter **NUMERICAL**

[Step-by-step solution](#) > [prepwise.in/questions/9KTvrsmA7f](https://www.prepwise.in/questions/9KTvrsmA7f)

A light beam of wavelength 500 nm is incident on a metal having work function of 1.25 eV, placed in a magnetic field of intensity B. The electrons emitted perpendicular to the magnetic field B, with maximum kinetic energy are bent into circular arc of radius 30 cm. The value of B is _____ $\times 10^{-7}$ T.

Given $hc = 20 \times 10^{-26}$ J-m, mass of electron = 9×10^{-31} kg

Q26 Semiconductors & Electronic Devices **NUMERICAL**

[Step-by-step solution](#) > [prepwise.in/questions/CQ2vxO5awM](https://www.prepwise.in/questions/CQ2vxO5awM)

In a semiconductor, the number density of intrinsic charge carriers at 27°C is $1.5 \times 10^{16}/\text{m}^3$. If the semiconductor is doped with impurity atom, the hole density increases to $4.5 \times 10^{22}/\text{m}^3$. The electron density in the doped semiconductor is _____ $\times 10^9/\text{m}^3$.

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A system consists of two types of gas molecules A and B having same number density $2 \times 10^{25}/\text{m}^3$. The diameter of A and B are $10 \text{ \AA}$ and $5 \text{ \AA}$ respectively. They suffer collision at room temperature. The ratio of average distance covered by the molecule A to that of B between two successive collision is $\text{_____} \times 10^{-2}$

A solid disc of radius 20 cm and mass 10 kg is rotating with an angular velocity of 600 rpm, about an axis normal to its circular plane and passing through its centre of mass. The retarding torque required to bring the disc at rest in 10 s is $\text{_____} \pi \times 10^{-1} \text{ Nm}$.

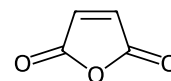
A force of $F = (5y + 20)\hat{j} \text{ N}$ acts on a particle. The work done by this force when the particle is moved from $y = 0 \text{ m}$ to $y = 10 \text{ m}$ is _____ J .

Chemistry Section A · Multiple choice

Q30 to Q47

Maleic anhydride can be prepared by:

- (A) Heating trans-but-2-enedioic acid
- (B) Heating cis-but-2-enedioic acid
- (C) Treating cis-but-2-enedioic acid with alcohol and acid
- (D) Treating trans-but-2-enedioic acid with alcohol and acid



Maleic anhydride

Which one of the following is correct structure for cytosine?

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

In the following the correct bond order sequence is:

- (A) $O_2^{2-} > O_2^+ > O_2^- > O_2$
- (B) $O_2^+ > O_2^- > O_2^{2-} > O_2$
- (C) $O_2^+ > O_2 > O_2^- > O_2^{2-}$
- (D) $O_2 > O_2^- > O_2^{2-} > O_2^+$

Identify the species having one π -bond and maximum number of canonical forms from the following:

- (A) SO_3
- (B) O_2
- (C) SO_2
- (D) CO_3^{2-}

Which one of the following metal complexes is most stable?

- (A) $[\text{Co(en)}(\text{NH}_3)_4]\text{Cl}_2$
- (B) $[\text{Co(en)}_3]\text{Cl}_2$
- (C) $[\text{Co(en)}_2(\text{NH}_3)_2]\text{Cl}_2$
- (D) $[\text{Co}(\text{NH}_3)_6]\text{Cl}_2$

Q35 d & f Block Elements[Step-by-step solution](#) › prepwiser.in/questions/RIf8uNsLim

The spin only magnetic moments (in BM) for free Ti^{3+} , V^{2+} and Sc^{3+} ions respectively are:
(At.No. Sc : 21, Ti : 22, V : 23)

- (A) 3.87, 1.73, 0 (B) 1.73, 3.87, 0 (C) 1.73, 0, 3.87 (D) 0, 3.87, 1.73

Q36 Hydrogen & s-Block Elements[Step-by-step solution](#) › prepwiser.in/questions/IC-UlZHPK7

Which one of the following metals forms interstitial hydride easily?

- (A) Cr (B) Fe (C) Mn (D) Co

Q37 Metallurgy[Step-by-step solution](#) › prepwiser.in/questions/ANiIoYatbk

Match List I with List II : (Both having metallurgical terms)

	List - I		List - II
(a)	Concentration of Ag ore	(i)	Reverberatory furnace
(b)	Blast furnace	(ii)	Pig iron
(c)	Blister copper	(iii)	Leaching with dilute NaCN solution
(d)	Froth floatation method	(iv)	Sulfide ores

Choose the correct answer from the options given below:

- (A) (a)-(iii), (b)-(ii), (c)-(i), (d)-(iv) (B) (a)-(iii), (b)-(iv), (c)-(i), (d)-(ii)
(C) (a)-(iv), (b)-(i), (c)-(iii), (d)-(ii) (D) (a)-(iv), (b)-(iii), (c)-(ii), (d)-(i)

Q38 Periodic Table & Periodicity[Step-by-step solution](#) › prepwiser.in/questions/Kd9T1EQfcA

The ionic radii of F^- and O^{2-} respectively are $1.33 \text{ \AA}$ and $1.4 \text{ \AA}$, while the covalent radius of N is $0.74 \text{ \AA}$.
The correct statement for the ionic radius of N^{3-} from the following is:

- (A) It is smaller than F^- and N
(B) It is bigger than O^{2-} and F^-
(C) It is bigger than F^- and N, but smaller than of O^{2-}
(D) It is smaller than O^{2-} and F^- , but bigger than of N

Q39 Polymers[Step-by-step solution](#) › prepwiser.in/questions/b6_9Mp9CFW

A biodegradable polyamide can be made from:

- (A) Glycine and isoprene (B) Hexamethylene diamine and adipic acid
(C) Glycine and aminocaproic acid (D) Styrene and caproic acid

Q40 Redox Reactions[Step-by-step solution](#) › prepwiser.in/questions/EKabWjnGC4

Identify the process in which change in the oxidation state is five:

- (A) $Cr_2O_7^{2-} \rightarrow 2Cr^{3+}$ (B) $MnO_4^- \rightarrow Mn^{2+}$ (C) $CrO_4^{2-} \rightarrow Cr^{3+}$ (D) $C_2O_4^{2-} \rightarrow 2CO_2$

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Match List I with List II:

	List-I Elements		List-II Properties
(a)	Li	(i)	Poor water solubility of I^- salt
(b)	Na	(ii)	Most abundant element in cell fluid
(c)	K	(iii)	Bicarbonate salt used in fire extinguisher
(d)	Cs	(iv)	Carbonate salt decomposes easily on heating

Choose the correct answer from the options given below:

(A) (a)-(iv), (b)-(iii), (c)-(ii), (d)-(i)

(B) (a)-(i), (b)-(iii), (c)-(ii), (d)-(iv)

(C) (a)-(iv), (b)-(ii), (c)-(iii), (d)-(i)

(D) (a)-(i), (b)-(ii), (c)-(iii), (d)-(iv)

Match List I with List II:

List-I Example of colloids	List - II Classification
(a) Cheese	(i) dispersion of liquid in liquid
(b) Pumice stone	(ii) dispersion of liquid in gas
(c) Hair cream	(iii) dispersion of gas in solid
(d) Cloud	(iv) dispersion of liquid in solid

Choose the most appropriate answer from the options given below

(A) (a)-(iv), (b)-(iii), (c)-(ii), (d)-(i)

(B) (a)-(iv), (b)-(i), (c)-(iii), (d)-(ii)

(C) (a)-(iii), (b)-(iv), (c)-(i), (d)-(ii)

(D) (a)-(iv), (b)-(iii), (c)-(i), (d)-(ii)

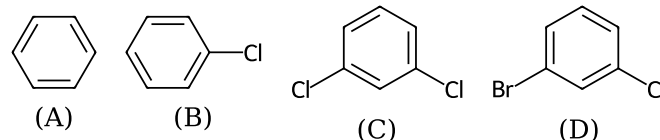
The correct decreasing order of densities of the following compounds is:

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

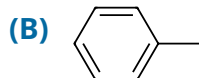
(B) (C) > (D) > (A) > (B)

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

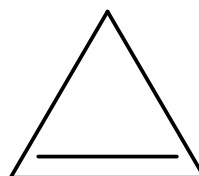
(D) (A) > (B) > (C) > (D)



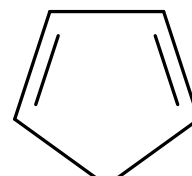
Which among the following is the strongest acid?

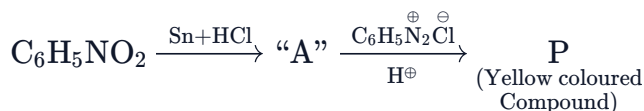
(A) $CH_3CH_2CH_2CH_3$ 

(C)

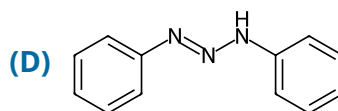
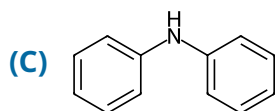
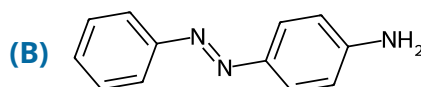
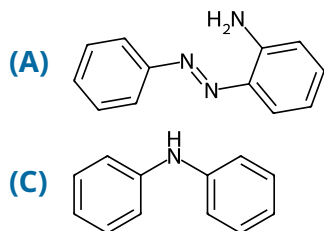


(D)

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Consider the above reaction, the product "P" is:



A reaction of benzonitrile with one equivalent CH_3MgBr followed by hydrolysis produces a yellow liquid "P". The compound "P" will give positive _____.

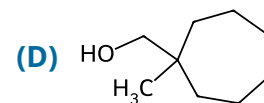
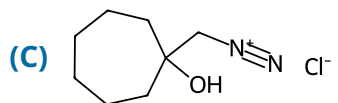
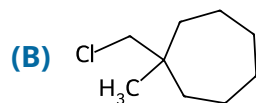
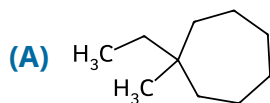
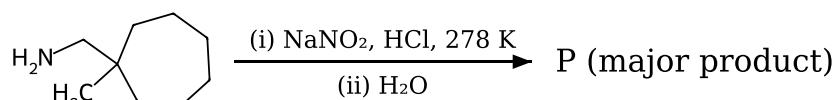
(A) Iodoform test

(B) Schiff's test

(C) Ninhydrin's test

(D) Tollen's test

What is the major product "P" of the following reaction?

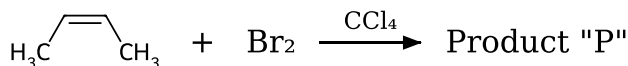


Chemistry Section B · Numerical value

Q48 to Q56

For a chemical reaction $\text{A} \rightarrow \text{B}$, it was found that concentration of B is increased by 0.2 mol L^{-1} in 30 min. The average rate of the reaction is _____ $\times 10^{-1} \text{ mol L}^{-1} \text{ h}^{-1}$. (in nearest integer)

Number of electrons present in 4f orbital of Ho^{3+} ion is _____. (Given Atomic No. of Ho = 67)



Consider the above chemical reaction. The total number of stereoisomers possible for Product "P" is _____.

When 3.00 g of a substance 'X' is dissolved in 100 g of CCl_4 , it raises the boiling point by 0.60 K. The molar mass of the substance 'X' is _____ g mol^{-1} . (Nearest integer).

[Given K_b for CCl_4 is $5.0 \text{ K kg mol}^{-1}$]

The number of significant figures in 0.00340 is _____.

An accelerated electron has a speed of $5 \times 10^6 \text{ ms}^{-1}$ with an uncertainty of 0.02%. The uncertainty in finding its location while in motion is $x \times 10^{-9} \text{ m}$. The value of x is _____. (Nearest integer)
[Use mass of electron = $9.1 \times 10^{-31} \text{ kg}$, $h = 6.63 \times 10^{-34} \text{ Js}$, $\pi = 3.14$]

A system does 200 J of work and at the same time absorbs 150 J of heat. The magnitude of the change in internal energy is _____. J. (Nearest integer)

Assuming that Ba(OH)_2 is completely ionised in aqueous solution under the given conditions the concentration of H_3O^+ ions in 0.005 M aqueous solution of Ba(OH)_2 at 298 K is _____ $\times 10^{-12} \text{ mol L}^{-1}$. (Nearest integer)

0.8 g of an organic compound was analyzed by Kjeldahl's method for the estimation of nitrogen. If the percentage of nitrogen in the compound was found to be 42%, then _____ mL of 1 M H_2SO_4 would have been neutralized by the ammonia evolved during the analysis.

Mathematics Section A · Multiple choice

Q57 to Q74

The sum of all those terms which are rational numbers in the expansion of $(2^{1/3} + 3^{1/4})^{12}$ is:

- (A) 89 (B) 27 (C) 35 (D) 43

If the greatest value of the term independent of 'x' in the expansion of $(x \sin \alpha + a \frac{\cos \alpha}{x})^{10}$ is $\frac{10!}{(5!)^2}$, then the value of 'a' is equal to:

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

The lowest integer which is greater than $(1 + \frac{1}{10^{100}})^{10^{100}}$ is _____.

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

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If

$$f(x) = \begin{cases} \int_0^x (5 + |1 - t|) dt, & x > 2 \\ 5x + 1, & x \leq 2 \end{cases}$$

, then

- (A) $f(x)$ is not continuous at $x = 2$
 (B) $f(x)$ is everywhere differentiable
 (C) $f(x)$ is continuous but not differentiable at $x = 2$
 (D) $f(x)$ is not differentiable at $x = 1$

The value of the

integral $\int_{-1}^1 \log(x + \sqrt{x^2 + 1}) dx$ is:

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

Let $y = y(x)$ be the solution of the differentialequation $xydy = (y + x^3 \cos x)dx$ with $y(\pi) = 0$, then $y\left(\frac{\pi}{2}\right)$ is equal to:

- (A) $\frac{\pi^2}{4} + \frac{\pi}{2}$ (B) $\frac{\pi^2}{2} + \frac{\pi}{4}$ (C) $\frac{\pi^2}{2} - \frac{\pi}{4}$ (D) $\frac{\pi^4}{4} - \frac{\pi}{2}$

If a tangent to the ellipse $x^2 + 4y^2 = 4$ meets the tangents at the extremities of its major axis at B and C, then the circle with BC as diameter passes through the point:

- (A) $(\sqrt{3}, 0)$ (B) $(\sqrt{2}, 0)$ (C) $(1, 1)$ (D) $(-1, 1)$

Consider function $f: A \rightarrow B$ and $g: B \rightarrow C$ ($A, B, C \subseteq \mathbb{R}$) such that $(g \circ f)^{-1}$ exists, then:

- (A) f and g both are one-one (B) f and g both are onto
 (C) f is one-one and g is onto (D) f is onto and g is one-one

The number of distinct real roots of

$$\begin{vmatrix} \sin x & \cos x & \cos x \\ \cos x & \sin x & \cos x \\ \cos x & \cos x & \sin x \end{vmatrix} = 0$$

in the interval $-\frac{\pi}{4} \leq x \leq \frac{\pi}{4}$ is:

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

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If

$$P = \begin{bmatrix} 1 & 0 \\ \frac{1}{2} & 1 \end{bmatrix}$$

, then P^{50} is:

(A) $\begin{bmatrix} 1 & 0 \\ 25 & 1 \end{bmatrix}$

(B) $\begin{bmatrix} 1 & 50 \\ 0 & 1 \end{bmatrix}$

(C) $\begin{bmatrix} 1 & 25 \\ 0 & 1 \end{bmatrix}$

(D) $\begin{bmatrix} 1 & 0 \\ 50 & 1 \end{bmatrix}$

If ${}^nP_r = {}^nP_{r+1}$ and ${}^nC_r = {}^nC_{r-1}$, then the value of r is equal to:

(A) 1

(B) 4

(C) 2

(D) 3

Let X be a random variable such that the probability function of a distribution is given by $P(X = 0) = \frac{1}{2}$, $P(X = j) = \frac{1}{3^j}$ ($j = 1, 2, 3, \dots, \infty$). Then the mean of the distribution and P(X is positive and even) respectively are:

(A) $\frac{3}{8}$ and $\frac{1}{8}$

(B) $\frac{3}{4}$ and $\frac{1}{8}$

(C) $\frac{3}{4}$ and $\frac{1}{9}$

(D) $\frac{3}{4}$ and $\frac{1}{16}$

If $[x]$ be the greatest integer less than or equal to x,then $\sum_{n=8}^{100} \left[\frac{(-1)^n n}{2} \right]$ is equal to:

(A) 0

(B) 4

(C) -2

(D) 2

The number of real solutions of the equation, $x^2 - |x| - 12 = 0$ is:

(A) 2

(B) 3

(C) 1

(D) 4

The first of the two samples in a group has 100 items with mean 15 and standard deviation 3. If the whole group has 250 items with mean 15.6 and standard deviation $\sqrt{13.44}$, then the standard deviation of the second sample is:

(A) 8

(B) 6

(C) 4

(D) 5

Let a, b and c be distinct positive numbers. If the vectors $a\hat{i} + a\hat{j} + c\hat{k}$, $\hat{i} + \hat{k}$ and $c\hat{i} + c\hat{j} + b\hat{k}$ are coplanar, then c is equal to:

(A) $\frac{2}{\frac{1}{a} + \frac{1}{b}}$

(B) $\frac{a+b}{2}$

(C) $\frac{1}{a} + \frac{1}{b}$

(D) $\sqrt{ab}$

If $|\vec{a}| = 2$, $|\vec{b}| = 5$ and $|\vec{a} \times \vec{b}| = 8$, then $|\vec{a} \cdot \vec{b}|$ is equal to:

(A) 6

(B) 4

(C) 3

(D) 5

The value of $\cot \frac{\pi}{24}$ is:

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

Mathematics Section B · Numerical value

Q75 to Q83

Q75 Three Dimensional Geometry **NUMERICAL**

Step-by-step solution › prepwiser.in/questions/GyG8INFm8O

If the lines $\frac{x-k}{1} = \frac{y-2}{2} = \frac{z-3}{3}$ and

$\frac{x+1}{3} = \frac{y+2}{2} = \frac{z+3}{1}$ are co-planar, then the value of k is _____.

Q76 Binomial Theorem **NUMERICAL**

Step-by-step solution › prepwiser.in/questions/9mTrSTu5fy

Let $n \in \mathbb{N}$ and $[x]$ denote the greatest integer less than or equal to x . If the sum of $(n+1)$ terms

${}^nC_0, 3 \cdot {}^nC_1, 5 \cdot {}^nC_2, 7 \cdot {}^nC_3, \dots$ is equal to $2^{100} \cdot 101$, then $2 \left[\frac{n-1}{2} \right]$ is equal to _____.

Q77 Binomial Theorem **NUMERICAL**

Step-by-step solution › prepwiser.in/questions/R8yFcGP_x8

If the co-efficient of x^7 and x^8 in the expansion of $\left(2 + \frac{x}{3}\right)^n$ are equal, then the value of n is equal to _____.

Q78 Complex Numbers **NUMERICAL**

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

The equation of a circle is $\text{Re}(z^2) + 2(\text{Im}(z))^2 + 2\text{Re}(z) = 0$, where $z = x + iy$. A line which passes through the center of the given circle and the vertex of the parabola, $x^2 - 6x - y + 13 = 0$, has y-intercept equal to _____.

Q79 Differential Equations **NUMERICAL**

Step-by-step solution › prepwiser.in/questions/YKUm1oqRxI

Let a curve $y = f(x)$ pass through the point $(2, (\log_e 2)^2)$ and have slope $\frac{2y}{x \log_e x}$ for all positive real value of x . Then the value of $f(e)$ is equal to _____.

Q80 Continuity & Differentiability **NUMERICAL**

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

Consider the function

where $P(x)$ is a polynomial such that $P''(x)$ is always a constant and $P(3) = 9$. If $f(x)$ is continuous at $x = 2$, then $P(5)$ is equal to _____.

$$f(x) = \frac{P(x)}{\sin(x-2)}, \quad x \neq 2$$

$$= 7, \quad x = 2$$

Q81 Probability: Advanced **NUMERICAL**

Step-by-step solution › prepwiser.in/questions/0XRKImkDbW

A fair coin is tossed n -times such that the probability of getting at least one head is at least 0.9. Then the minimum value of n is _____.

Q82 Quadratic Equations & Polynomial Inequalities **NUMERICAL**

Step-by-step solution › prepwiser.in/questions/bFe5YcLr-M

If $a + b + c = 1$, $ab + bc + ca = 2$ and $abc = 3$, then the value of $a^4 + b^4 + c^4$ is equal to _____.

Q83 Vectors **NUMERICAL**

Step-by-step solution › prepwiser.in/questions/zyI4gJ_qev

If $(\vec{a} + 3\vec{b})$ is perpendicular to $(7\vec{a} - 5\vec{b})$ and $(\vec{a} - 4\vec{b})$ is perpendicular to $(7\vec{a} - 2\vec{b})$, then the angle between $\vec{a}$ and $\vec{b}$ (in degrees) is _____.

Answer key: JEE Main 2021 · 25 Jul · Shift 2

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Physics

1.	A	2.	B	3.	A	4.	C	5.	C	6.	B	7.	C	8.	A	9.	A	10.	C
11.	D	12.	C	13.	B	14.	A	15.	C	16.	B	17.	C	18.	B	19.	B	20.	B
21.	500	22.	27	23.	10	24.	45	25.	125	26.	5	27.	25	28.	4	29.	450		

Chemistry

30.	B	31.	C	32.	C	33.	D	34.	B	35.	B	36.	A	37.	A	38.	B	39.	C
40.	B	41.	A	42.	D	43.	A	44.	D	45.	B	46.	A	47.	D	48.	4	49.	10
50.	2	51.	250	52.	3	53.	58	54.	50	55.	1	56.	12						

Mathematics

57.	D	58.	D	59.	A	60.	C	61.	B	62.	A	63.	A	64.	C	65.	B	66.	A
67.	C	68.	B	69.	B	70.	A	71.	C	72.	D	73.	A	74.	B	75.	1	76.	98
77.	55	78.	1	79.	1	80.	39	81.	4	82.	13	83.	60						

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