

JEE MAIN 2021 · QUESTION PAPER

20 Jul 2021 **Shift 1**

84 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	19 Q30 to Q48	9 Q49 to Q57
● Mathematics	18 Q58 to Q75	9 Q76 to Q84
In this PDF	84 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/2021-07-20-morning · 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 Electromagnetic Waves

[Step-by-step solution](#) > [prepwisar.in/questions/yAOjHbj4Yq](https://www.prepwisar.in/questions/yAOjHbj4Yq)

AC voltage $V(t) = 20 \sin \omega t$ of frequency 50 Hz is applied to a parallel plate capacitor. The separation between the plates is 2 mm and the area is 1 m^2 . The amplitude of the oscillating displacement current for the applied AC voltage is _____. [Take $\epsilon_0 = 8.85 \times 10^{-12} \text{ F/m}$]

- (A) $55.58 \mu\text{A}$ (B) $21.14 \mu\text{A}$ (C) $27.79 \mu\text{A}$ (D) $83.37 \mu\text{A}$

Q2 Nuclear Physics

[Step-by-step solution](#) > [prepwisar.in/questions/_IO95K523S](https://www.prepwisar.in/questions/_IO95K523S)

A radioactive material decays by simultaneous emissions of two particles with half lives of 1400 years and 700 years respectively. What will be the time after which one third of the material remains? (Take $\ln 3 = 1.1$)

- (A) 740 years (B) 1110 years (C) 700 years (D) 340 years

Q3 Nuclear Physics

[Step-by-step solution](#) > [prepwisar.in/questions/seEw78C7hY](https://www.prepwisar.in/questions/seEw78C7hY)

A nucleus of mass M emits γ -ray photon of frequency ' ν '. The loss of internal energy by the nucleus is: [Take ' c ' as the speed of electromagnetic wave]

- (A) $h\nu$ (B) $h\nu \left[1 + \frac{h\nu}{2Mc^2} \right]$ (C) $h\nu \left[1 - \frac{h\nu}{2Mc^2} \right]$ (D) 0

Q4 Circular Motion

[Step-by-step solution](#) > [prepwisar.in/questions/_vQkajz8rg](https://www.prepwisar.in/questions/_vQkajz8rg)

The normal reaction ' N ' for a vehicle of 800 kg mass, negotiating a turn on a 30° banked road at maximum possible speed without skidding is _____ $\times 10^3 \text{ kg m/s}^2$. [Given $\cos 30^\circ = 0.87$, $\mu_s = 0.2$]

- (A) 12.4 (B) 7.2 (C) 6.96 (D) 10.2

Q5 Current Electricity

[Step-by-step solution](#) > [prepwisar.in/questions/pa-b3MIYw](https://www.prepwisar.in/questions/pa-b3MIYw)

A current of 5 A is passing through a non-linear magnesium wire of cross-section 0.04 m^2 . At every point the direction of current density is at an angle of 60° with the unit vector of area of cross-section. The magnitude of electric field at every point of the conductor is: (Resistivity of magnesium $\rho = 44 \times 10^{-8} \Omega\text{m}$)

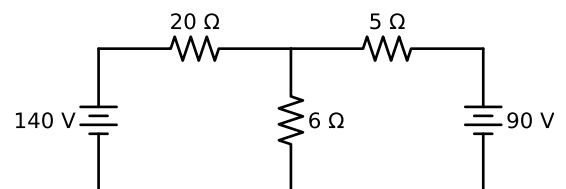
- (A) $11 \times 10^{-5} \text{ V/m}$ (B) $11 \times 10^{-3} \text{ V/m}$ (C) $11 \times 10^{-7} \text{ V/m}$ (D) $11 \times 10^{-2} \text{ V/m}$

Q6 Current Electricity

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

The value of current in the 6Ω resistance is:

- (A) 4A (B) 8A (C) 10A (D) 6A



Q7 Dual Nature of Radiation & Matter

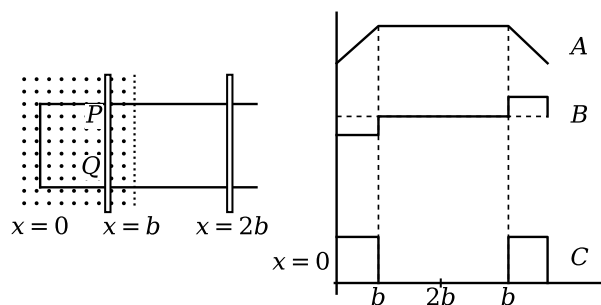
[Step-by-step solution](#) > [prepwisar.in/questions/ov8pqD2tMs](https://www.prepwisar.in/questions/ov8pqD2tMs)

The radiation corresponding to $3 \rightarrow 2$ transition of a hydrogen atom falls on a gold surface to generate photoelectrons. The electrons are passed through a magnetic field of $5 \times 10^{-4} \text{ T}$. Assume that the radius of the largest circular path followed by these electrons is 7 mm, the work function of the metal is : (Mass of electron = $9.1 \times 10^{-31} \text{ kg}$)

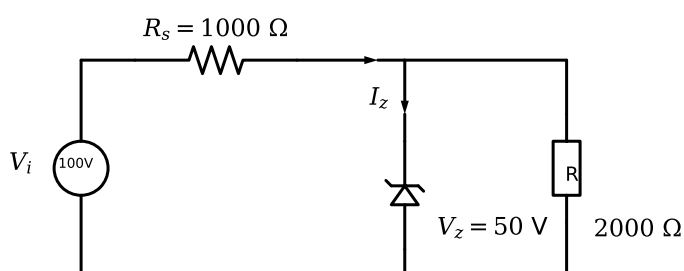
- (A) 1.36 eV (B) 1.88 eV (C) 0.82 eV (D) 0.16 eV

Q8 Electromagnetic Induction[Step-by-step solution > prepwiser.in/questions/y9V-NIHFq-](https://www.prepwiser.in/questions/y9V-NIHFq-)

The arm PQ of a rectangular conductor is moving from $x = 0$ to $x = 2b$ outwards and then inwards from $x = 2b$ to $x = 0$ as shown in the figure. A uniform magnetic field perpendicular to the plane is acting from $x = 0$ to $x = b$. Identify the graph showing the variation of different quantities with distance.

**(A)** A-Flux, B-Power dissipated, C-EMF**(B)** A-Flux, B-EMF, C-Power dissipated**(C)** A-Power dissipated, B-Flux, C-EMF**(D)** A-EMF, B-Power dissipated, C-Flux**Q9** Semiconductors & Electronic Devices[Step-by-step solution > prepwiser.in/questions/Yz0Ub3HtFx](https://www.prepwiser.in/questions/Yz0Ub3HtFx)

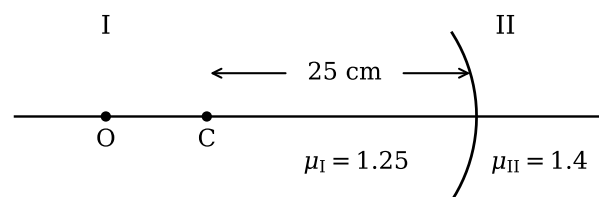
For the circuit shown below, calculate the value of I_z :

**(A)** 25 mA**(B)** 0.1 A**(C)** 0.15 A**(D)** 0.05 A**Q10** Electrostatics I: Charges, Field & Gauss's Law[Step-by-step solution > prepwiser.in/questions/jSyFRIURM0](https://www.prepwiser.in/questions/jSyFRIURM0)

A certain charge Q is divided into two parts q and $(Q - q)$. How should the charges Q and q be divided so that q and $(Q - q)$ placed at a certain distance apart experience maximum electrostatic repulsion?

(A) $Q = 2q$ **(B)** $Q = 4q$ **(C)** $Q = 3q$ **(D)** $Q = \frac{q}{2}$ **Q11** Ray Optics[Step-by-step solution > prepwiser.in/questions/LHq6CjyLHO](https://www.prepwiser.in/questions/LHq6CjyLHO)

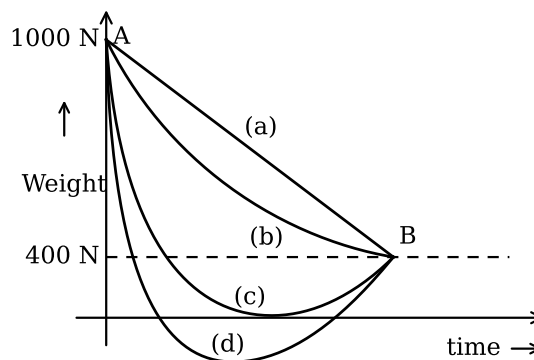
Region I and II are separated by a spherical surface of radius 25 cm. An object is kept in region I at a distance of 40 cm from the surface. The distance of the image from the surface is:

**(A)** 55.44 cm**(B)** 18.23 cm**(C)** 9.52 cm**(D)** 37.58 cm

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Q12 Gravitation[Step-by-step solution](https://www.prepwisar.in/questions/DwIP0rnclq)

A person whose mass is 100 kg travels from Earth to Mars in a spaceship. Neglect all other objects in sky and take acceleration due to gravity on the surface of the Earth and Mars as 10 m/s^2 and 4 m/s^2 respectively. Identify from the below figures, the curve that fits best for the weight of the passenger as a function of time.

**(A)** (b)**(B)** (c)**(C)** (d)**(D)** (a)**Q13** Kinetic Theory of Gases[Step-by-step solution](https://www.prepwisar.in/questions/7bZvcjZcEM)

Consider a mixture of gas molecule of types A, B and C having masses $m_A < m_B < m_C$. The ratio of their root mean square speeds at normal temperature and pressure is:

(A) $v_A = v_B \neq v_C$ **(B)** $\frac{1}{v_A} > \frac{1}{v_B} > \frac{1}{v_C}$ **(C)** $\frac{1}{v_A} < \frac{1}{v_B} < \frac{1}{v_C}$ **(D)** $v_A = v_B = v_C = 0$ **Q14** Thermodynamics[Step-by-step solution](https://www.prepwisar.in/questions/ePBYjC8uH7)

The amount of heat needed to raise the temperature of 4 moles of rigid diatomic gas from 0°C to 50°C when no work is done is _____. (R is the universal gas constant).

(A) 500 R**(B)** 250 R**(C)** 750 R**(D)** 175 R**Q15** Thermodynamics[Step-by-step solution](https://www.prepwisar.in/questions/fNV314qA64)

The entropy of any system is given by

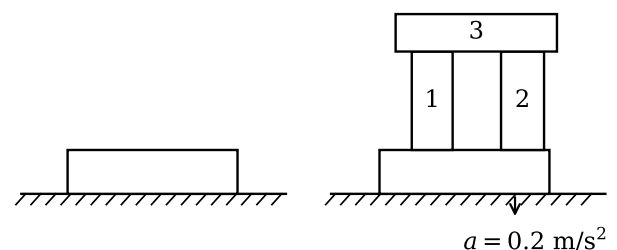
$S = \alpha^2 \beta \ln \left[\frac{\mu k R}{J \beta^2} + 3 \right]$ where α and β are the constants. μ , J, k and R are no. of moles, mechanical equivalent of heat, Boltzmann constant and gas constant respectively.

[Take $S = \frac{dQ}{T}$]

Choose the incorrect option from the following:

(A) α and J have the same dimensions.**(B)** S and α have different dimensions**(C)** S, β , k and μR have the same dimensions**(D)** α and k have the same dimensions**Q16** Friction[Step-by-step solution](https://www.prepwisar.in/questions/IgM8IzIz5)

A steel block of 10 kg rests on a horizontal floor as shown. When three iron cylinders are placed on it as shown, the block and cylinders go down with an acceleration 0.2 m/s^2 . The normal reaction R' by the floor if mass of the iron cylinders are equal and of 20 kg each, is _____. N. [Take $g = 10 \text{ m/s}^2$ and $\mu_s = 0.2$]

**(A)** 686**(B)** 684**(C)** 714**(D)** 716

Q17 Moving Charges & Magnetism[Step-by-step solution](https://www.prepwiser.in/questions/PDKe1leQBp) > prepwiser.in/questions/PDKe1leQBp

A deuteron and an alpha particle having equal kinetic energy enter perpendicularly into a magnetic field. Let r_d and r_α be their respective radii of circular path. The value of $\frac{r_d}{r_\alpha}$ is equal to:

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

Q18 Projectile Motion & Relative Motion[Step-by-step solution](https://www.prepwiser.in/questions/Mb8UNXLvso) > prepwiser.in/questions/Mb8UNXLvso

A butterfly is flying with a velocity $4\sqrt{2}$ m/s in North-East direction. Wind is slowly blowing at 1 m/s from North to South. The resultant displacement of the butterfly in 3 seconds is:

- (A) $12\sqrt{2}$ m (B) 20 m (C) 3 m (D) 15 m

Q19 Elasticity[Step-by-step solution](https://www.prepwiser.in/questions/Iw95HEtQ5N) > prepwiser.in/questions/Iw95HEtQ5N

The value of tension in a long thin metal wire has been changed from T_1 to T_2 . The lengths of the metal wire at two different values of tension T_1 and T_2 are l_1 and l_2 respectively. The actual length of the metal wire is:

- (A) $\frac{l_1 + l_2}{2}$ (B) $\sqrt{T_1 T_2 l_1 l_2}$ (C) $\frac{T_1 l_2 - T_2 l_1}{T_1 - T_2}$ (D) $\frac{T_1 l_1 - T_2 l_2}{T_1 - T_2}$

Q20 Vectors[Step-by-step solution](https://www.prepwiser.in/questions/Eiwy2W1iEW) > prepwiser.in/questions/Eiwy2W1iEW

If $\vec{A}$ and $\vec{B}$ are two vectors satisfying the relation $\vec{A} \cdot \vec{B} = |\vec{A} \times \vec{B}|$. Then the value of $|\vec{A} - \vec{B}|$ will be:

- (A) $\sqrt{A^2 + B^2 + \sqrt{2}AB}$ (B) $\sqrt{A^2 + B^2}$
(C) $\sqrt{A^2 + B^2 - \sqrt{2}AB}$ (D) $\sqrt{A^2 + B^2 + 2AB}$

Physics Section B · Numerical value

Q21 to Q29

Q21 Alternating Current **NUMERICAL**[Step-by-step solution](https://www.prepwiser.in/questions/R4Ue9KvCxH) > prepwiser.in/questions/R4Ue9KvCxH

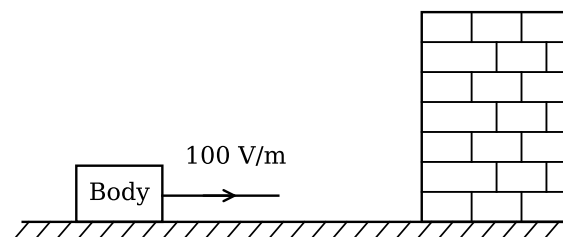
In an LCR series circuit, an inductor 30 mH and a resistor 1Ω are connected to an AC source of angular frequency 300 rad/s. The value of capacitance for which, the current leads the voltage by 45° is $\frac{1}{x} \times 10^{-3}$ F. Then the value of x is _____.

Q22 Rotational Motion **NUMERICAL**[Step-by-step solution](https://www.prepwiser.in/questions/Ht4AUkVyS0) > prepwiser.in/questions/Ht4AUkVyS0

A rod of mass M and length L is lying on a horizontal frictionless surface. A particle of mass 'm' travelling along the surface hits at one end of the rod with a velocity 'u' in a direction perpendicular to the rod. The collision is completely elastic. After collision, particle comes to rest. The ratio of masses ($\frac{m}{M}$) is $\frac{1}{x}$. The value of 'x' will be _____.

Q23 Electrostatics I: Charges, Field & Gauss's Law **NUMERICAL**[Step-by-step solution](https://www.prepwiser.in/questions/75RtX4P1RI) > prepwiser.in/questions/75RtX4P1RI

A body having specific charge $8 \mu\text{C/g}$ is resting on a frictionless plane at a distance 10 cm from the wall (as shown in the figure). It starts moving towards the wall when a uniform electric field of 100 V/m is applied horizontally towards the wall. If the collision of the body with the wall is perfectly elastic, then the time period of the motion will be _____ s.

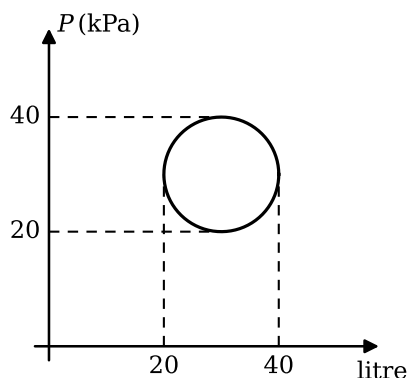


Q24 Ray Optics **NUMERICAL**[Step-by-step solution](#) > [prepwisar.in/questions/3wPvaBxbuF](https://www.prepwisar.in/questions/3wPvaBxbuF)

An object viewed from a near point distance of 25 cm, using a microscopic lens with magnification '6', gives an unresolved image. A resolved image is observed at infinite distance with a total magnification double the earlier using an eyepiece along with the given lens and a tube of length 0.6 m, if the focal length of the eyepiece is equal to _____ cm.

Q25 Thermodynamics **NUMERICAL**[Step-by-step solution](#) > [prepwisar.in/questions/YSnf0Uu8Gq](https://www.prepwisar.in/questions/YSnf0Uu8Gq)

In the reported figure, heat energy absorbed by a system in going through a cyclic process is _____ π J.

**Q26** Rotational Motion **NUMERICAL**[Step-by-step solution](#) > [prepwisar.in/questions/-oi4Uh2Kg_](https://www.prepwisar.in/questions/-oi4Uh2Kg_)

A circular disc reaches from top to bottom of an inclined plane of length 'L'. When it slips down the plane, it makes time ' t_1 '. When it rolls down the plane, it takes time t_2 . The value of $\frac{t_2}{t_1}$ is $\sqrt{\frac{3}{x}}$. The value of x will be _____.

Q27 Sound Waves **NUMERICAL**[Step-by-step solution](#) > [prepwisar.in/questions/ectP7u3fCM](https://www.prepwisar.in/questions/ectP7u3fCM)

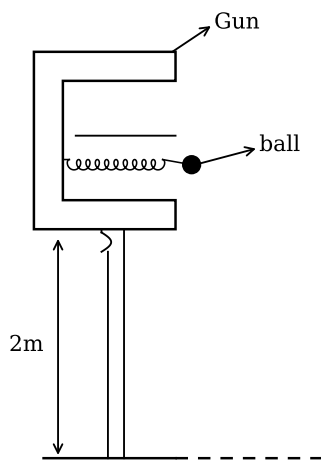
The frequency of a car horn encountered a change from 400 Hz to 500 Hz, when the car approaches a vertical wall. If the speed of sound is 330 m/s. Then the speed of car is _____ km/h.

Q28 Mechanical Waves **NUMERICAL**[Step-by-step solution](#) > [prepwisar.in/questions/M3sTvnsxDs](https://www.prepwisar.in/questions/M3sTvnsxDs)

The amplitude of wave disturbance propagating in the positive x-direction is given by $y = \frac{1}{1+x^2}$ at time $t = 0$ and $y = \frac{1}{1+(x-2)^2}$ at $t = 1$ s, where x and y are in metres. The shape of wave does not change during the propagation. The velocity of the wave will be _____ m/s.

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In a spring gun having spring constant 100 N/m a small ball 'B' of mass 100 g is put in its barrel (as shown in figure) by compressing the spring through 0.05 m. There should be a box placed at a distance 'd' on the ground so that the ball falls in it. If the ball leaves the gun horizontally at a height of 2 m above the ground. The value of d is _____ m. ($g = 10 \text{ m/s}^2$).



Chemistry Section A · Multiple choice

Q30 to Q48

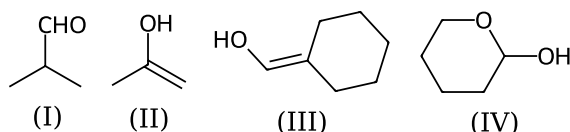
In the given reaction

3-Bromo-2, 2-dimethyl butane



Product A is:

- (A) 2-Ethoxy-3, 3-dimethyl butane (B) 1-Ethoxy-3, 3-dimethyl butane
(C) 2-Ethoxy-2, 3-dimethyl butane (D) 2-Hydroxy-3, 3-dimethyl butane



Which among the above compound/s does/do not form Silver mirror when treated with Tollen's reagent?

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

Identify the incorrect statement from the following

- (A) Amylose is a branched chain polymer of glucose
(B) Starch is a polymer of α -D glucose
(C) β -Glycosidic linkage makes cellulose polymer
(D) Glycogen is called as animal starch

Green chemistry in day-to-day life is in the use of:

- (A) Chlorine for bleaching of paper
- (B) Large amount of water alone for washing clothes
- (C) Tetrachloroethene for laundry
- (D) Liquified CO_2 for dry cleaning of clothes

According to the valence bond theory the hybridization of central metal atom is dsp^2 for which one of the following compounds?

- (A) $\text{NiCl}_2 \cdot 6\text{H}_2\text{O}$
- (B) $\text{K}_2[\text{Ni}(\text{CN})_4]$
- (C) $[\text{Ni}(\text{CO})_4]$
- (D) $\text{Na}_2[\text{NiCl}_4]$

The correct order of intensity of colors of the compounds is:

- (A) $[\text{Ni}(\text{CN})_4]^{2-} > [\text{NiCl}_4]^{2-} > [\text{Ni}(\text{H}_2\text{O})_6]^{2+}$
- (B) $[\text{Ni}(\text{H}_2\text{O})_6]^{2+} > [\text{NiCl}_4]^{2-} > [\text{Ni}(\text{CN})_4]^{2-}$
- (C) $[\text{NiCl}_4]^{2-} > [\text{Ni}(\text{H}_2\text{O})_6]^{2+} > [\text{Ni}(\text{CN})_4]^{2-}$
- (D) $[\text{NiCl}_4]^{2-} > [\text{Ni}(\text{CN})_4]^{2-} > [\text{Ni}(\text{H}_2\text{O})_6]^{2+}$

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

Assertion A : The dihedral angles in H_2O_2 in gaseous phase is 90.2° and in solid phase is 111.5° .

Reason R : The change in dihedral angle in solid and gaseous phase is due to the difference in the intermolecular forces.

Choose the most appropriate answer from the options given below for A and R.

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

The metal that can be purified economically by fractional distillation method is:

- (A) Fe
- (B) Zn
- (C) Cu
- (D) Ni

The species given below that does NOT show disproportionation reaction is:

- (A) BrO_4^-
- (B) BrO^-
- (C) BrO_2^-
- (D) BrO_3^-

Chemical nature of the nitrogen oxide compound obtained from a reaction of concentrated nitric acid and P_4O_{10} (in 4 : 1 ratio) is:

- (A) acidic
- (B) basic
- (C) amphoteric
- (D) neutral

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Orlon fibres are made up of:

- (A) Polyacrylonitrile (B) Polyesters (C) Polyamide (D) Cellulose

The set in which compounds have different nature is:

- (A) $B(OH)_3$ and H_3PO_3 (B) $B(OH)_3$ and $Al(OH)_3$
(C) $NaOH$ and $Ca(OH)_2$ (D) $Be(OH)_2$ and $Al(OH)_3$

A s-block element (M) reacts with oxygen to form an oxide of the formula MO_2 . The oxide is pale yellow in colour and paramagnetic. The element (M) is:

- (A) Mg (B) Na (C) Ca (D) K

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

Assertion A : Sharp glass edge becomes smooth on heating it upto its melting point.

Reason R : The viscosity of glass decreases on melting.

Choose the most appropriate 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.

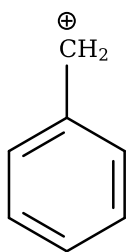
The conditions given below are in the context of observing Tyndall effect in colloidal solutions:

- (A) The diameter of the colloidal particles is comparable to the wavelength of light used.
(B) The diameter of the colloidal particles is much smaller than the wavelength of light used.
(C) The diameter of the colloidal particles is much larger than the wavelength of light used.
(D) The refractive indices of the dispersed phase and the dispersion medium are comparable.
(E) The dispersed phase has a very different refractive index from the dispersion medium.

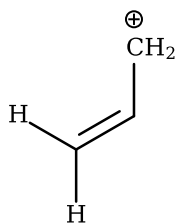
Choose the most appropriate conditions from the options given below:

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

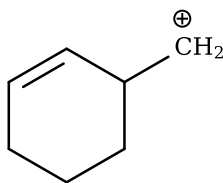
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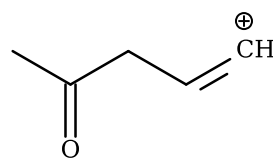
(A)



(B)



(C)

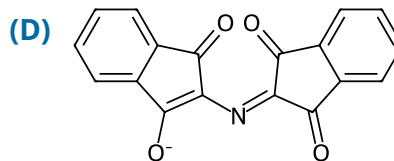
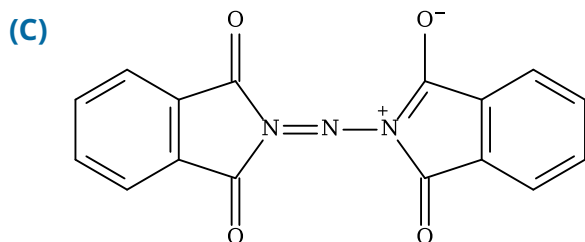
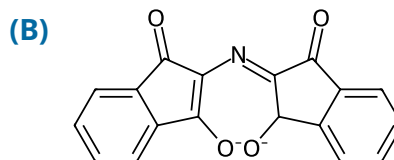
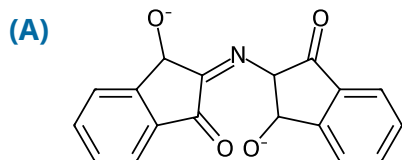


(D)

Among the given species the Resonance stabilised carbocations are:

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

The correct structure of Rhumann's Purple, the compound formed in the reaction of ninhydrin with proteins is:



Compound A is converted to B on reaction with CHCl_3 and KOH . The compound B is toxic and can be decomposed by C. A, B and C respectively are:

- (A) primary amine, nitrile compound, conc. HCl
 (B) secondary amine, isonitrile compound, conc. NaOH
 (C) primary amine, isonitrile compound, conc. HCl
 (D) secondary amine, nitrile compound, conc. NaOH

An inorganic Compound 'X' on treatment with concentrated H_2SO_4 produces brown fumes and gives dark brown ring with FeSO_4 in presence of concentrated H_2SO_4 . Also Compound 'X' gives precipitate 'Y', when its solution in dilute HCl is treated with H_2S gas. The precipitate 'Y' on treatment with concentrated HNO_3 followed by excess of NH_4OH further gives deep blue coloured solution, Compound 'X' is:

- (A) $\text{Co}(\text{NO}_3)_2$ (B) $\text{Pb}(\text{NO}_2)_2$ (C) $\text{Cu}(\text{NO}_3)_2$ (D) $\text{Pb}(\text{NO}_3)_2$

Q49 Halogen Derivatives: Haloalkanes & Haloarenes **NUMERICAL** [Step-by-step solution](#) › prepwiser.in/questions/k4etDeauS_

To synthesize 1.0 mole of 2-methylpropan-2-ol from Ethylethanoate _____ equivalents of CH_3MgBr Reagent will be required. (Integer value)

Q50 Chemical Bonding & Molecular Structure **NUMERICAL** [Step-by-step solution](#) › prepwiser.in/questions/oYSrOOWujh

The number of lone pairs of electrons on the central I atom in I_3^- is _____.

Q51 Chemical Kinetics **NUMERICAL** [Step-by-step solution](#) › prepwiser.in/questions/8BLTxIIQfI

The inactivation rate of a viral preparation is proportional to the amount of virus. In the first minute after preparation, 10% of the virus is inactivated. The rate constant for viral inactivation is _____ $\times 10^{-3} \text{ min}^{-1}$. (Nearest integer)

[Use : $\ln 10 = 2.303$; $\log_{10} 3 = 0.477$; property of logarithm : $\log x^y = y \log x$]

Q52 Solutions & Colligative Properties **NUMERICAL** [Step-by-step solution](#) › prepwiser.in/questions/wVzLyXvPVS

At 20°C , the vapour pressure of benzene is 70 torr and that of methyl benzene is 20 torr. The mole fraction of benzene in the vapour phase at 20° above an equimolar mixture of benzene and methyl benzene is _____ $\times 10^{-2}$. (Nearest integer)

Q53 Mole Concept & Stoichiometry **NUMERICAL** [Step-by-step solution](#) › prepwiser.in/questions/931MNS3YR2

250 mL of 0.5 M NaOH was added to 500 mL of 1 M HCl. The number of unreacted HCl molecules in the solution after complete reaction is _____ $\times 10^{21}$. (Nearest integer)
($N_A = 6.022 \times 10^{23}$)

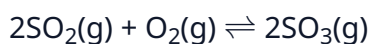
Q54 Chemical Thermodynamics **NUMERICAL** [Step-by-step solution](#) › prepwiser.in/questions/ZsUD55F_J8

An average person needs about 10000 kJ energy per day. The amount of glucose (molar mass = 180.0 g mol^{-1}) needed to meet this energy requirement is _____ g.
(Use: $\Delta_c H(\text{glucose}) = -2700 \text{ kJ mol}^{-1}$)

Q55 Atomic Structure **NUMERICAL** [Step-by-step solution](#) › prepwiser.in/questions/UWThAvSh5Q

The Azimuthal quantum number for the valence electrons of Ga^+ ion is _____.
(Atomic number of Ga = 31)

Q56 Chemical Equilibrium **NUMERICAL** [Step-by-step solution](#) › prepwiser.in/questions/wq6QV6Xeyb



In an equilibrium mixture, the partial pressures are

$P_{\text{SO}_3} = 43 \text{ kPa}$; $P_{\text{O}_2} = 530 \text{ Pa}$ and $P_{\text{SO}_2} = 45 \text{ kPa}$. The equilibrium constant $K_p =$ _____ $\times 10^{-2}$.
(Nearest integer)

Q57 Aldehydes & Ketones **NUMERICAL** [Step-by-step solution](#) › prepwiser.in/questions/gDdIiat4ck

The number of nitrogen atoms in a semicarbazone molecule of acetone is _____.

Q58 Determinants

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

Let $A = [a_{ij}]$ be a 3×3 matrix, where

$$a_{ij} = \begin{cases} 1 & , \quad \text{if } i = j \\ -x & , \quad \text{if } |i - j| = 1 \\ 2x + 1 & , \quad \text{otherwise.} \end{cases}$$

Let a function $f : \mathbb{R} \rightarrow \mathbb{R}$ be defined as $f(x) = \det(A)$. Then the sum of maximum and minimum values of f on $\mathbb{R}$ is equal to:

- (A) $-\frac{20}{27}$ (B) $\frac{88}{27}$ (C) $\frac{20}{27}$ (D) $-\frac{88}{27}$

Q59 Applications of Derivatives

[Step-by-step solution](#) › [prepwise.in/questions/9A3L8vsCPX](https://www.prepwise.in/questions/9A3L8vsCPX)

Let 'a' be a real number such that the function $f(x) = ax^2 + 6x - 15$, $x \in \mathbb{R}$ is increasing in $(-\infty, \frac{3}{4})$ and decreasing in $(\frac{3}{4}, \infty)$. Then the function $g(x) = ax^2 - 6x + 15$, $x \in \mathbb{R}$ has a:

- (A) local maximum at $x = -\frac{3}{4}$ (B) local minimum at $x = -\frac{3}{4}$
(C) local maximum at $x = \frac{3}{4}$ (D) local minimum at $x = \frac{3}{4}$

Q60 Binomial Theorem

[Step-by-step solution](#) › [prepwise.in/questions/p5dyDVkz7N](https://www.prepwise.in/questions/p5dyDVkz7N)

The coefficient of x^{256} in the expansion of $(1 - x)^{101} (x^2 + x + 1)^{100}$ is:

- (A) $^{100}C_{16}$ (B) $^{100}C_{15}$ (C) $-^{100}C_{16}$ (D) $-^{100}C_{15}$

Q61 Complex Numbers

[Step-by-step solution](#) › [prepwise.in/questions/9Q6HtGHN73](https://www.prepwise.in/questions/9Q6HtGHN73)

If z and ω are two complex numbers such that $|z\omega| = 1$ and $\arg(z) - \arg(\omega) = \frac{3\pi}{2}$, then

$$\arg\left(\frac{1 - 2\bar{z}\omega}{1 + 3\bar{z}\omega}\right)$$

is:

(Here $\arg(z)$ denotes the principal argument of complex number z)

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

Q62 Definite Integration

[Step-by-step solution](#) › [prepwise.in/questions/bR6joK-nvj](https://www.prepwise.in/questions/bR6joK-nvj)

Let a be a positive real number such that $\int_0^a e^{x-[x]} dx = 10e - 9$ where $[x]$ is the greatest integer less than or equal to x . Then a is equal to:

- (A) $10 - \log_e(1 + e)$ (B) $10 + \log_e 2$ (C) $10 + \log_e 3$ (D) $10 + \log_e(1 + e)$

Q63 Definite Integration

[Step-by-step solution](#) › [prepwise.in/questions/7BIto6zmeu](https://www.prepwise.in/questions/7BIto6zmeu)

The value of the integral $\int_{-1}^1 \log_e(\sqrt{1-x} + \sqrt{1+x}) dx$ is equal to:

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

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Q64 Differential Equations[Step-by-step solution](https://www.prepwisar.in/questions/AldiqSUZ3w) > prepwisar.in/questions/AldiqSUZ3w

Let $y = y(x)$ be the solution of the differential equation

$$x \tan\left(\frac{y}{x}\right) dy = \left(y \tan\left(\frac{y}{x}\right) - x\right) dx$$

, $-1 \leq x \leq 1$, $y\left(\frac{1}{2}\right) = \frac{\pi}{6}$. Then the area of the region bounded by the curves $x = 0$, $x = \frac{1}{\sqrt{2}}$ and $y = y(x)$ in the upper half plane is:

- (A) $\frac{1}{8}(\pi - 1)$ (B) $\frac{1}{12}(\pi - 3)$ (C) $\frac{1}{4}(\pi - 2)$ (D) $\frac{1}{6}(\pi - 1)$

Q65 Differential Equations[Step-by-step solution](https://www.prepwisar.in/questions/j0ZmZvWFvH) > prepwisar.in/questions/j0ZmZvWFvH

Let $y = y(x)$ be the solution of the differential equation $e^x \sqrt{1 - y^2} dx + \left(\frac{y}{x}\right) dy = 0$, $y(1) = -1$. Then the value of $(y(3))^2$ is equal to:

- (A) $1 - 4e^3$ (B) $1 - 4e^6$ (C) $1 + 4e^3$ (D) $1 + 4e^6$

Q66 Relations & Functions (Basic)[Step-by-step solution](https://www.prepwisar.in/questions/RAdzWGa0J_) > prepwisar.in/questions/RAdzWGa0J_

Let $[x]$ denote the greatest integer $\leq x$, where $x \in \mathbb{R}$. If the domain of the real valued function

$f(x) = \sqrt{\frac{[x]-2}{[x]-3}}$ is $(-\infty, a) \cup [b, c) \cup [4, \infty)$, $a < b < c$, then the value of $a + b + c$ is:

- (A) 8 (B) 1 (C) -2 (D) -3

Q67 Inverse Trigonometric Functions[Step-by-step solution](https://www.prepwisar.in/questions/UtlWePcR7h) > prepwisar.in/questions/UtlWePcR7h

The number of real roots of the equation

$$\tan^{-1} \sqrt{x(x+1)} + \sin^{-1} \sqrt{x^2 + x + 1} = \frac{\pi}{4}$$

is:

- (A) 1 (B) 2 (C) 4 (D) 0

Q68 Continuity & Differentiability[Step-by-step solution](https://www.prepwisar.in/questions/IMCw4cFpVu) > prepwisar.in/questions/IMCw4cFpVu

Let a function $f : \mathbb{R} \rightarrow \mathbb{R}$ be defined as

$$f(x) = \begin{cases} \sin x - e^x & \text{if } x \leq 0 \\ a + [-x] & \text{if } 0 < x < 1 \\ 2x - b & \text{if } x \geq 1 \end{cases}$$

where $[x]$ is the greatest integer less than or equal to x . If f is continuous on $\mathbb{R}$, then $(a + b)$ is equal to:

- (A) 4 (B) 3 (C) 2 (D) 5

Q69 Matrices[Step-by-step solution](https://www.prepwisar.in/questions/N-Qft1_aOB) > prepwisar.in/questions/N-Qft1_aOB

Let $A = \begin{bmatrix} 2 & 3 \\ a & 0 \end{bmatrix}$, $a \in \mathbb{R}$ be written as $P + Q$ where P is a symmetric matrix and Q is skew symmetric matrix. If $\det(Q) = 9$, then the modulus of the sum of all possible values of determinant of P is equal to:

- (A) 36 (B) 24 (C) 45 (D) 18

Q70 Parabola[Step-by-step solution](https://www.prepwisar.in/questions/3M1fHF-cLu) > prepwisar.in/questions/3M1fHF-cLu

Let the tangent to the parabola $S : y^2 = 2x$ at the point $P(2, 2)$ meet the x -axis at Q and normal at it meet the parabola S at the point R . Then the area (in sq. units) of the triangle PQR is equal to:

- (A) $\frac{25}{2}$ (B) $\frac{35}{2}$ (C) $\frac{15}{2}$ (D) 25

Words with or without meaning are to be formed using all the letters of the word EXAMINATION. The probability that the letter M appears at the fourth position in any such word is:

- (A) $\frac{1}{66}$ (B) $\frac{1}{11}$ (C) $\frac{1}{9}$ (D) $\frac{2}{11}$

The probability of selecting integers $a \in [-5, 30]$ such that $x^2 + 2(a+4)x - 5a + 64 > 0$, for all $x \in \mathbb{R}$, is:

- (A) $\frac{7}{36}$ (B) $\frac{2}{9}$ (C) $\frac{1}{6}$ (D) $\frac{1}{4}$

If α and β are the distinct roots of the equation $x^2 + (3)^{1/4}x + 3^{1/2} = 0$, then the value of $\alpha^{96}(\alpha^{12} - 1) + \beta^{96}(\beta^{12} - 1)$ is equal to:

- (A) 56×3^{25} (B) 56×3^{24} (C) 52×3^{24} (D) 28×3^{25}

The mean of 6 distinct observations is 6.5 and their variance is 10.25. If 4 out of 6 observations are 2, 4, 5 and 7, then the remaining two observations are:

- (A) 10, 11 (B) 3, 18 (C) 8, 13 (D) 1, 20

Let $\vec{a} = 2\hat{i} + \hat{j} - 2\hat{k}$ and $\vec{b} = \hat{i} + \hat{j}$. If $\vec{c}$ is a vector such that

$$\vec{a} \cdot \vec{c} = |\vec{c}|, |\vec{c} - \vec{a}| = 2\sqrt{2}$$

and the angle between $(\vec{a} \times \vec{b})$ and $\vec{c}$ is $\frac{\pi}{6}$, then the value of

$$|(\vec{a} \times \vec{b}) \times \vec{c}|$$

is:

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

Mathematics Section B · Numerical value

Q76 to Q84

Let P be a plane passing through the points (1, 0, 1), (1, -2, 1) and (0, 1, -2). Let a vector $\vec{a} = \alpha\hat{i} + \beta\hat{j} + \gamma\hat{k}$ be such that $\vec{a}$ is parallel to the plane P, perpendicular to $(\hat{i} + 2\hat{j} + 3\hat{k})$ and $\vec{a} \cdot (\hat{i} + \hat{j} + 2\hat{k}) = 2$, then $(\alpha - \beta + \gamma)^2$ equals _____.

The number of rational terms in the binomial expansion of $\left(4^{\frac{1}{4}} + 5^{\frac{1}{6}}\right)^{120}$ is _____.

If the value of

$$\lim_{x \rightarrow 0} (2 - \cos x \sqrt{\cos 2x})^{\left(\frac{x+2}{x^2}\right)}$$

is equal to e^a , then a is equal to _____.

Let

$$A = \begin{pmatrix} 1 & -1 & 0 \\ 0 & 1 & -1 \\ 0 & 0 & 1 \end{pmatrix}$$

and $B = 7A^{20} - 20A^7 + 2I$, where I is an identity matrix of order 3×3 . If $B = [b_{ij}]$, then b_{13} is equal to _____.

Let a, b, c, d in arithmetic progression with common difference λ . If

$$\begin{vmatrix} x+a-c & x+b & x+a \\ x-1 & x+c & x+b \\ x-b+d & x+d & x+c \end{vmatrix} = 2$$

, then value of λ^2 is equal to _____.

Let $y = mx + c$, $m > 0$ be the focal chord of $y^2 = -64x$, which is tangent to $(x+10)^2 + y^2 = 4$. Then, the value of $4\sqrt{2}(m+c)$ is equal to _____.

There are 15 players in a cricket team, out of which 6 are bowlers, 7 are batsman and 2 are wicketkeepers. The number of ways, a team of 11 players be selected from them so as to include at least 4 bowlers, 5 batsman and 1 wicketkeeper, is _____.

Let $\vec{a}, \vec{b}, \vec{c}$ be three mutually perpendicular vectors of the same magnitude and equally inclined at an angle θ , with the vector $\vec{a} + \vec{b} + \vec{c}$. Then $36\cos^2 2\theta$ is equal to _____.

If the shortest distance between the lines

$$\vec{r}_1 = \alpha\hat{i} + 2\hat{j} + 2\hat{k} + \lambda(\hat{i} - 2\hat{j} + 2\hat{k})$$

, $\lambda \in \mathbb{R}$, $\alpha > 0$ and

$$\vec{r}_2 = -4\hat{i} - \hat{k} + \mu(3\hat{i} - 2\hat{j} - 2\hat{k})$$

, $\mu \in \mathbb{R}$ is 9, then α is equal to _____.

Answer key: JEE Main 2021 · 20 Jul · Shift 1

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Physics

1.	C	2.	A	3.	B	4.	D	5.	A	6.	C	7.	C	8.	B	9.	A	10.	A
11.	D	12.	B	13.	C	14.	A	15.	D	16.	A	17.	C	18.	D	19.	C	20.	C
21.	3	22.	4	23.	1	24.	25	25.	100	26.	2	27.	132	28.	2	29.	1		

Chemistry

30.	C	31.	C	32.	A	33.	D	34.	B	35.	C	36.	D	37.	B	38.	A	39.	A
40.	A	41.	B	42.	D	43.	B	44.	A	45.	C	46.	D	47.	C	48.	C	49.	2
50.	3	51.	106	52.	78	53.	226	54.	667	55.	0	56.	172	57.	3				

Mathematics

58.	D	59.	A	60.	B	61.	B	62.	B	63.	C	64.	A	65.	B	66.	C	67.	D
68.	B	69.	A	70.	A	71.	B	72.	B	73.	C	74.	A	75.	D	76.	81	77.	21
78.	3	79.	910	80.	1	81.	34	82.	777	83.	4	84.	6						

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