

## JEE MAIN 2023 · QUESTION PAPER

# 11 Apr 2023 **Shift 1**

81 questions in exam order, with answer key

| Subject              | Section A multiple choice                   | Section B numerical value |
|----------------------|---------------------------------------------|---------------------------|
| ● <b>Physics</b>     | <b>19</b> Q1 to Q19                         | <b>10</b> Q20 to Q29      |
| ● <b>Chemistry</b>   | <b>16</b> Q30 to Q45                        | <b>8</b> Q46 to Q53       |
| ● <b>Mathematics</b> | <b>19</b> Q54 to Q72                        | <b>9</b> Q73 to Q81       |
| <b>In this PDF</b>   | <b>81</b> 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.

[prepwis.in/pyqs/paper/2023-04-11-morning](https://prepwis.in/pyqs/paper/2023-04-11-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? [prepwis.in/feedback](https://prepwis.in/feedback) · Terms: [prepwis.in/terms](https://prepwis.in/terms)

**Q1** Alternating Current

[Step-by-step solution](https://www.prepwiser.in/questions/Q1bW4XoqZy) > prepwiser.in/questions/Q1bW4XoqZy

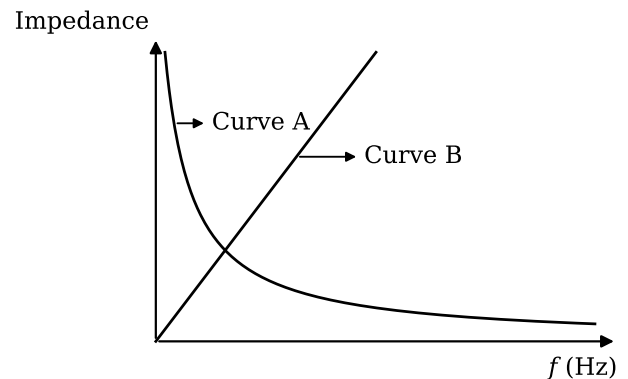
As per the given graph, choose the correct representation for curve A and curve B.

Where  $X_C$  = reactance of pure capacitive circuit connected with A.C. source

$X_L$  = reactance of pure inductive circuit connected with A.C. source

$R$  = impedance of pure resistive circuit connected with A.C. source.

$Z$  = Impedance of the LCR series circuit }



- (A)  $A = X_L, B = R$       (B)  $A = X_L, B = Z$       (C)  $A = X_C, B = X_L$       (D)  $A = X_C, B = R$

**Q2** Nuclear Physics

[Step-by-step solution](https://www.prepwiser.in/questions/TARTffF8nj) > prepwiser.in/questions/TARTffF8nj

Two radioactive elements A and B initially have same number of atoms. The half life of A is same as the average life of B. If  $\lambda_A$  and  $\lambda_B$  are decay constants of A and B respectively, then choose the correct relation from the given options.

- (A)  $\lambda_A = \lambda_B \ln 2$       (B)  $\lambda_A \ln 2 = \lambda_B$       (C)  $\lambda_A = 2\lambda_B$       (D)  $\lambda_A = \lambda_B$

**Q3** Electrostatics II: Potential & Capacitance

[Step-by-step solution](https://www.prepwiser.in/questions/jRfVlJdQx_) > prepwiser.in/questions/jRfVlJdQx\_

A parallel plate capacitor of capacitance  $2F$  is charged to a potential  $V$ , The energy stored in the capacitor is  $E_1$ . The capacitor is now connected to another uncharged identical capacitor in parallel combination. The energy stored in the combination is  $E_2$ . The ratio  $E_2/E_1$  is:

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

**Q4** Centre of Mass & Linear Momentum

[Step-by-step solution](https://www.prepwiser.in/questions/AIAFNcEnS3) > prepwiser.in/questions/AIAFNcEnS3

An average force of  $125N$  is applied on a machine gun firing bullets each of mass  $10g$  at the speed of  $250m/s$  to keep it in position. The number of bullets fired per second by the machine gun is:

- (A) 25      (B) 50      (C) 5      (D) 100

**Q5** Circular Motion

[Step-by-step solution](https://www.prepwiser.in/questions/69MWxv5cHS) > prepwiser.in/questions/69MWxv5cHS

A coin placed on a rotating table just slips when it is placed at a distance of  $1cm$  from the center. If the angular velocity of the table is halved, it will just slip when placed at a distance of \_\_\_\_\_ from the centre:

- (A) 1 cm      (B) 8 cm      (C) 4 cm      (D) 2 cm

**Q6** Current Electricity

[Step-by-step solution](https://www.prepwiser.in/questions/UurfCDsF3v) > prepwiser.in/questions/UurfCDsF3v

Two identical heater filaments are connected first in parallel and then in series. At the same applied voltage, the ratio of heat produced in same time for parallel to series will be:

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

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**Q7** Moving Charges & Magnetism[Step-by-step solution > prepwiser.in/questions/pyMznusvC-](https://www.prepwiser.in/questions/pyMznusvC-)

The current sensitivity of moving coil galvanometer is increased by 25%. This increase is achieved only by changing in the number of turns of coils and area of cross section of the wire while keeping the resistance of galvanometer coil constant. The percentage change in the voltage sensitivity will be:

- (A) +25% (B) -50% (C) -25% (D) Zero

**Q8** Dual Nature of Radiation & Matter[Step-by-step solution > prepwiser.in/questions/hYIB\\_FIPsu](https://www.prepwiser.in/questions/hYIB_FIPsu)

A metallic surface is illuminated with radiation of wavelength  $\lambda$ , the stopping potential is  $V_0$ . If the same surface is illuminated with radiation of wavelength  $2\lambda$ , the stopping potential becomes  $\frac{V_0}{4}$ . The threshold wavelength for this metallic surface will be

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

**Q9** Electromagnetic Waves[Step-by-step solution > prepwiser.in/questions/ZP\\_iZYBO5U](https://www.prepwiser.in/questions/ZP_iZYBO5U)

The electric field in an electromagnetic wave is given as

$$\vec{E} = 20 \sin \omega \left( t - \frac{x}{c} \right) \vec{j} \text{ NC}^{-1}$$

where  $\omega$  and  $c$  are angular frequency and velocity of electromagnetic wave respectively. The energy contained in a volume of  $5 \times 10^{-4} \text{ m}^3$  will be

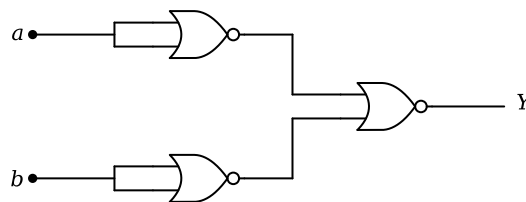
(Given  $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{Nm}^2$ )

- (A)  $17.7 \times 10^{-13} \text{ J}$  (B)  $28.5 \times 10^{-13} \text{ J}$  (C)  $8.85 \times 10^{-13} \text{ J}$  (D)  $88.5 \times 10^{-13} \text{ J}$

**Q10** Semiconductors & Electronic Devices[Step-by-step solution > prepwiser.in/questions/Gy-xepGHbi](https://www.prepwiser.in/questions/Gy-xepGHbi)

The logic performed by the circuit shown in figure is equivalent to:

- (A) NAND (B) AND (C) OR (D) NOR

**Q11** Ray Optics[Step-by-step solution > prepwiser.in/questions/JmUMU8tVit](https://www.prepwiser.in/questions/JmUMU8tVit)

The critical angle for a denser-rarer interface is  $45^\circ$ . The speed of light in rarer medium is  $3 \times 10^8 \text{ m/s}$ . The speed of light in the denser medium is:

- (A)  $2.12 \times 10^8 \text{ m/s}$  (B)  $5 \times 10^7 \text{ m/s}$  (C)  $\sqrt{2} \times 10^8 \text{ m/s}$  (D)  $3.12 \times 10^7 \text{ m/s}$

**Q12** Gravitation[Step-by-step solution > prepwiser.in/questions/jgwftseUHG](https://www.prepwiser.in/questions/jgwftseUHG)

The radii of two planets 'A' and 'B' are 'R' and '4R' and their densities are  $\rho$  and  $\rho/3$  respectively. The ratio of acceleration due to gravity at their surfaces ( $g_A : g_B$ ) will be:

- (A) 3 : 16 (B) 4 : 3 (C) 1 : 16 (D) 3 : 4

**Q13** Thermodynamics[Step-by-step solution > prepwiser.in/questions/ilqe4I-Ehk](https://www.prepwiser.in/questions/ilqe4I-Ehk)

1kg of water at  $100^\circ\text{C}$  is converted into steam at  $100^\circ\text{C}$  by boiling at atmospheric pressure. The volume of water changes from  $1.00 \times 10^{-3} \text{ m}^3$  as a liquid to  $1.671 \text{ m}^3$  as steam. The change in internal energy of the system during the process will be

(Given latent heat of vaporisation =  $2257 \text{ kJ/kg}$ , Atmospheric pressure =  $1 \times 10^5 \text{ Pa}$ )

- (A) + 2090 kJ (B) - 2426 kJ (C) + 2476 kJ (D) - 2090 kJ

**Q14** Thermometry & Calorimetry[Step-by-step solution](https://www.prepwiser.in/questions/ovHbZarBsD) > prepwiser.in/questions/ovHbZarBsD

On a temperature scale 'X', the boiling point of water is  $65^{\circ}\text{X}$  and the freezing point is  $-15^{\circ}\text{X}$ . Assume that the X scale is linear. The equivalent temperature corresponding to  $-95^{\circ}\text{X}$  on the Fahrenheit scale would be:

- (A)  $-148^{\circ}\text{F}$  (B)  $-48^{\circ}\text{F}$  (C)  $-63^{\circ}\text{F}$  (D)  $-112^{\circ}\text{F}$

**Q15** Kinetic Theory of Gases[Step-by-step solution](https://www.prepwiser.in/questions/pSIWjTKhAe) > prepwiser.in/questions/pSIWjTKhAe

Three vessels of equal volume contain gases at the same temperature and pressure. The first vessel contains neon (monoatomic), the second contains chlorine (diatomic) and third contains uranium hexafluoride (polyatomic). Arrange these on the basis of their root mean square speed ( $v_{\text{rms}}$ ) and choose the correct answer from the options given below:

- (A)  $v_{\text{rms}}(\text{mono}) = v_{\text{rms}}(\text{dia}) = v_{\text{rms}}(\text{poly})$  (B)  $v_{\text{rms}}(\text{mono}) > v_{\text{rms}}(\text{dia}) > v_{\text{rms}}(\text{poly})$   
(C)  $v_{\text{rms}}(\text{dia}) < v_{\text{rms}}(\text{poly}) < v_{\text{rms}}(\text{mono})$  (D)  $v_{\text{rms}}(\text{mono}) < v_{\text{rms}}(\text{dia}) < v_{\text{rms}}(\text{poly})$

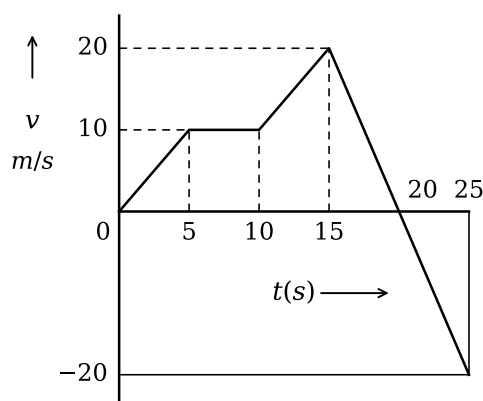
**Q16** Magnetism & Matter[Step-by-step solution](https://www.prepwiser.in/questions/2LPw4bg-oi) > prepwiser.in/questions/2LPw4bg-oi

The free space inside a current carrying toroid is filled with a material of susceptibility  $2 \times 10^{-2}$ . The percentage increase in the value of magnetic field inside the toroid will be

- (A) 0.1% (B) 1% (C) 2% (D) 0.2%

**Q17** Rectilinear Motion[Step-by-step solution](https://www.prepwiser.in/questions/euXMuOratW) > prepwiser.in/questions/euXMuOratW

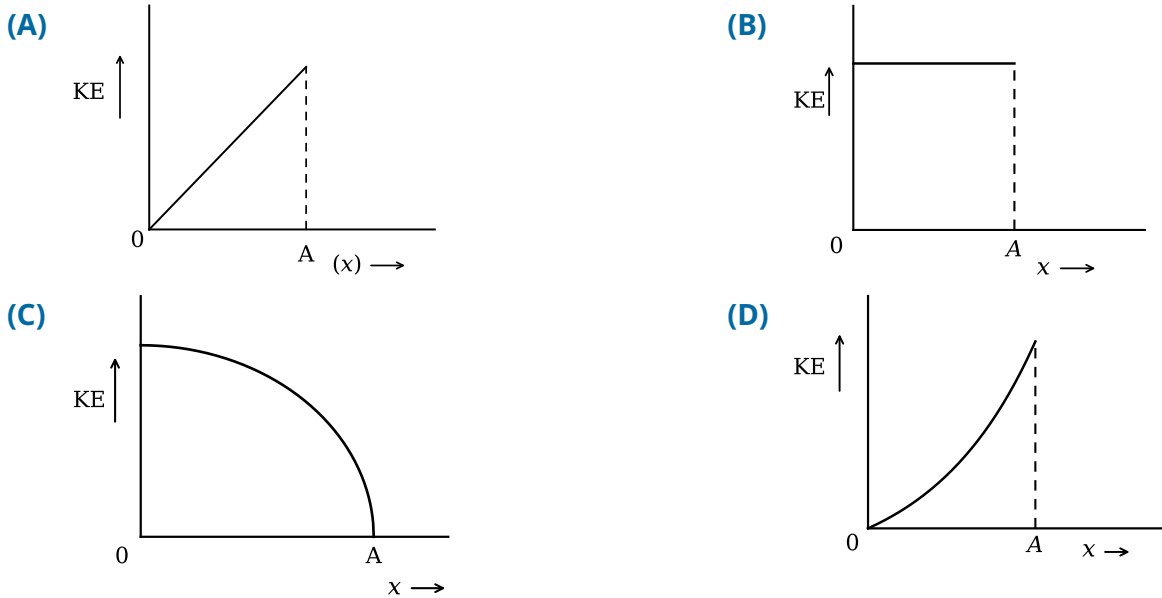
From the  $v - t$  graph shown, the ratio of distance to displacement in 25s of motion is:



- (A) 1 (B)  $\frac{3}{5}$  (C)  $\frac{1}{2}$  (D)  $\frac{5}{3}$

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The variation of kinetic energy (KE) of a particle executing simple harmonic motion with the displacement ( $x$ ) starting from mean position to extreme position (A) is given by



Given below are two statements:

Statements I : Astronomical unit (Au), Parsec (Pc) and Light year (ly) are units for measuring astronomical distances.

Statements II:  $\text{Au} < \text{Parsec}(\text{Pc}) < \text{ly}$

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

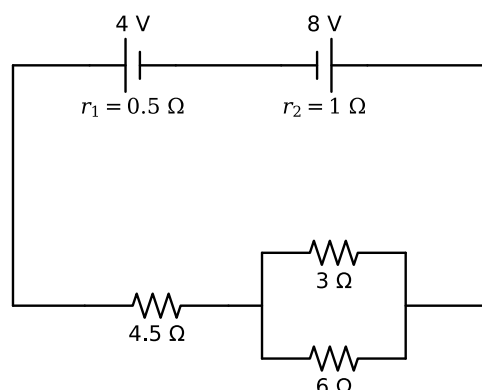
- (A) Both Statements I and Statements II are incorrect.
- (B) Both Statements I and Statements II are correct,
- (C) Statements I is incorrect but Statements II is correct.
- (D) Statements I is correct but Statements II is incorrect.

## Physics Section B · Numerical value

Q20 to Q29

In the circuit diagram shown in figure given below, the current flowing through resistance  $3\Omega$  is  $\frac{x}{3}A$ .

The value of  $x$  is \_\_\_\_\_



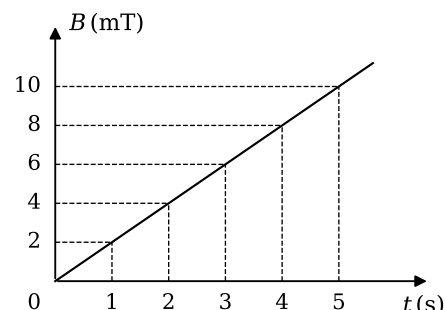
**Q21** Atomic Physics **NUMERICAL**[Step-by-step solution](https://www.prepwiser.in/questions/Dg1mDluihY)

A monochromatic light is incident on a hydrogen sample in ground state. Hydrogen atoms absorb a fraction of light and subsequently emit radiation of six different wavelengths. The frequency of incident light is  $x \times 10^{15} \text{ Hz}$ . The value of  $x$  is \_\_\_\_\_.

(Given  $h = 4.25 \times 10^{-15} \text{ eVs}$ )

**Q22** Electromagnetic Induction **NUMERICAL**[Step-by-step solution](https://www.prepwiser.in/questions/Z4IuahFU1m)

The magnetic field  $B$  crossing normally a square metallic plate of area  $4 \text{ m}^2$  is changing with time as shown in figure. The magnitude of induced emf in the plate during  $t = 2 \text{ s}$  to  $t = 4 \text{ s}$ , is \_\_\_\_\_  $\text{mV}$ .

**Q23** Electrostatics I: Charges, Field & Gauss's Law **NUMERICAL**[Step-by-step solution](https://www.prepwiser.in/questions/dw7ipDv4RI)

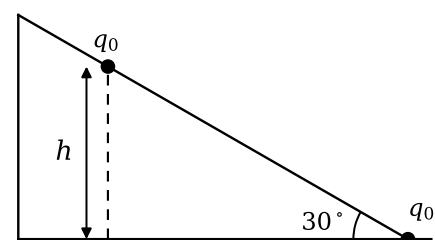
As shown in the figure, a configuration of two equal point charges ( $q_0 = +2\mu\text{C}$ ) is placed on an inclined plane. Mass of each point charge is  $20 \text{ g}$ . Assume that there is no friction between charge and plane. For the system of two point charges to be in equilibrium (at rest) the height  $h = x \times 10^{-3} \text{ m}$ .

The value of  $x$  is \_\_\_\_\_.

(Take

$$\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ Nm}^2\text{C}^{-2}, g = 10 \text{ ms}^{-2}$$

)

**Q24** Ray Optics **NUMERICAL**[Step-by-step solution](https://www.prepwiser.in/questions/hhbJioSbGs)

The radius of curvature of each surface of a convex lens having refractive index  $1.8$  is  $20 \text{ cm}$ . The lens is now immersed in a liquid of refractive index  $1.5$ . The ratio of power of lens in air to its power in the liquid will be  $x : 1$ . The value of  $x$  is \_\_\_\_\_.

**Q25** Projectile Motion & Relative Motion **NUMERICAL**[Step-by-step solution](https://www.prepwiser.in/questions/iAgWvN55b4)

A projectile fired at  $30^\circ$  to the ground is observed to be at same height at time  $3 \text{ s}$  and  $5 \text{ s}$  after projection, during its flight. The speed of projection of the projectile is \_\_\_\_\_  $\text{ms}^{-1}$ .

(Given  $g = 10 \text{ ms}^{-2}$ )

**Q26** Elasticity **NUMERICAL**[Step-by-step solution](https://www.prepwiser.in/questions/xEPmPJctd)

The length of a wire becomes  $l_1$  and  $l_2$  when  $100 \text{ N}$  and  $120 \text{ N}$  tensions are applied respectively. If  $10l_2 = 11l_1$ , the natural length of wire will be  $\frac{1}{x}l_1$ . Here the value of  $x$  is \_\_\_\_\_.

**Q27** Rotational Motion **NUMERICAL**[Step-by-step solution](https://www.prepwiser.in/questions/7Ks7kpKue7)

A solid sphere of mass  $500 \text{ g}$  and radius  $5 \text{ cm}$  is rotated about one of its diameter with angular speed of  $10 \text{ rad s}^{-1}$ . If the moment of inertia of the sphere about its tangent is  $x \times 10^{-2}$  times its angular momentum about the diameter. Then the value of  $x$  will be \_\_\_\_\_.

The equation of wave is given by

$$Y = 10^{-2} \sin 2\pi(160t - 0.5x + \pi/4)$$

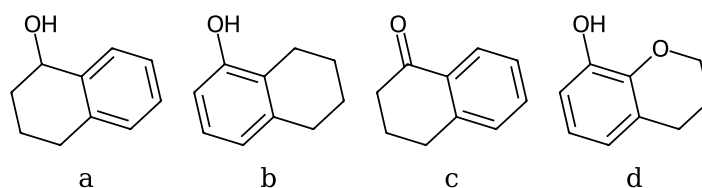
where  $x$  and  $Y$  are in m and  $t$  in s. The speed of the wave is \_\_\_\_\_  $\text{kmh}^{-1}$ .

A force  $\vec{F} = (2 + 3x)\hat{i}$  acts on a particle in the  $x$  direction where  $F$  is in newton and  $x$  is in meter. The work done by this force during a displacement from  $x = 0$  to  $x = 4\text{m}$ , is \_\_\_\_\_ J.

## Chemistry Section A · Multiple choice

Q30 to Q45

Arrange the following compounds in increasing order of rate of aromatic electrophilic substitution reaction



(A) d, b, a, c

(B) b, c, a, d

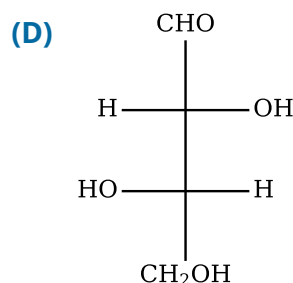
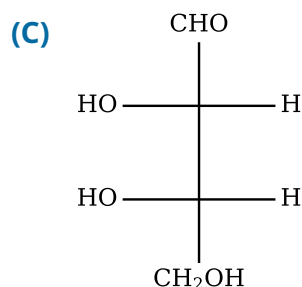
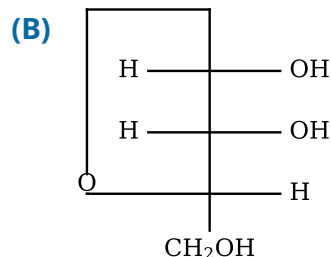
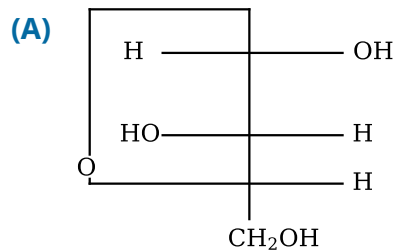
(C) c, a, b, d

(D) d, b, c, a

L-isomer of tetrose X ( $\text{C}_4\text{H}_8\text{O}_4$ ) gives positive Schiff's test and has two chiral carbons. On acetylation, 'X' yields triacetate. 'X' also undergoes following reactions



'X' is



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Match List - I with List - II:

|    | List - I Species       |      | List - II Geometry/Shape |
|----|------------------------|------|--------------------------|
| A. | $\text{H}_3\text{O}^+$ | I.   | Tetrahedral              |
| B. | Acetylide anion        | II.  | Linear                   |
| C. | $\text{NH}_4^+$        | III. | Pyramidal                |
| D. | $\text{ClO}_2^-$       | IV.  | Bent                     |

Choose the correct answer from the options given below:

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

The complex that dissolves in water is:

- (A)  $\text{Fe}_4[\text{Fe}(\text{CN})_6]_3$       (B)  $(\text{NH}_4)_3[\text{As}(\text{Mo}_3\text{O}_{10})_4]$   
 (C)  $\text{K}_3[\text{Co}(\text{NO}_2)_6]$       (D)  $[\text{Fe}_3(\text{OH})_2(\text{OAc})_6]\text{Cl}$

The set which does not have ambidentate ligand(s) is:

- (A)  $\text{C}_2\text{O}_4^{2-}$ ,  $\text{NO}_2^-$ ,  $\text{NCS}^-$       (B)  $\text{C}_2\text{O}_4^{2-}$ , ethylene diammine,  $\text{H}_2\text{O}$   
 (C)  $\text{NO}_2^-$ ,  $\text{C}_2\text{O}_4^{2-}$ ,  $\text{EDTA}^{4-}$       (D)  $\text{EDTA}^{4-}$ ,  $\text{NCS}^-$ ,  $\text{C}_2\text{O}_4^{2-}$

Which of the following complex has a possibility to exist as meridional isomer?

- (A)  $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$       (B)  $[\text{Co}(\text{en})_2\text{Cl}_2]$   
 (C)  $[\text{Co}(\text{en})_3]$       (D)  $[\text{Co}(\text{NH}_3)_3(\text{NO}_2)_3]$

Given below are two statements:

Statement-I : Methane and steam passed over a heated Ni catalyst produces hydrogen gas.

Statement-II : Sodium nitrite reacts with  $\text{NH}_4\text{Cl}$  to give  $\text{H}_2\text{O}$ ,  $\text{N}_2$  and  $\text{NaCl}$ .

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

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

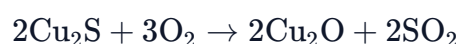
25mL of silver nitrate solution (1M) is added dropwise to 25mL of potassium iodide (1.05M) solution. The ion(s) present in very small quantity in the solution is/are:

- (A)  $\text{I}^-$  only      (B)  $\text{K}^+$  only      (C)  $\text{Ag}^+$  and  $\text{I}^-$  both      (D)  $\text{NO}_3^-$  only

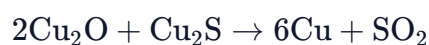
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In the extraction process of copper, the product obtained after carrying out the reactions

(i)



(ii)



is called

- (A) Copper matte      (B) Blister copper      (C) Reduced copper      (D) Copper scrap

For compound having the formula  $\text{GaAlCl}_4$ , the correct option from the following is:

- (A) Cl forms bond with both Al and Ga in  $\text{GaAlCl}_4$   
 (B) Oxidation state of Ga in the salt  $\text{GaAlCl}_4$  is +3.  
 (C) Ga is coordinated with Cl in  $\text{GaAlCl}_4$   
 (D) Ga is more electronegative than Al and is present as a cationic part of the salt  $\text{GaAlCl}_4$

For elements B, C, N, Li, Be, O and F, the correct order of first ionization enthalpy is

- (A)  $\text{Li} < \text{Be} < \text{B} < \text{C} < \text{O} < \text{N} < \text{F}$       (B)  $\text{B} > \text{Li} > \text{Be} > \text{C} > \text{N} > \text{O} > \text{F}$   
 (C)  $\text{Li} < \text{Be} < \text{B} < \text{C} < \text{N} < \text{O} < \text{F}$       (D)  $\text{Li} < \text{B} < \text{Be} < \text{C} < \text{O} < \text{N} < \text{F}$

The polymer X - consists of linear molecules and is closely packed. It is prepared in the presence of triethylaluminium and titanium tetrachloride under low pressure. The polymer X is-

- (A) High density polythene      (B) Polytetrafluoroethane  
 (C) Low density polythene      (D) Polyacrylonitrile

Match List-I with List-II:

|    | List - I |      | List - II                  |
|----|----------|------|----------------------------|
| A. | K        | I.   | Thermonuclear reactions    |
| B. | KCl      | II.  | Fertilizer                 |
| C. | KOH      | III. | Sodium potassium pump      |
| D. | Li       | IV.  | Absorbent of $\text{CO}_2$ |

Choose the correct answer from the options given below:

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

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

Assertion A : In the photoelectric effect, the electrons are ejected from the metal surface as soon as the beam of light of frequency greater than threshold frequency strikes the surface.

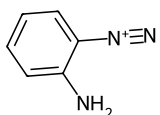
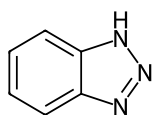
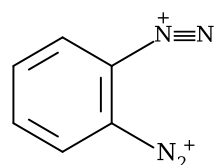
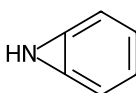
Reason R : When the photon of any energy strikes an electron in the atom, transfer of energy from the photon to the electron takes place.

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

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



'X' is

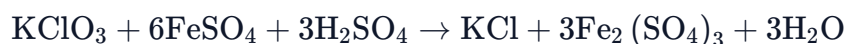
- (A)  (B)  (C)  (D) 

When a solution of mixture having two inorganic salts was treated with freshly prepared ferrous sulphate in acidic medium, a dark brown ring was formed whereas on treatment with neutral  $\text{FeCl}_3$ , it gave deep red colour which disappeared on boiling and a brown red ppt was formed. The mixture contains:

- (A)  $\text{SO}_3^{2-}$  &  $\text{C}_2\text{O}_4^{2-}$  (B)  $\text{CH}_3\text{COO}^-$  &  $\text{NO}_3^-$  (C)  $\text{C}_2\text{O}_4^{2-}$  &  $\text{NO}_3^-$  (D)  $\text{SO}_3^{2-}$  &  $\text{CH}_3\text{COO}^-$

## Chemistry Section B · Numerical value

Q46 to Q53



The above reaction was studied at 300K by monitoring the concentration of  $\text{FeSO}_4$  in which initial concentration was 10M and after half an hour became 8.8 M. The rate of production of  $\text{Fe}_2(\text{SO}_4)_3$  is  $\text{_____} \times 10^{-6} \text{molLs}^{-1}$  (Nearest integer)

The ratio of spin-only magnetic moment values

$$\mu_{\text{eff}} [\text{Cr}(\text{CN})_6]^{3-} / \mu_{\text{eff}} [\text{Cr}(\text{H}_2\text{O})_6]^{3+}$$

is \_\_\_\_\_.

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**Q48** Electrochemistry **NUMERICAL**[Step-by-step solution](#) > [prepwiser.in/questions/Ca5nbeV\\_Qb](#)

In an electrochemical reaction of lead, at standard temperature, if  $E^0(\text{Pb}^{2+}/\text{Pb}) = m$  Volt and  $E^0(\text{Pb}^{4+}/\text{Pb}) = n$  Volt, then the value of  $E^0(\text{Pb}^{2+}/\text{Pb}^{4+})$  is given by  $m - xn$ . The value of  $x$  is \_\_\_\_\_. (Nearest integer)

**Q49** Solid State **NUMERICAL**[Step-by-step solution](#) > [prepwiser.in/questions/6-pME\\_tca2](#)

An atomic substance A of molar mass  $12\text{g mol}^{-1}$  has a cubic crystal structure with edge length of  $300\text{pm}$ . The no. of atoms present in one unit cell of A is \_\_\_\_\_. (Nearest integer)  
Given the density of A is  $3.0\text{g mL}^{-1}$  and  $N_A = 6.02 \times 10^{23}\text{mol}^{-1}$

**Q50** Solutions & Colligative Properties **NUMERICAL**[Step-by-step solution](#) > [prepwiser.in/questions/Ez\\_k\\_81VRv](#)

$0.004\text{ M K}_2\text{SO}_4$  solution is isotonic with  $0.01\text{ M}$  glucose solution. Percentage dissociation of  $\text{K}_2\text{SO}_4$  is \_\_\_\_\_. (Nearest integer)

**Q51** Mole Concept & Stoichiometry **NUMERICAL**[Step-by-step solution](#) > [prepwiser.in/questions/CP2GgppJK5](#)

A solution of sugar is obtained by mixing  $200\text{g}$  of its  $25\%$  solution and  $500\text{g}$  of its  $40\%$  solution (both by mass). The mass percentage of the resulting sugar solution is \_\_\_\_\_. (Nearest integer)

**Q52** Chemical Thermodynamics **NUMERICAL**[Step-by-step solution](#) > [prepwiser.in/questions/ErFhUGFynS](#)

Solid fuel used in rocket is a mixture of  $\text{Fe}_2\text{O}_3$  and  $\text{Al}$  (in ratio  $1 : 2$ ). The heat evolved (kJ) per gram of the mixture is \_\_\_\_\_. (Nearest integer)

Given:

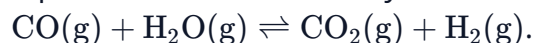
$$\Delta H_f^\theta(\text{Al}_2\text{O}_3) = -1700\text{kJ mol}^{-1}$$

$$\Delta H_f^\theta(\text{Fe}_2\text{O}_3) = -840\text{kJ mol}^{-1}$$

Molar mass of Fe, Al and O are  $56$ ,  $27$  and  $16\text{ g mol}^{-1}$  respectively.

**Q53** Chemical Equilibrium **NUMERICAL**[Step-by-step solution](#) > [prepwiser.in/questions/ccKL4ZLRsw](#)

A mixture of  $1$  mole of  $\text{H}_2\text{O}$  and  $1$  mole of  $\text{CO}$  is taken in a  $10$  litre container and heated to  $725\text{K}$ . At equilibrium  $40\%$  of water by mass reacts with carbon monoxide according to the equation:



The equilibrium constant  $K_c \times 10^2$  for the reaction is \_\_\_\_\_. (Nearest integer)

**Mathematics Section A · Multiple choice**

Q54 to Q72

**Q54** Three Dimensional Geometry[Step-by-step solution](#) > [prepwiser.in/questions/asD69mxjnr](#)

Let  $(\alpha, \beta, \gamma)$  be the image of the point  $P(2, 3, 5)$  in the plane  $2x + y - 3z = 6$ . Then  $\alpha + \beta + \gamma$  is equal to:

**(A)** 10**(B)** 9**(C)** 5**(D)** 12**Q55** Three Dimensional Geometry[Step-by-step solution](#) > [prepwiser.in/questions/YJctHNh4aK](#)

If equation of the plane that contains the point  $(-2, 3, 5)$  and is perpendicular to each of the planes  $2x + 4y + 5z = 8$  and  $3x - 2y + 3z = 5$  is  $\alpha x + \beta y + \gamma z + 97 = 0$  then  $\alpha + \beta + \gamma =$

**(A)** 15**(B)** 16**(C)** 17**(D)** 18

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Let  $f : [2, 4] \rightarrow \mathbb{R}$  be a differentiable function such that

$$(x \log_e x) f'(x) + (\log_e x) f(x) + f(x) \geq 1, x \in [2, 4]$$

with  $f(2) = \frac{1}{2}$  and  $f(4) = \frac{1}{4}$ .

Consider the following two statements:

(A):  $f(x) \leq 1$ , for all  $x \in [2, 4]$

(B):  $f(x) \geq \frac{1}{8}$ , for all  $x \in [2, 4]$

Then,

(A) Neither statement (A) nor statement (B) is true

(B) Only statement (A) is true

(C) Only statement (B) is true

(D) Both the statements (A) and (B) are true

Let  $w_1$  be the point obtained by the rotation of  $z_1 = 5 + 4i$  about the origin through a right angle in the anticlockwise direction, and  $w_2$  be the point obtained by the rotation of  $z_2 = 3 + 5i$  about the origin through a right angle in the clockwise direction. Then the principal argument of  $w_1 - w_2$  is equal to:

(A)  $-\pi + \tan^{-1} \frac{8}{9}$

(B)  $-\pi + \tan^{-1} \frac{33}{5}$

(C)  $\pi - \tan^{-1} \frac{8}{9}$

(D)  $\pi - \tan^{-1} \frac{33}{5}$

The value of the integral

$$\int_{-\log_e 2}^{\log_e 2} e^x \left( \log_e \left( e^x + \sqrt{1 + e^{2x}} \right) \right) dx$$

is equal to:

(A)  $\log_e \left( \frac{(2 + \sqrt{5})^2}{\sqrt{1 + \sqrt{5}}} \right) + \frac{\sqrt{5}}{2}$

(B)  $\log_e \left( \frac{\sqrt{2}(2 + \sqrt{5})^2}{\sqrt{1 + \sqrt{5}}} \right) - \frac{\sqrt{5}}{2}$

(C)  $\log_e \left( \frac{2(2 + \sqrt{5})}{\sqrt{1 + \sqrt{5}}} \right) - \frac{\sqrt{5}}{2}$

(D)  $\log_e \left( \frac{\sqrt{2}(3 - \sqrt{5})^2}{\sqrt{1 + \sqrt{5}}} \right) + \frac{\sqrt{5}}{2}$

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

$$(1 - x^2 y^2) dx = y dx + x dy.$$

If the line  $x = 1$  intersects the curve  $y = y(x)$  at  $y = 2$  and the line  $x = 2$  intersects the curve  $y = y(x)$  at  $y = \alpha$ , then a value of  $\alpha$  is:

(A)  $\frac{1 + 3e^2}{2(3e^2 - 1)}$

(B)  $\frac{3e^2}{2(3e^2 - 1)}$

(C)  $\frac{1 - 3e^2}{2(3e^2 + 1)}$

(D)  $\frac{3e^2}{2(3e^2 + 1)}$

**Q60** Ellipse[Step-by-step solution](https://www.prepwiser.in/questions/5bY0EyckHq)

Consider ellipses  $E_k : kx^2 + ky^2 = 1, k = 1, 2, \dots, 20$ . Let  $C_k$  be the circle which touches the four chords joining the end points (one on minor axis and another on major axis) of the ellipse  $E_k$ . If  $r_k$  is the radius of the circle  $C_k$ , then the value of  $\sum_{k=1}^{20} \frac{1}{r_k^2}$  is:

- (A) 2870 (B) 3210 (C) 3320 (D) 3080

**Q61** Straight Lines[Step-by-step solution](https://www.prepwiser.in/questions/8FsI1O0i6t)

Let  $R$  be a rectangle given by the lines  $x = 0, x = 2, y = 0$  and  $y = 5$ . Let  $A(\alpha, 0)$  and  $B(0, \beta), \alpha \in [0, 2]$  and  $\beta \in [0, 5]$ , be such that the line segment  $AB$  divides the area of the rectangle  $R$  in the ratio  $4 : 1$ . Then, the mid-point of  $AB$  lies on a:

- (A) hyperbola (B) straight line (C) parabola (D) circle

**Q62** Continuity & Differentiability[Step-by-step solution](https://www.prepwiser.in/questions/SUqj2ivbF7)

Let  $f(x) = [x^2 - x] + |-x + [x]|$ , where  $x \in \mathbb{R}$  and  $[t]$  denotes the greatest integer less than or equal to  $t$ . Then,  $f$  is:

- (A) continuous at  $x = 0$ , but not continuous at  $x = 1$   
 (B) continuous at  $x = 0$  and  $x = 1$   
 (C) continuous at  $x = 1$ , but not continuous at  $x = 0$   
 (D) not continuous at  $x = 0$  and  $x = 1$

**Q63** Matrices[Step-by-step solution](https://www.prepwiser.in/questions/PLY6YDmLa6)

Let  $A$  be a  $2 \times 2$  matrix with real entries such that  $A' = \alpha A + I$ , where  $\alpha \in \mathbb{R} - \{-1, 1\}$ . If  $\det(A^2 - A) = 4$ , then the sum of all possible values of  $\alpha$  is equal to:

- (A) 2 (B)  $\frac{3}{2}$  (C) 0 (D)  $\frac{5}{2}$

**Q64** Permutations & Combinations[Step-by-step solution](https://www.prepwiser.in/questions/-FpLzw3RPY)

The number of triplets  $(x, y, z)$ , where  $x, y, z$  are distinct non negative integers satisfying  $x + y + z = 15$ , is:

- (A) 136 (B) 80 (C) 92 (D) 114

**Q65** Probability: Basic[Step-by-step solution](https://www.prepwiser.in/questions/T6rKULewW5)

Let

$$S = \{M = [a_{ij}], a_{ij} \in \{0, 1, 2\}, 1 \leq i, j \leq 2\}$$

be a sample space and  $A = \{M \in S : M \text{ is invertible}\}$  be an event. Then  $P(A)$  is equal to:

- (A)  $\frac{47}{81}$  (B)  $\frac{49}{81}$  (C)  $\frac{50}{81}$  (D)  $\frac{16}{27}$

**Q66** Sequences & Series[Step-by-step solution](https://www.prepwiser.in/questions/hINOA9Tofx)

Let  $x_1, x_2, \dots, x_{100}$  be in an arithmetic progression, with  $x_1 = 2$  and their mean equal to 200. If  $y_i = i(x_i - i), 1 \leq i \leq 100$ , then the mean of  $y_1, y_2, \dots, y_{100}$  is:

- (A) 10051.50 (B) 10049.50 (C) 10100 (D) 10101.50

**Q67** Sets[Step-by-step solution](https://www.prepwisar.in/questions/oDKvgeJ7hQ) › prepwisar.in/questions/oDKvgeJ7hQ

An organization awarded 48 medals in event 'A', 25 in event 'B' and 18 in event 'C'. If these medals went to total 60 men and only five men got medals in all the three events, then, how many received medals in exactly two of three events?

- (A) 10 (B) 15 (C) 21 (D) 9

**Q68** Statistics[Step-by-step solution](https://www.prepwisar.in/questions/7TH9EhMhAk) › prepwisar.in/questions/7TH9EhMhAk

Let sets A and B have 5 elements each. Let the mean of the elements in sets A and B be 5 and 8 respectively and the variance of the elements in sets A and B be 12 and 20 respectively. A new set C of 10 elements is formed by subtracting 3 from each element of A and adding 2 to each element of B. Then the sum of the mean and variance of the elements of C is \_\_\_\_\_.

- (A) 36 (B) 40 (C) 38 (D) 32

**Q69** Trigonometric Equations[Step-by-step solution](https://www.prepwisar.in/questions/HjQpDag5Ko) › prepwisar.in/questions/HjQpDag5Ko

The number of elements in the set

$$S = \{\theta \in [0, 2\pi] : 3 \cos^4 \theta - 5 \cos^2 \theta - 2 \sin^6 \theta + 2 = 0\}$$

is:

- (A) 9 (B) 8 (C) 12 (D) 10

**Q70** Vectors[Step-by-step solution](https://www.prepwisar.in/questions/U5LpWuZiBg) › prepwisar.in/questions/U5LpWuZiBg

For any vector  $\vec{a} = a_1\hat{i} + a_2\hat{j} + a_3\hat{k}$ , with  $10|a_i| < 1, i = 1, 2, 3$ , consider the following statements:

(A):

$$\max\{|a_1|, |a_2|, |a_3|\} \leq |\vec{a}|$$

(B):

$$|\vec{a}| \leq 3 \max\{|a_1|, |a_2|, |a_3|\}$$

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

**Q71** Vectors[Step-by-step solution](https://www.prepwisar.in/questions/cKiKOVUxnH) › prepwisar.in/questions/cKiKOVUxnH

Let  $\vec{a}$  be a non-zero vector parallel to the line of intersection of the two planes described by  $\hat{i} + \hat{j}, \hat{i} + \hat{k}$  and  $\hat{i} - \hat{j}, \hat{j} - \hat{k}$ . If  $\theta$  is the angle between the vector  $\vec{a}$  and the vector  $\vec{b} = 2\hat{i} - 2\hat{j} + \hat{k}$  and  $\vec{a} \cdot \vec{b} = 6$ , then the ordered pair  $(\theta, |\vec{a} \times \vec{b}|)$  is equal to:

- (A)  $(\frac{\pi}{3}, 3\sqrt{6})$  (B)  $(\frac{\pi}{3}, 6)$  (C)  $(\frac{\pi}{4}, 3\sqrt{6})$  (D)  $(\frac{\pi}{4}, 6)$

**Q72** Area Under Curves[Step-by-step solution](https://www.prepwisar.in/questions/JLD09nXQbx) › prepwisar.in/questions/JLD09nXQbx

Area of the region  $\{(x, y) : x^2 + (y - 2)^2 \leq 4, x^2 \geq 2y\}$  is

- (A)  $2\pi + \frac{16}{3}$  (B)  $\pi - \frac{8}{3}$  (C)  $\pi + \frac{8}{3}$  (D)  $2\pi - \frac{16}{3}$

**Q73** Three Dimensional Geometry **NUMERICAL**

[Step-by-step solution](#) › prepwiser.in/questions/J6moNy9Qur

Let a line  $l$  pass through the origin and be perpendicular to the lines

$$l_1 : \vec{r} = (\hat{i} - 11\hat{j} - 7\hat{k}) + \lambda(\hat{i} + 2\hat{j} + 3\hat{k}), \lambda \in \mathbb{R}$$

and

$$l_2 : \vec{r} = (-\hat{i} + \hat{k}) + \mu(2\hat{i} + 2\hat{j} + \hat{k}), \mu \in \mathbb{R}$$

If  $P$  is the point of intersection of  $l$  and  $l_1$ , and  $Q(\alpha, \beta, \gamma)$  is the foot of perpendicular from  $P$  on  $l_2$ , then  $9(\alpha + \beta + \gamma)$  is equal to \_\_\_\_\_.

**Q74** Binomial Theorem **NUMERICAL**

[Step-by-step solution](#) › prepwiser.in/questions/loPhwGs9Cj

The mean of the coefficients of  $x, x^2, \dots, x^7$  in the binomial expansion of  $(2 + x)^9$  is \_\_\_\_\_.

**Q75** Binomial Theorem **NUMERICAL**

[Step-by-step solution](#) › prepwiser.in/questions/O9AC\_vjkk7

The number of integral terms in the expansion of  $\left(3^{\frac{1}{2}} + 5^{\frac{1}{4}}\right)^{680}$  is equal to \_\_\_\_\_.

**Q76** Definite Integration **NUMERICAL**

[Step-by-step solution](#) › prepwiser.in/questions/W0rED0rFHM

For  $m, n > 0$ , let  $\alpha(m, n) = \int_0^2 t^m (1 + 3t)^n dt$ . If  $11\alpha(10, 6) + 18\alpha(11, 5) = p(14)^6$ , then  $p$  is equal to \_\_\_\_\_.

**Q77** Hyperbola **NUMERICAL**

[Step-by-step solution](#) › prepwiser.in/questions/RJ7TUKMeI4

Let  $H_n : \frac{x^2}{1+n} - \frac{y^2}{3+n} = 1, n \in \mathbb{N}$ . Let  $k$  be the smallest even value of  $n$  such that the eccentricity of  $H_k$  is a rational number. If  $l$  is the length of the latus rectum of  $H_k$ , then  $21l$  is equal to \_\_\_\_\_.

**Q78** Matrices **NUMERICAL**

[Step-by-step solution](#) › prepwiser.in/questions/-h0TKWaOX2

Let

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

, where  $a, c \in \mathbb{R}$ . If  $A^3 = A$  and the positive value of  $a$  belongs to the interval  $(n - 1, n]$ , where  $n \in \mathbb{N}$ , then  $n$  is equal to \_\_\_\_\_.

**Q79** Permutations & Combinations **NUMERICAL**

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

In an examination, 5 students have been allotted their seats as per their roll numbers. The number of ways, in which none of the students sits on the allotted seat, is \_\_\_\_\_.

**Q80** Sequences & Series **NUMERICAL**

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

If  $a$  and  $b$  are the roots of the equation  $x^2 - 7x - 1 = 0$ , then the value of  $\frac{a^{21} + b^{21} + a^{17} + b^{17}}{a^{19} + b^{19}}$  is equal to \_\_\_\_\_.

Let

$$S = 109 + \frac{108}{5} + \frac{107}{5^2} + \dots + \frac{2}{5^{107}} + \frac{1}{5^{108}}$$

. Then the value of  $(16S - (25)^{-54})$  is equal to \_\_\_\_\_.

## Answer key: JEE Main 2023 · 11 Apr · Shift 1

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### Physics

|               |              |               |                 |               |              |                |              |
|---------------|--------------|---------------|-----------------|---------------|--------------|----------------|--------------|
| 1. <b>C</b>   | 2. <b>A</b>  | 3. <b>A</b>   | 4. <b>B</b>     | 5. <b>C</b>   | 6. <b>A</b>  | 7. <b>A</b>    | 8. <b>A</b>  |
| 9. <b>C</b>   | 10. <b>B</b> | 11. <b>A</b>  | 12. <b>D</b>    | 13. <b>A</b>  | 14. <b>A</b> | 15. <b>B</b>   | 16. <b>C</b> |
| 17. <b>D</b>  | 18. <b>C</b> | 19. <b>D</b>  | 20. <b>1</b>    | 21. <b>3</b>  | 22. <b>8</b> | 23. <b>300</b> | 24. <b>4</b> |
| 25. <b>80</b> | 26. <b>2</b> | 27. <b>35</b> | 28. <b>1152</b> | 29. <b>32</b> |              |                |              |

### Chemistry

|                |              |              |              |               |               |              |               |
|----------------|--------------|--------------|--------------|---------------|---------------|--------------|---------------|
| 30. <b>C</b>   | 31. <b>D</b> | 32. <b>B</b> | 33. <b>D</b> | 34. <b>B</b>  | 35. <b>D</b>  | 36. <b>C</b> | 37. <b>C</b>  |
| 38. <b>B</b>   | 39. <b>D</b> | 40. <b>D</b> | 41. <b>A</b> | 42. <b>B</b>  | 43. <b>C</b>  | 44. <b>B</b> | 45. <b>B</b>  |
| 46. <b>333</b> | 47. <b>1</b> | 48. <b>2</b> | 49. <b>4</b> | 50. <b>75</b> | 51. <b>36</b> | 52. <b>4</b> | 53. <b>44</b> |

### Mathematics

|              |               |               |                 |                 |                |               |                |
|--------------|---------------|---------------|-----------------|-----------------|----------------|---------------|----------------|
| 54. <b>A</b> | 55. <b>A</b>  | 56. <b>D</b>  | 57. <b>C</b>    | 58. <b>B</b>    | 59. <b>A</b>   | 60. <b>D</b>  | 61. <b>A</b>   |
| 62. <b>C</b> | 63. <b>D</b>  | 64. <b>D</b>  | 65. <b>C</b>    | 66. <b>B</b>    | 67. <b>C</b>   | 68. <b>C</b>  | 69. <b>A</b>   |
| 70. <b>D</b> | 71. <b>D</b>  | 72. <b>D</b>  | 73. <b>5</b>    | 74. <b>2736</b> | 75. <b>171</b> | 76. <b>32</b> | 77. <b>306</b> |
| 78. <b>2</b> | 79. <b>44</b> | 80. <b>51</b> | 81. <b>2175</b> |                 |                |               |                |

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