

## JEE MAIN 2023 · QUESTION PAPER

# 29 Jan 2023 **Shift 1**

84 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>18</b> Q30 to Q47                        | <b>8</b> Q48 to Q55       |
| ● <b>Mathematics</b> | <b>19</b> Q56 to Q74                        | <b>10</b> Q75 to Q84      |
| <b>In this PDF</b>   | <b>84</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/2023-01-29-morning](https://prepwis.in/pyqs/paper/2023-01-29-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** Nuclear Physics

[Step-by-step solution](#) > [prepwiser.in/questions/AtVn9IOCC-](https://www.prepwiser.in/questions/AtVn9IOCC-)

If a radioactive element having half-life of 30min is undergoing beta decay, the fraction of radioactive element remains undecayed after 90min. will be

- (A)  $\frac{1}{16}$  (B)  $\frac{1}{4}$  (C)  $\frac{1}{8}$  (D)  $\frac{1}{2}$

**Q2** Circular Motion

[Step-by-step solution](#) > [prepwiser.in/questions/M3gakpCdnZ](https://www.prepwiser.in/questions/M3gakpCdnZ)

A car is moving on a horizontal curved road with radius 50 m. The approximate maximum speed of car will be, if friction between tyres and road is 0.34. [take  $g = 10 \text{ ms}^{-2}$ ]

- (A)  $3.4 \text{ ms}^{-1}$  (B)  $13 \text{ ms}^{-1}$  (C)  $22.4 \text{ ms}^{-1}$  (D)  $17 \text{ ms}^{-1}$

**Q3** Current Electricity

[Step-by-step solution](#) > [prepwiser.in/questions/EK4G-CF5M-](https://www.prepwiser.in/questions/EK4G-CF5M-)

Ratio of thermal energy released in two resistors R and 3R connected in parallel in an electric circuit is:

- (A) 1 : 1 (B) 1 : 27 (C) 1 : 3 (D) 3 : 1

**Q4** Dual Nature of Radiation & Matter

[Step-by-step solution](#) > [prepwiser.in/questions/xulJM\\_GEix](https://www.prepwiser.in/questions/xulJM_GEix)

The threshold wavelength for photoelectric emission from a material is  $5500 \text{ \AA}$ . Photoelectrons will be emitted, when this material is illuminated with monochromatic radiation from a

- A. 75 W infra-red lamp  
B. 10 W infra-red lamp  
C. 75 W ultra-violet lamp  
D. 10 W ultra-violet lamp

Choose the correct answer from the options given below:

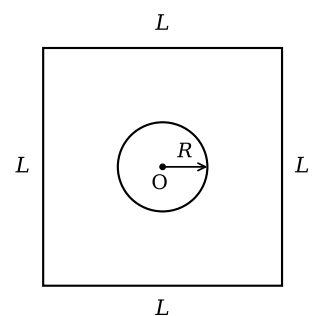
- (A) C only (B) A and D only (C) C and D only (D) B and C only

**Q5** Electromagnetic Induction

[Step-by-step solution](#) > [prepwiser.in/questions/EGAgx9DHR-](https://www.prepwiser.in/questions/EGAgx9DHR-)

Find the mutual inductance in the arrangement, when a small circular loop of wire of radius ' $R$ ' is placed inside a large square loop of wire of side  $L$  ( $L \gg R$ ). The loops are coplanar and their centres coincide:

- (A)  $M = \frac{\sqrt{2}\mu_0 R}{L^2}$  (B)  $M = \frac{2\sqrt{2}\mu_0 R}{L^2}$  (C)  $M = \frac{2\sqrt{2}\mu_0 R^2}{L}$  (D)  $M = \frac{\sqrt{2}\mu_0 R^2}{L}$



Attempt this paper online with instant answer checking > [prepwiser.in/pyqs/paper/2023-01-29-morning](https://www.prepwiser.in/pyqs/paper/2023-01-29-morning)

Which of the following are true?

- A. Speed of light in vacuum is dependent on the direction of propagation.
- B. Speed of light in a medium is independent of the wavelength of light.
- C. The speed of light is independent of the motion of the source.
- D. The speed of light in a medium is independent of intensity.

Choose the correct answer from the options given below:

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

Which one of the following statement is **not** correct in the case of light emitting diodes?

- A. It is a heavily doped p-n junction.
- B. It emits light only when it is forward biased.
- C. It emits light only when it is reverse biased.
- D. The energy of the light emitted is equal to or slightly less than the energy gap of the semiconductor used.

Choose the correct answer from the options given below:

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

In a cuboid of dimension  $2L \times 2L \times L$ , a charge  $q$  is placed at the center of the surface 'S' having area of  $4L^2$ . The flux through the opposite surface to 'S' is given by

- (A)  $\frac{q}{2\epsilon_0}$       (B)  $\frac{q}{3\epsilon_0}$       (C)  $\frac{q}{12\epsilon_0}$       (D)  $\frac{q}{6\epsilon_0}$

Two particles of equal mass ' $m$ ' move in a circle of radius ' $r$ ' under the action of their mutual gravitational attraction. The speed of each particle will be:

- (A)  $\sqrt{\frac{Gm}{4r}}$       (B)  $\sqrt{\frac{Gm}{2r}}$       (C)  $\sqrt{\frac{Gm}{r}}$       (D)  $\sqrt{\frac{4Gm}{r}}$

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

Assertion A: If  $dQ$  and  $dW$  represent the heat supplied to the system and the work done on the system respectively. Then according to the first law of thermodynamics  $dQ = dU - dW$ .

Reason R: First law of thermodynamics is based on law of conservation of energy.

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

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

**Q11** Friction[Step-by-step solution > prepwiser.in/questions/iqm54wjLgr](https://www.prepwiser.in/questions/iqm54wjLgr)

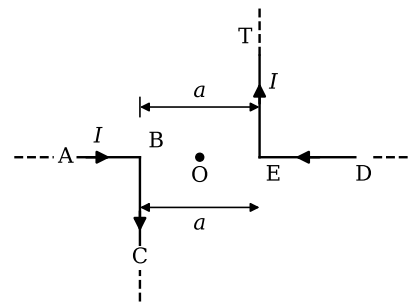
A block of mass  $m$  slides down the plane inclined at angle  $30^\circ$  with an acceleration  $\frac{g}{4}$ . The value of coefficient of kinetic friction will be:

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

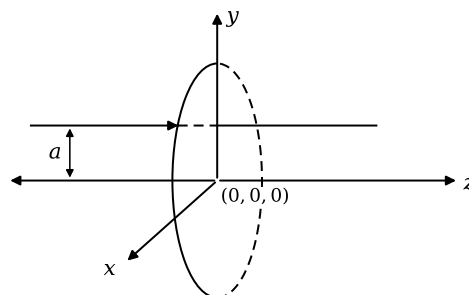
**Q12** Moving Charges & Magnetism[Step-by-step solution > prepwiser.in/questions/qu7dj1Xey](https://www.prepwiser.in/questions/qu7dj1Xey)

The magnitude of magnetic induction at mid point O due to current arrangement as shown in Fig will be

- (A)  $\frac{\mu_0 I}{\pi a}$  (B)  $\frac{\mu_0 I}{4\pi a}$  (C)  $\frac{\mu_0 I}{2\pi a}$  (D) 0

**Q13** Moving Charges & Magnetism[Step-by-step solution > prepwiser.in/questions/xvOXnr0Fzi](https://www.prepwiser.in/questions/xvOXnr0Fzi)

A single current carrying loop of wire carrying current  $I$  flowing in anticlockwise direction seen from +ve  $z$  direction and lying in  $xy$  plane is shown in figure. The plot of  $\hat{j}$  component of magnetic field ( $B_y$ ) at a distance ' $a$ ' (less than radius of the coil) and on  $yz$  plane vs  $z$  coordinate looks like



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

**Q14** Surface Tension[Step-by-step solution > prepwiser.in/questions/kRtkdaL2sg](https://www.prepwiser.in/questions/kRtkdaL2sg)

Surface tension of a soap bubble is  $2.0 \times 10^{-2} \text{ N m}^{-1}$ . Work done to increase the radius of soap bubble from 3.5cm to 7cm will be:

Take  $\left[\pi = \frac{22}{7}\right]$

- (A)  $18.48 \times 10^{-4} \text{ J}$  (B)  $5.76 \times 10^{-4} \text{ J}$  (C)  $0.72 \times 10^{-4} \text{ J}$  (D)  $9.24 \times 10^{-4} \text{ J}$

Attempt this paper online with instant answer checking > [prepwiser.in/pyqs/paper/2023-01-29-morning](https://www.prepwiser.in/pyqs/paper/2023-01-29-morning)

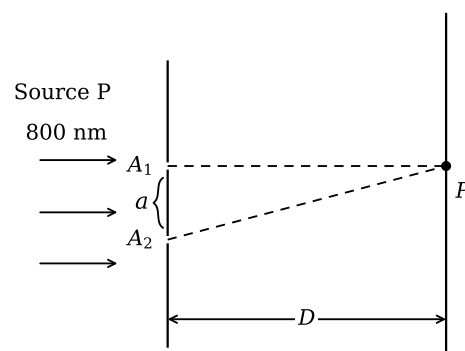
A bicycle tyre is filled with air having pressure of 270kPa at 27°C. The approximate pressure of the air in the tyre when the temperature increases to 36°C is

- (A) 262 kPa (B) 360 kPa (C) 270 kPa (D) 278 kPa

In a Young's double slit experiment, two slits are illuminated with a light of wavelength 800nm. The line joining  $A_1P$  is perpendicular to  $A_1A_2$  as shown in the figure. If the first minimum is detected at  $P$ , the value of slits separation 'a' will be:

The distance of screen from slits  $D = 5$  cm

- (A) 0.2 mm (B) 0.5 mm (C) 0.4 mm (D) 0.1 mm



A person observes two moving trains, 'A' reaching the station and 'B' leaving the station with equal speed of 30m/s. If both trains emit sounds with frequency 300Hz, (Speed of sound: 330m/s) approximate difference of frequencies heard by the person will be:

- (A) 10 Hz (B) 55 Hz (C) 80 Hz (D) 33 Hz

A stone is projected at angle 30° to the horizontal. The ratio of kinetic energy of the stone at point of projection to its kinetic energy at the highest point of flight will be -

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

Match List I with List II:

|    | List I (Physical Quantity) |      | List II (Dimensional Formula) |
|----|----------------------------|------|-------------------------------|
| A. | Pressure gradient          | I.   | $[M^0L^2T^{-2}]$              |
| B. | Energy density             | II.  | $[M^1L^{-1}T^{-2}]$           |
| C. | Electric Field             | III. | $[M^1L^{-2}T^{-2}]$           |
| D. | Latent heat                | IV.  | $[M^1L^1T^{-3}A^{-1}]$        |

Choose the correct answer from the options given below:

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

**Q20** Nuclear Physics **NUMERICAL**

[Step-by-step solution](#) › [prepwiser.in/questions/sBPtL8Pev6](https://www.prepwiser.in/questions/sBPtL8Pev6)

A radioactive element  ${}^{242}_{92}\text{X}$  emits two  $\alpha$ -particles, one electron and two positrons. The product nucleus is represented by  ${}^{234}_{\text{P}}\text{Y}$ . The value of P is \_\_\_\_\_.

**Q21** Current Electricity **NUMERICAL**

[Step-by-step solution](#) › [prepwiser.in/questions/hj0rGel3Qt](https://www.prepwiser.in/questions/hj0rGel3Qt)

In a metre bridge experiment the balance point is obtained if the gaps are closed by  $2\Omega$  and  $3\Omega$ . A shunt of  $X\Omega$  is added to  $3\Omega$  resistor to shift the balancing point by 22.5 cm. The value of X is \_\_\_\_\_.

**Q22** Electromagnetic Induction **NUMERICAL**

[Step-by-step solution](#) › [prepwiser.in/questions/OT9RUZqJf](https://www.prepwiser.in/questions/OT9RUZqJf)

A certain elastic conducting material is stretched into a circular loop. It is placed with its plane perpendicular to a uniform magnetic field  $B = 0.8\text{ T}$ . When released the radius of the loop starts shrinking at a constant rate of  $2\text{ cms}^{-1}$ . The induced emf in the loop at an instant when the radius of the loop is 10 cm will be \_\_\_\_\_ mV.

**Q23** Electrostatics I: Charges, Field & Gauss's Law **NUMERICAL**

[Step-by-step solution](#) › [prepwiser.in/questions/GHT2g4qktS](https://www.prepwiser.in/questions/GHT2g4qktS)

A point charge  $q_1 = 4q_0$  is placed at origin. Another point charge  $q_2 = -q_0$  is placed at  $x = 12\text{ cm}$ . Charge of proton is  $q_0$ . The proton is placed on  $x$  axis so that the electrostatic force on the proton is zero. In this situation, the position of the proton from the origin is \_\_\_\_\_ cm.

**Q24** Rectilinear Motion **NUMERICAL**

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

A tennis ball is dropped on to the floor from a height of 9.8 m. It rebounds to a height 5.0 m. Ball comes in contact with the floor for 0.2s. The average acceleration during contact is \_\_\_\_\_  $\text{ms}^{-2}$ . (Given  $g = 10\text{ ms}^{-2}$ )

**Q25** Heat Transfer **NUMERICAL**

[Step-by-step solution](#) › [prepwiser.in/questions/NBkinBm9WE](https://www.prepwiser.in/questions/NBkinBm9WE)

A body cools from  $60^\circ\text{C}$  to  $40^\circ\text{C}$  in 6 minutes. If, temperature of surroundings is  $10^\circ\text{C}$ . Then, after the next 6 minutes, its temperature will be \_\_\_\_\_  $^\circ\text{C}$ .

**Q26** Rotational Motion **NUMERICAL**

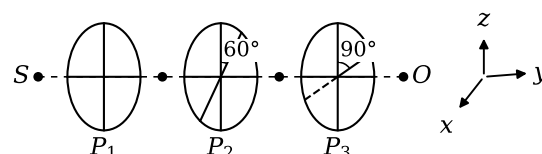
[Step-by-step solution](#) › [prepwiser.in/questions/6Dswsszq4h](https://www.prepwiser.in/questions/6Dswsszq4h)

A solid sphere of mass 2 kg is making pure rolling on a horizontal surface with kinetic energy 2240 J. The velocity of centre of mass of the sphere will be \_\_\_\_\_  $\text{ms}^{-1}$ .

**Q27** Wave Optics **NUMERICAL**

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

As shown in the figure, three identical polaroids  $P_1$ ,  $P_2$  and  $P_3$  are placed one after another. The pass axis of  $P_2$  and  $P_3$  are inclined at angle of  $60^\circ$  and  $90^\circ$  with respect to axis of  $P_1$ . The source S has an intensity of  $256\frac{\text{W}}{\text{m}^2}$ . The intensity of light at point O is \_\_\_\_\_  $\frac{\text{W}}{\text{m}^2}$ .



**Q28** Simple Harmonic Motion **NUMERICAL**

[Step-by-step solution](#) › [prepwiser.in/questions/oNISWk95Ck](https://www.prepwiser.in/questions/oNISWk95Ck)

Two simple harmonic waves having equal amplitudes of 8 cm and equal frequency of 10 Hz are moving along the same direction. The resultant amplitude is also 8 cm. The phase difference between the individual waves is \_\_\_\_\_ degree.

A 0.4 kg mass takes 8s to reach ground when dropped from a certain height 'P' above surface of earth. The loss of potential energy in the last second of fall is \_\_\_\_\_ J.

(Take  $g = 10 \text{ m/s}^2$ )

## Chemistry Section A · Multiple choice

Q30 to Q47

The increasing order of  $pK_a$  for the following phenols is

- (A) 2, 4 - Dinitrophenol
- (B) 4 - Nitrophenol
- (C) 2, 4, 5 - Trimethylphenol
- (D) Phenol
- (E) 3-Chlorophenol

Choose the correct answer from the option given below:

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

Number of cyclic tripeptides formed with 2 amino acids A and B is:

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

The magnetic behaviour of  $\text{Li}_2\text{O}$ ,  $\text{Na}_2\text{O}_2$  and  $\text{KO}_2$ , respectively, are:

- (A) paramagnetic, paramagnetic and diamagnetic
- (B) paramagnetic, diamagnetic and paramagnetic
- (C) diamagnetic, paramagnetic and diamagnetic
- (D) diamagnetic, diamagnetic and paramagnetic

The bond dissociation energy is highest for

- (A)  $\text{Cl}_2$       (B)  $\text{I}_2$       (C)  $\text{Br}_2$       (D)  $\text{F}_2$

Match List I with List II.

|     | List I                     |       | List II         |
|-----|----------------------------|-------|-----------------|
|     | Antimicrobials             |       | Names           |
| (A) | Narrow Spectrum Antibiotic | (I)   | Furacin         |
| (B) | Antiseptic                 | (II)  | Sulphur dioxide |
| (C) | Disinfectants              | (III) | Penicillin G    |
| (D) | Broad spectrum antibiotic  | (IV)  | Chloramphenicol |

Choose the correct answer from the options given below:

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

Chiral complex from the following is:

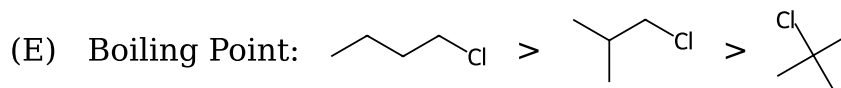
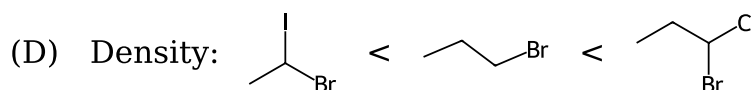
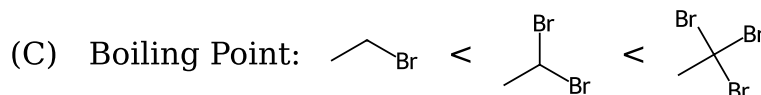
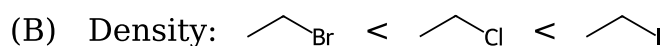
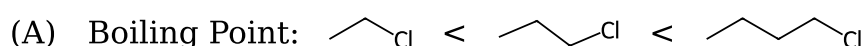
Here en = ethylene diamine



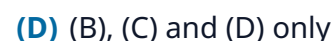
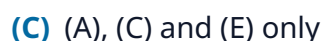
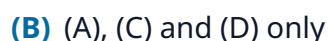
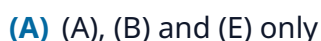
The standard electrode potential ( $M^{3+}/M^{2+}$ ) for V, Cr, Mn & Co are  $-0.26\text{ V}$ ,  $-0.41\text{ V}$ ,  $+1.57\text{ V}$  and  $+1.97\text{ V}$ , respectively. The metal ions which can liberate  $\text{H}_2$  from a dilute acid are:



Identify the correct order for the given property for following compounds.



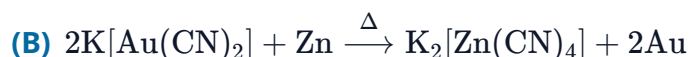
Choose the correct answer from the option given below:



Which of the given compounds can enhance the efficiency of hydrogen storage tank?



The reaction representing the Mond process for metal refining is \_\_\_\_\_.



During the borax bead test with  $\text{CuSO}_4$ , a blue green colour of the bead was observed in oxidising flame due to the formation of:



"A" obtained by Ostwald's method involving air oxidation of  $\text{NH}_3$ , upon further air oxidation produces "B", "B" on hydration forms an oxoacid of Nitrogen along with evolution of "A". The oxoacid also produces "A" and gives positive brown ring test.

Identify A and B, respectively:

- (A)  $\text{N}_2\text{O}_3, \text{NO}_2$  (B)  $\text{NO}_2, \text{N}_2\text{O}_5$  (C)  $\text{NO}_2, \text{N}_2\text{O}_4$  (D)  $\text{NO}, \text{NO}_2$

The correct order of hydration enthalpies is

- (A)  $\text{K}^+$   
 (B)  $\text{Rb}^+$   
 (C)  $\text{Mg}^{2+}$   
 (D)  $\text{Cs}^+$   
 (E)  $\text{Ca}^{2+}$

Choose the correct answer from the options given below:

- (A)  $E > C > A > B > D$  (B)  $C > A > E > B > D$  (C)  $C > E > A > D > B$  (D)  $C > E > A > B > D$

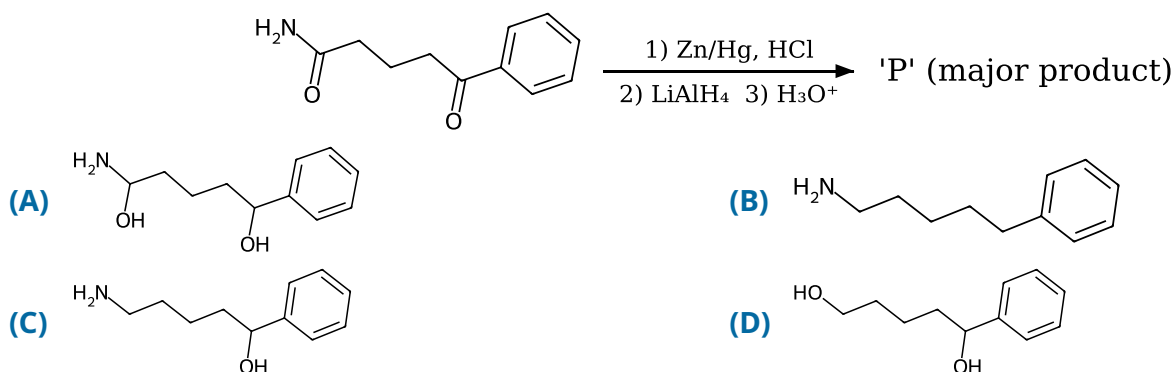
The shortest wavelength of hydrogen atom in Lyman series is  $\lambda$ . The longest wavelength is Balmer series of  $\text{He}^+$  is

- (A)  $\frac{36\lambda}{5}$  (B)  $\frac{5}{9\lambda}$  (C)  $\frac{9\lambda}{5}$  (D)  $\frac{5\lambda}{9}$

Which of the following salt solutions would coagulate the colloid solution formed when  $\text{FeCl}_3$  is added to  $\text{NaOH}$  solution, at the fastest rate?

- (A) 10 mL of  $0.15 \text{ mol dm}^{-3} \text{CaCl}_2$  (B) 10 mL of  $0.2 \text{ mol dm}^{-3} \text{AlCl}_3$   
 (C) 10 mL of  $0.1 \text{ mol dm}^{-3} \text{Na}_2\text{SO}_4$  (D) 10 mL of  $0.1 \text{ mol dm}^{-3} \text{Ca}_3(\text{PO}_4)_2$

The major product 'P' for the following sequence of reactions is:



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Match List I with List II

|     | List I                  |       | List II                                        |
|-----|-------------------------|-------|------------------------------------------------|
|     | Reaction                |       | Reagents                                       |
| (A) | Hoffmann Degradation    | (I)   | Conc.KOH, $\Delta$                             |
| (B) | Clemenson reduction     | (II)  | $\text{CHCl}_3$ , NaOH/ $\text{H}_3\text{O}^+$ |
| (C) | Cannizaro reaction      | (III) | $\text{Br}_2$ , NaOH                           |
| (D) | Reimer-Tiemann Reaction | (IV)  | Zn – Hg/HCl                                    |

Choose the correct answer from the options given below:

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

Compound that will give positive Lassaigne's test for both nitrogen and halogen is:

**(A)**  $\text{NH}_2\text{OH} \cdot \text{HCl}$ **(B)**  $\text{N}_2\text{H}_4 \cdot \text{HCl}$ **(C)**  $\text{CH}_3\text{NH}_2 \cdot \text{HCl}$ **(D)**  $\text{NH}_4\text{Cl}$ **Chemistry** Section B · Numerical value

Q48 to Q55

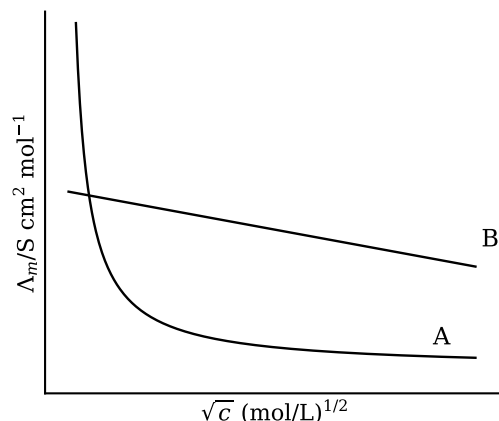
The number of molecules or ions from the following, which do not have odd number of electrons are \_\_\_\_\_.

(A)  $\text{NO}_2$ (B)  $\text{ICl}_4^-$ (C)  $\text{BrF}_3$ (D)  $\text{ClO}_2$ (E)  $\text{NO}_2^+$ 

(F) NO

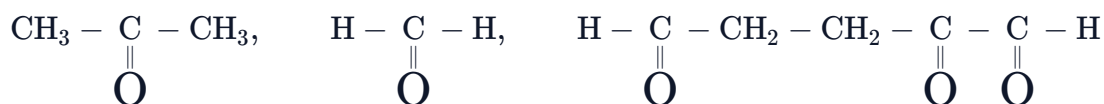
The sum of bridging carbonyls in  $\text{W}(\text{CO})_6$  and  $\text{Mn}_2(\text{CO})_{10}$  is \_\_\_\_\_.Following figure shows dependence of molar conductance of two electrolytes on concentration.  $\Lambda_m^\circ$  is the limiting molar conductivity.The number of incorrect statement(s) from the following is \_\_\_\_\_(A)  $\Lambda_m^\circ$  for electrolyte A is obtained by extrapolation(B) For electrolyte B,  $\Lambda_m$  vs  $\sqrt{c}$  graph is a straight line with intercept equal to  $\Lambda_m^\circ$ 

(C) At infinite dilution, the value of degree of dissociation approaches zero for electrolyte B.

(D)  $\Lambda_m^\circ$  for any electrolyte A and B can be calculated using  $\lambda^\circ$  for individual ions

**Q51** Hydrocarbons: Alkenes & Alkynes **NUMERICAL**[Step-by-step solution](#) > [prepwiser.in/questions/NzkMPUQaG4](https://www.prepwiser.in/questions/NzkMPUQaG4)

17 mg of a hydrocarbon (M.F.  $C_{10}H_{16}$ ) takes up 8.40 mL of the  $H_2$  gas measured at  $0^\circ C$  and 760 mm of Hg. Ozonolysis of the same hydrocarbon yields



The number of double bond/s present in the hydrocarbon is \_\_\_\_\_.

**Q52** Ionic Equilibrium **NUMERICAL**[Step-by-step solution](#) > [prepwiser.in/questions/6Zh6w3oB5\\_](https://www.prepwiser.in/questions/6Zh6w3oB5_)

Millimoles of calcium hydroxide required to produce 100 mL of the aqueous solution of pH 12 is  $x \times 10^{-1}$ . The value of  $x$  is \_\_\_\_\_ (Nearest integer).

Assume complete dissociation.

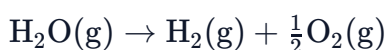
**Q53** Solutions & Colligative Properties **NUMERICAL**[Step-by-step solution](#) > [prepwiser.in/questions/Ls8QVj\\_xkU](https://www.prepwiser.in/questions/Ls8QVj_xkU)

Solid Lead nitrate is dissolved in 1 litre of water. The solution was found to boil at  $100.15^\circ C$ . When 0.2 mol of NaCl is added to the resulting solution, it was observed that the solution froze at  $-0.8^\circ C$ . The solubility product of  $PbCl_2$  formed is \_\_\_\_\_  $\times 10^{-6}$  at 298 K. (Nearest integer)

Given:  $K_b = 0.5 \text{ K kg mol}^{-1}$  and  $K_f = 1.8 \text{ K kg mol}^{-1}$ . Assume molality to be equal to molarity in all cases.

**Q54** Chemical Equilibrium **NUMERICAL**[Step-by-step solution](#) > [prepwiser.in/questions/p\\_tLePJJuK](https://www.prepwiser.in/questions/p_tLePJJuK)

Water decomposes at 2300 K

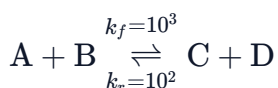


The percent of water decomposing at 2300 K and 1 bar is \_\_\_\_\_ (Nearest integer).

Equilibrium constant for the reaction is  $2 \times 10^{-3}$  at 2300 K.

**Q55** Chemical Equilibrium **NUMERICAL**[Step-by-step solution](#) > [prepwiser.in/questions/hx9KjCADMF](https://www.prepwiser.in/questions/hx9KjCADMF)

Consider the following reaction approaching equilibrium at  $27^\circ C$  and 1 atm pressure



The standard Gibbs energy change ( $\Delta_r G^\theta$ ) at  $27^\circ C$  is (–) \_\_\_\_\_  $\text{kJ mol}^{-1}$  (Nearest integer).

(Given:  $R = 8.3 \text{ JK}^{-1} \text{ mol}^{-1}$  and  $\ln 10 = 2.3$ )

**Mathematics Section A · Multiple choice**

Q56 to Q74

**Q56** Circles[Step-by-step solution](#) > [prepwiser.in/questions/TdSRar7wgM](https://www.prepwiser.in/questions/TdSRar7wgM)

Let the tangents at the points  $A(4, -11)$  and  $B(8, -5)$  on the circle  $x^2 + y^2 - 3x + 10y - 15 = 0$ , intersect at the point  $C$ . Then the radius of the circle, whose centre is  $C$  and the line joining  $A$  and  $B$  is its tangent, is equal to:

- (A)  $\frac{2\sqrt{13}}{3}$  (B)  $\frac{3\sqrt{3}}{4}$  (C)  $\sqrt{13}$  (D)  $2\sqrt{13}$

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**Q57** Complex Numbers[Step-by-step solution](#) > [prepwisar.in/questions/sdCY1MsDwM](https://www.prepwisar.in/questions/sdCY1MsDwM)

For two non-zero complex numbers  $z_1$  and  $z_2$ , if  $\operatorname{Re}(z_1 z_2) = 0$  and  $\operatorname{Re}(z_1 + z_2) = 0$ , then which of the following are possible?

- A.  $\operatorname{Im}(z_1) > 0$  and  $\operatorname{Im}(z_2) > 0$
- B.  $\operatorname{Im}(z_1) < 0$  and  $\operatorname{Im}(z_2) > 0$
- C.  $\operatorname{Im}(z_1) > 0$  and  $\operatorname{Im}(z_2) < 0$
- D.  $\operatorname{Im}(z_1) < 0$  and  $\operatorname{Im}(z_2) < 0$

Choose the correct answer from the options given below:

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

**Q58** Definite Integration[Step-by-step solution](#) > [prepwisar.in/questions/368WztgeB1](https://www.prepwisar.in/questions/368WztgeB1)

Let

$$f(x) = x + \frac{a}{\pi^2 - 4} \sin x + \frac{b}{\pi^2 - 4} \cos x, x \in \mathbb{R}$$

be a function which

satisfies  $f(x) = x + \int_0^{\pi/2} \sin(x+y)f(y)dy$ . then  $(a+b)$  is equal to

- (A)  $-2\pi(\pi+2)$                       (B)  $-\pi(\pi-2)$                       (C)  $-\pi(\pi+2)$                       (D)  $-2\pi(\pi-2)$

**Q59** Differential Equations[Step-by-step solution](#) > [prepwisar.in/questions/dqRCX\\_ZK2F](https://www.prepwisar.in/questions/dqRCX_ZK2F)

Let  $y = f(x)$  be the solution of the differential equation  $y(x+1)dx - x^2 dy = 0$ ,  $y(1) = e$ . Then

$\lim_{x \rightarrow 0^+} f(x)$  is equal to

- (A)  $e^2$                       (B) 0                      (C)  $\frac{1}{e^2}$                       (D)  $\frac{1}{e}$

**Q60** Functions (Advanced)[Step-by-step solution](#) > [prepwisar.in/questions/TuWpzXgKwz](https://www.prepwisar.in/questions/TuWpzXgKwz)

The domain of

$$f(x) = \frac{\log_{(x+1)}(x-2)}{e^{2\log_e x} - (2x+3)}, x \in \mathbb{R}$$

is

- (A)  $(-1, \infty) - \{3\}$                       (B)  $\mathbb{R} - \{-1, 3\}$                       (C)  $(2, \infty) - \{3\}$                       (D)  $\mathbb{R} - \{3\}$

**Q61** Relations & Functions (Basic)[Step-by-step solution](#) > [prepwisar.in/questions/v5KmJudmsI](https://www.prepwisar.in/questions/v5KmJudmsI)

Let  $f: \mathbb{R} \rightarrow \mathbb{R}$  be a function such that  $f(x) = \frac{x^2+2x+1}{x^2+1}$ . Then

- (A)  $f(x)$  is many-one in  $(-\infty, -1)$                       (B)  $f(x)$  is one-one in  $(-\infty, \infty)$   
(C)  $f(x)$  is one-one in  $[1, \infty)$  but not in  $(-\infty, \infty)$                       (D)  $f(x)$  is many-one in  $(1, \infty)$

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**Q62** Limits[Step-by-step solution](#) › [prepwisar.in/questions/1FYgApPQIO](https://www.prepwisar.in/questions/1FYgApPQIO)

Let  $x = 2$  be a root of the equation  $x^2 + px + q = 0$  and

$$f(x) = \begin{cases} \frac{1 - \cos(x^2 - 4px + q^2 + 8q + 16)}{(x - 2p)^4}, & x \neq 2p \\ 0, & x = 2p \end{cases}$$

Then  $\lim_{x \rightarrow 2p^+} [f(x)]$ , where  $[.]$  denotes greatest integer function, is

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

**Q63** Matrices[Step-by-step solution](#) › [prepwisar.in/questions/WK6ZFZLazrv](https://www.prepwisar.in/questions/WK6ZFZLazrv)

Let  $\alpha$  and  $\beta$  be real numbers. Consider a  $3 \times 3$  matrix  $A$  such that  $A^2 = 3A + \alpha I$ . If  $A^4 = 21A + \beta I$ , then

- (A)  $\alpha = 1$  (B)  $\alpha = 4$  (C)  $\beta = 8$  (D)  $\beta = -8$

**Q64** Determinants[Step-by-step solution](#) › [prepwisar.in/questions/r0VmUdLsFt](https://www.prepwisar.in/questions/r0VmUdLsFt)

Consider the following system of equations

$$\alpha x + 2y + z = 1$$

$$2\alpha x + 3y + z = 1$$

$$3x + \alpha y + 2z = \beta$$

for some  $\alpha, \beta \in \mathbb{R}$ . Then which of the following is NOT correct.

- (A) It has a solution for all  $\alpha \neq -1$  and  $\beta = 2$   
(B) It has no solution if  $\alpha = -1$  and  $\beta \neq 2$   
(C) It has no solution for  $\alpha = -1$  and for all  $\beta \in \mathbb{R}$   
(D) It has no solution for  $\alpha = 3$  and for all  $\beta \neq 2$

**Q65** Probability: Basic[Step-by-step solution](#) › [prepwisar.in/questions/bCaP7xijc0](https://www.prepwisar.in/questions/bCaP7xijc0)

Fifteen football players of a club-team are given 15 T-shirts with their names written on the backside. If the players pick up the T-shirts randomly, then the probability that at least 3 players pick the correct T-shirt is:

- (A)  $\frac{1}{6}$  (B)  $\frac{2}{15}$  (C)  $\frac{5}{24}$  (D) 0.08

**Q66** Quadratic Equations & Polynomial Inequalities[Step-by-step solution](#) › [prepwisar.in/questions/uT2L07rSe9](https://www.prepwisar.in/questions/uT2L07rSe9)

Let  $\lambda \neq 0$  be a real number. Let  $\alpha, \beta$  be the roots of the equation  $14x^2 - 31x + 3\lambda = 0$  and  $\alpha, \gamma$  be the roots of the equation  $35x^2 - 53x + 4\lambda = 0$ . Then  $\frac{3\alpha}{\beta}$  and  $\frac{4\alpha}{\gamma}$  are the roots of the equation

- (A)  $7x^2 - 245x + 250 = 0$  (B)  $49x^2 - 245x + 250 = 0$   
(C)  $49x^2 + 245x + 250 = 0$  (D)  $7x^2 + 245x - 250 = 0$

**Q67** Probability: Advanced[Step-by-step solution](#) › [prepwisar.in/questions/Fe2Vou7R1e](https://www.prepwisar.in/questions/Fe2Vou7R1e)

Three rotten apples are mixed accidentally with seven good apples and four apples are drawn one by one without replacement. Let the random variable  $X$  denote the number of rotten apples. If  $\mu$  and  $\sigma^2$  represent mean and variance of  $X$ , respectively, then  $10(\mu^2 + \sigma^2)$  is equal to:

- (A) 20 (B) 30 (C) 250 (D) 25

**Q68** Vectors[Step-by-step solution](https://www.prepwiser.in/questions/EKsmGBgPmC)

If the vectors  $\vec{a} = \lambda\hat{i} + \mu\hat{j} + 4\hat{k}$ ,  $\vec{b} = -2\hat{i} + 4\hat{j} - 2\hat{k}$  and  $\vec{c} = 2\hat{i} + 3\hat{j} + \hat{k}$  are coplanar and the projection of  $\vec{a}$  on the vector  $\vec{b}$  is  $\sqrt{54}$  units, then the sum of all possible values of  $\lambda + \mu$  is equal to:

- (A) 24 (B) 0 (C) 18 (D) 6

**Q69** Area Under Curves[Step-by-step solution](https://www.prepwiser.in/questions/MgaQk4IKMA)

Let  $\Delta$  be the area of the region  $\{(x, y) \in \mathbb{R}^2 : x^2 + y^2 \leq 21, y^2 \leq 4x, x \geq 1\}$ . Then  $\frac{1}{2} \left( \Delta - 21\sin^{-1} \frac{2}{\sqrt{7}} \right)$  is equal to

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

**Q70** Area Under Curves[Step-by-step solution](https://www.prepwiser.in/questions/MIW38MZkBL)

Let  $[x]$  denote the greatest integer  $\leq x$ . Consider the function  $f(x) = \max \{x^2, 1 + [x]\}$ . Then the value of the integral  $\int_0^2 f(x) dx$  is

- (A)  $\frac{5 + 4\sqrt{2}}{3}$  (B)  $\frac{4 + 5\sqrt{2}}{3}$  (C)  $\frac{8 + 4\sqrt{2}}{3}$  (D)  $\frac{1 + 5\sqrt{2}}{3}$

**Q71** Area Under Curves[Step-by-step solution](https://www.prepwiser.in/questions/fYdZ1n3fwL)

Let  $A = \{(x, y) \in \mathbb{R}^2 : y \geq 0, 2x \leq y \leq \sqrt{4 - (x - 1)^2}\}$  and

$B = \{(x, y) \in \mathbb{R} \times \mathbb{R} : 0 \leq y \leq \min \{2x, \sqrt{4 - (x - 1)^2}\}\}$  ..

Then the ratio of the area of A to the area of B is

- (A)  $\frac{\pi}{\pi + 1}$  (B)  $\frac{\pi - 1}{\pi + 1}$  (C)  $\frac{\pi}{\pi - 1}$  (D)  $\frac{\pi + 1}{\pi - 1}$

**Q72** Straight Lines[Step-by-step solution](https://www.prepwiser.in/questions/v_lxiDvqC)

Let  $B$  and  $C$  be the two points on the line  $y + x = 0$  such that  $B$  and  $C$  are symmetric with respect to the origin. Suppose  $A$  is a point on  $y - 2x = 2$  such that  $\triangle ABC$  is an equilateral triangle. Then, the area of the  $\triangle ABC$  is:

- (A)  $\frac{10}{\sqrt{3}}$  (B)  $2\sqrt{3}$  (C)  $3\sqrt{3}$  (D)  $\frac{8}{\sqrt{3}}$

**Q73** Straight Lines[Step-by-step solution](https://www.prepwiser.in/questions/em_aNN3XEx)

A light ray emits from the origin making an angle  $30^\circ$  with the positive  $x$ -axis. After getting reflected by the line  $x + y = 1$ , if this ray intersects  $x$ -axis at Q, then the abscissa of Q is:

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

**Q74** Trigonometric Ratios & Identities[Step-by-step solution](https://www.prepwiser.in/questions/cmfP2DcuYV)

Let  $f(\theta) = 3 \left( \sin^4 \left( \frac{3\pi}{2} - \theta \right) + \sin^4(3\pi + \theta) \right) - 2(1 - \sin^2 2\theta)$  and  $S = \left\{ \theta \in [0, \pi] : f'(\theta) = -\frac{\sqrt{3}}{2} \right\}$ . If  $4\beta = \sum_{\theta \in S} \theta$ , then  $f(\beta)$  is equal to

- (A)  $\frac{9}{8}$  (B)  $\frac{3}{2}$  (C)  $\frac{5}{4}$  (D)  $\frac{11}{8}$

**Q75** Three Dimensional Geometry **NUMERICAL**

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

Let the equation of the plane  $P$  containing the line  $x + 10 = \frac{8-y}{2} = z$  be  $ax + by + 3z = 2(a + b)$  and the distance of the plane  $P$  from the point  $(1, 27, 7)$  be  $c$ . Then  $a^2 + b^2 + c^2$  is equal to \_\_\_\_\_.

**Q76** Three Dimensional Geometry **NUMERICAL**

[Step-by-step solution](#) › [prepwiser.in/questions/uPRHCA-aXi](https://www.prepwiser.in/questions/uPRHCA-aXi)

Let the co-ordinates of one vertex of  $\triangle ABC$  be  $A(0, 2, \alpha)$  and the other two vertices lie on the line  $\frac{x+\alpha}{5} = \frac{y-1}{2} = \frac{z+4}{3}$ . For  $\alpha \in \mathbb{Z}$ , if the area of  $\triangle ABC$  is 21 sq. units and the line segment  $BC$  has length  $2\sqrt{21}$  units, then  $\alpha^2$  is equal to \_\_\_\_\_.

**Q77** Binomial Theorem **NUMERICAL**

[Step-by-step solution](#) › [prepwiser.in/questions/4G93fZgD4o](https://www.prepwiser.in/questions/4G93fZgD4o)

Let the coefficients of three consecutive terms in the binomial expansion of  $(1 + 2x)^n$  be in the ratio 2 : 5 : 8. Then the coefficient of the term, which is in the middle of those three terms, is \_\_\_\_\_.

**Q78** Binomial Theorem **NUMERICAL**

[Step-by-step solution](#) › [prepwiser.in/questions/iIMM\\_Yqd5B](https://www.prepwiser.in/questions/iIMM_Yqd5B)

If the co-efficient of  $x^9$  in  $\left(\alpha x^3 + \frac{1}{\beta x}\right)^{11}$  and the co-efficient of  $x^{-9}$  in  $\left(\alpha x - \frac{1}{\beta x^3}\right)^{11}$  are equal, then  $(\alpha\beta)^2$  is equal to \_\_\_\_\_.

**Q79** Functions (Advanced) **NUMERICAL**

[Step-by-step solution](#) › [prepwiser.in/questions/Y7ace1Fds4](https://www.prepwiser.in/questions/Y7ace1Fds4)

Let  $f : \mathbb{R} \rightarrow \mathbb{R}$  be a differentiable function that satisfies the relation  $f(x + y) = f(x) + f(y) - 1, \forall x, y \in \mathbb{R}$ . If  $f'(0) = 2$ , then  $|f(-2)|$  is equal to \_\_\_\_\_.

**Q80** Functions (Advanced) **NUMERICAL**

[Step-by-step solution](#) › [prepwiser.in/questions/YRJ8plfOV1](https://www.prepwiser.in/questions/YRJ8plfOV1)

Suppose  $f$  is a function satisfying  $f(x + y) = f(x) + f(y)$  for all  $x, y \in \mathbb{N}$  and  $f(1) = \frac{1}{5}$ . If  $\sum_{n=1}^m \frac{f(n)}{n(n+1)(n+2)} = \frac{1}{12}$ , then  $m$  is equal to \_\_\_\_\_.

**Q81** Permutations & Combinations **NUMERICAL**

[Step-by-step solution](#) › [prepwiser.in/questions/nrE6diFUad](https://www.prepwiser.in/questions/nrE6diFUad)

If all the six digit numbers  $x_1 x_2 x_3 x_4 x_5 x_6$  with  $0 < x_1 < x_2 < x_3 < x_4 < x_5 < x_6$  are arranged in the increasing order, then the sum of the digits in the 72<sup>th</sup> number is \_\_\_\_\_.

**Q82** Permutations & Combinations **NUMERICAL**

[Step-by-step solution](#) › [prepwiser.in/questions/eGEeYK8MWH](https://www.prepwiser.in/questions/eGEeYK8MWH)

Five digit numbers are formed using the digits 1, 2, 3, 5, 7 with repetitions and are written in descending order with serial numbers. For example, the number 77777 has serial number 1. Then the serial number of 35337 is \_\_\_\_\_.

**Q83** Sequences & Series **NUMERICAL**

[Step-by-step solution](#) › [prepwiser.in/questions/E8OZmpTS3G](https://www.prepwiser.in/questions/E8OZmpTS3G)

Let  $a_1, a_2, a_3, \dots$  be a  $GP$  of increasing positive numbers. If the product of fourth and sixth terms is 9 and the sum of fifth and seventh terms is 24, then  $a_1 a_9 + a_2 a_4 a_9 + a_5 + a_7$  is equal to \_\_\_\_\_.

**Q84** Vectors **NUMERICAL**

[Step-by-step solution](#) › [prepwiser.in/questions/Hf\\_RwCx2tl](https://www.prepwiser.in/questions/Hf_RwCx2tl)

Let  $\vec{a}, \vec{b}$  and  $\vec{c}$  be three non-zero non-coplanar vectors. Let the position vectors of four points  $A, B, C$  and  $D$  be

$$\vec{a} - \vec{b} + \vec{c}, \lambda \vec{a} - 3\vec{b} + 4\vec{c}, -\vec{a} + 2\vec{b} - 3\vec{c}$$

and  $2\vec{a} - 4\vec{b} + 6\vec{c}$  respectively. If  $\vec{AB}, \vec{AC}$  and  $\vec{AD}$  are coplanar, then  $\lambda$  is equal to \_\_\_\_\_.

# Answer key: JEE Main 2023 · 29 Jan · Shift 1

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

Numbers match the question numbers above. For full working, open the solution link at the top right of each question.

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## Physics

|               |               |               |                |                |               |               |                |
|---------------|---------------|---------------|----------------|----------------|---------------|---------------|----------------|
| 1. <b>C</b>   | 2. <b>B</b>   | 3. <b>D</b>   | 4. <b>C</b>    | 5. <b>C</b>    | 6. <b>D</b>   | 7. <b>D</b>   | 8. <b>D</b>    |
| 9. <b>A</b>   | 10. <b>B</b>  | 11. <b>C</b>  | 12. <b>A</b>   | 13. <b>D</b>   | 14. <b>A</b>  | 15. <b>D</b>  | 16. <b>A</b>   |
| 17. <b>B</b>  | 18. <b>C</b>  | 19. <b>A</b>  | 20. <b>87</b>  | 21. <b>2</b>   | 22. <b>10</b> | 23. <b>24</b> | 24. <b>120</b> |
| 25. <b>28</b> | 26. <b>40</b> | 27. <b>24</b> | 28. <b>120</b> | 29. <b>300</b> |               |               |                |

## Chemistry

|              |              |              |              |              |              |              |               |
|--------------|--------------|--------------|--------------|--------------|--------------|--------------|---------------|
| 30. <b>D</b> | 31. <b>D</b> | 32. <b>D</b> | 33. <b>A</b> | 34. <b>A</b> | 35. <b>A</b> | 36. <b>C</b> | 37. <b>C</b>  |
| 38. <b>C</b> | 39. <b>D</b> | 40. <b>B</b> | 41. <b>D</b> | 42. <b>D</b> | 43. <b>C</b> | 44. <b>B</b> | 45. <b>B</b>  |
| 46. <b>A</b> | 47. <b>C</b> | 48. <b>3</b> | 49. <b>0</b> | 50. <b>2</b> | 51. <b>3</b> | 52. <b>5</b> | 53. <b>13</b> |
| 54. <b>2</b> | 55. <b>6</b> |              |              |              |              |              |               |

## Mathematics

|               |               |                 |                |              |                 |              |              |
|---------------|---------------|-----------------|----------------|--------------|-----------------|--------------|--------------|
| 56. <b>A</b>  | 57. <b>D</b>  | 58. <b>A</b>    | 59. <b>B</b>   | 60. <b>C</b> | 61. <b>C</b>    | 62. <b>C</b> | 63. <b>D</b> |
| 64. <b>C</b>  | 65. <b>D</b>  | 66. <b>B</b>    | 67. <b>A</b>   | 68. <b>A</b> | 69. <b>C</b>    | 70. <b>A</b> | 71. <b>B</b> |
| 72. <b>D</b>  | 73. <b>D</b>  | 74. <b>C</b>    | 75. <b>355</b> | 76. <b>9</b> | 77. <b>1120</b> | 78. <b>1</b> | 79. <b>3</b> |
| 80. <b>10</b> | 81. <b>32</b> | 82. <b>1436</b> | 83. <b>60</b>  | 84. <b>2</b> |                 |              |              |

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