

## JEE MAIN 2022 · QUESTION PAPER

# 26 Jun 2022 Shift 1

82 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>9</b> Q20 to Q28       |
| ● <b>Chemistry</b>   | <b>16</b> Q29 to Q44                        | <b>9</b> Q45 to Q53       |
| ● <b>Mathematics</b> | <b>19</b> Q54 to Q72                        | <b>10</b> Q73 to Q82      |
| <b>In this PDF</b>   | <b>82</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/2022-06-26-morning](https://prepwis.in/pyqs/paper/2022-06-26-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](#) · [prepwisar.in/questions/eikbNWTmBI](https://www.prepwisar.in/questions/eikbNWTmBI)

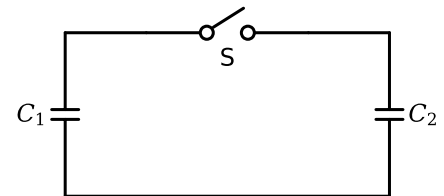
How many alpha and beta particles are emitted when Uranium  ${}_{92}\text{U}^{238}$  decays to lead  ${}_{82}\text{Pb}^{206}$ ?

- (A) 3 alpha particles and 5 beta particles  
(B) 6 alpha particles and 4 beta particles  
(C) 4 alpha particles and 5 beta particles  
(D) 8 alpha particles and 6 beta particles

**Q2** Electrostatics II: Potential & Capacitance

[Step-by-step solution](#) · [prepwisar.in/questions/w4FkjrMFk2](https://www.prepwisar.in/questions/w4FkjrMFk2)

Two capacitors having capacitance  $C_1$  and  $C_2$  respectively are connected as shown in figure. Initially, capacitor  $C_1$  is charged to a potential difference  $V$  volt by a battery. The battery is then removed and the charged capacitor  $C_1$  is now connected to uncharged capacitor  $C_2$  by closing the switch  $S$ . The amount of charge on the capacitor  $C_2$ , after equilibrium, is:



- (A)  $\frac{C_1 C_2}{(C_1 + C_2)} V$   
(B)  $\frac{(C_1 + C_2)}{C_1 C_2} V$   
(C)  $(C_1 + C_2) V$   
(D)  $(C_1 - C_2) V$

**Q3** Rectilinear Motion

[Step-by-step solution](#) · [prepwisar.in/questions/NRcur547kc](https://www.prepwisar.in/questions/NRcur547kc)

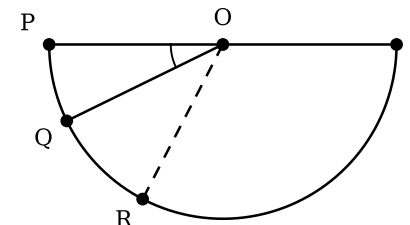
An object is thrown vertically upwards. At its maximum height, which of the following quantity becomes zero?

- (A) Momentum  
(B) Potential Energy  
(C) Acceleration  
(D) Force

**Q4** Circular Motion

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

A ball is released from rest from point P of a smooth semi-spherical vessel as shown in figure. The ratio of the centripetal force and normal reaction on the ball at point Q is  $A$  while angular position of point Q is  $\alpha$  with respect to point P. Which of the following graphs represent the correct relation between  $A$  and  $\alpha$  when ball goes from Q to R?



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

**Q5** Current Electricity

[Step-by-step solution](#) · [prepwisar.in/questions/137iKzEgJa](https://www.prepwisar.in/questions/137iKzEgJa)

An aluminium wire is stretched to make its length, 0.4% larger. The percentage change in resistance is:

- (A) 0.4%  
(B) 0.2%  
(C) 0.8%  
(D) 0.6%

An electron with speed  $v$  and a photon with speed  $c$  have the same de-Broglie wavelength. If the kinetic energy and momentum of electron are  $E_e$  and  $p_e$  and that of photon are  $E_{ph}$  and  $p_{ph}$  respectively. Which of the following is correct?

- (A)  $\frac{E_e}{E_{ph}} = \frac{2c}{v}$  (B)  $\frac{E_e}{E_{ph}} = \frac{v}{2c}$  (C)  $\frac{p_e}{p_{ph}} = \frac{2c}{v}$  (D)  $\frac{p_e}{p_{ph}} = \frac{v}{2c}$

The magnetic flux through a coil perpendicular to its plane is varying according to the relation  $\phi = (5t^3 + 4t^2 + 2t - 5)$  Weber. If the resistance of the coil is 5 ohm, then the induced current through the coil at  $t = 2$  s will be,

- (A) 15.6 A (B) 16.6 A (C) 17.6 A (D) 18.6 A

If Electric field intensity of a uniform plane electromagnetic wave is given as

$$E = -301.6 \sin(kz - \omega t) \hat{a}_x + 452.4 \sin(kz - \omega t) \hat{a}_y \frac{V}{m}$$

. Then magnetic intensity 'H' of this wave in  $\text{Am}^{-1}$  will be:

[Given : Speed of light in vacuum  $c = 3 \times 10^8 \text{ ms}^{-1}$ , Permeability of vacuum  $\mu_0 = 4\pi \times 10^{-7} \text{ NA}^{-2}$ ]

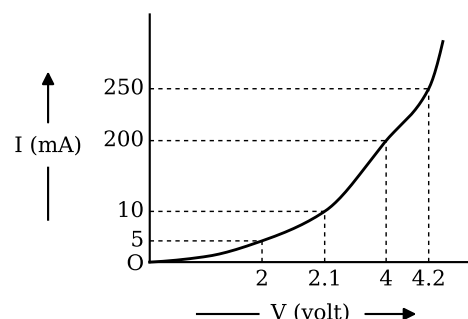
- (A)  $+0.8 \sin(kz - \omega t) \hat{a}_y + 0.8 \sin(kz - \omega t) \hat{a}_x$   
 (B)  $+1.0 \times 10^{-6} \sin(kz - \omega t) \hat{a}_y + 1.5 \times 10^{-6} \sin(kz - \omega t) \hat{a}_x$   
 (C)  $-0.8 \sin(kz - \omega t) \hat{a}_y - 1.2 \sin(kz - \omega t) \hat{a}_x$   
 (D)  $-1.0 \times 10^{-6} \sin(kz - \omega t) \hat{a}_y - 1.5 \times 10^{-6} \sin(kz - \omega t) \hat{a}_x$

In free space, an electromagnetic wave of 3 GHz frequency strikes over the edge of an object of size  $\frac{\lambda}{100}$ , where  $\lambda$  is the wavelength of the wave in free space. The phenomenon, which happens there will be:

- (A) Reflection (B) Refraction (C) Diffraction (D) Scattering

The I-V characteristics of a p-n junction diode in forward bias is shown in the figure. The ratio of dynamic resistance, corresponding to forward bias voltage of 2 V and 4 V respectively, is:

- (A) 1 : 2 (B) 5 : 1 (C) 1 : 40 (D) 20 : 1



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

Assertion (A) : Non-polar materials do not have any permanent dipole moment.

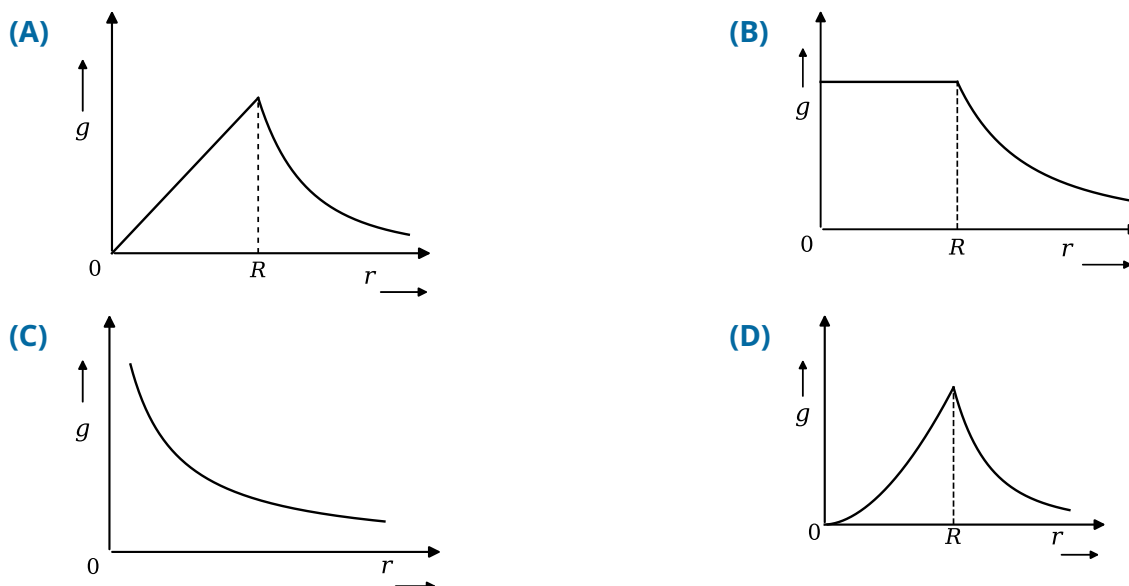
Reason (R) : When a non-polar material is placed in an electric field, the centre of the positive charge distribution of it's individual atom or molecule coincides with the centre of the negative charge distribution.

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

The variation of acceleration due to gravity ( $g$ ) with distance ( $r$ ) from the center of the earth is correctly represented by:

(Given  $R$  = radius of earth)



The efficiency of a Carnot's engine, working between steam point and ice point, will be:

- (A) 26.81%                      (B) 37.81%                      (C) 47.81%                      (D) 57.81%

A thermally insulated vessel contains an ideal gas of molecular mass  $M$  and ratio of specific heats 1.4. Vessel is moving with speed  $v$  and is suddenly brought to rest. Assuming no heat is lost to the surrounding and vessel temperature of the gas increases by:

( $R$  = universal gas constant)

- (A)  $\frac{Mv^2}{7R}$                       (B)  $\frac{Mv^2}{5R}$                       (C)  $2 \frac{Mv^2}{7R}$                       (D)  $7 \frac{Mv^2}{5R}$

Attempt this paper online with instant answer checking > [prepwisar.in/pyqs/paper/2022-06-26-morning](https://www.prepwisar.in/pyqs/paper/2022-06-26-morning)

A person is standing in an elevator. In which situation, he experiences weight loss?

- (A) When the elevator moves upward with constant acceleration
- (B) When the elevator moves downward with constant acceleration
- (C) When the elevator moves upward with uniform velocity
- (D) When the elevator moves downward with uniform velocity

A proton and an alpha particle of the same velocity enter in a uniform magnetic field which is acting perpendicular to their direction of motion. The ratio of the radii of the circular paths described by the alpha particle and proton is:

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

A thin circular ring of mass  $M$  and radius  $R$  is rotating with a constant angular velocity  $2 \text{ rads}^{-1}$  in a horizontal plane about an axis vertical to its plane and passing through the center of the ring. If two objects each of mass  $m$  be attached gently to the opposite ends of a diameter of ring, the ring will then rotate with an angular velocity (in  $\text{rads}^{-1}$ ).

- (A)  $\frac{M}{(M+m)}$
- (B)  $\frac{(M+2m)}{2M}$
- (C)  $\frac{2M}{(M+2m)}$
- (D)  $\frac{2(M+2m)}{M}$

Time period of a simple pendulum in a stationary lift is 'T'. If the lift accelerates with  $\frac{g}{6}$  vertically upwards then the time period will be:

(Where  $g$  = acceleration due to gravity)

- (A)  $\sqrt{\frac{6}{5}}T$
- (B)  $\sqrt{\frac{5}{6}}T$
- (C)  $\sqrt{\frac{6}{7}}T$
- (D)  $\sqrt{\frac{7}{6}}T$

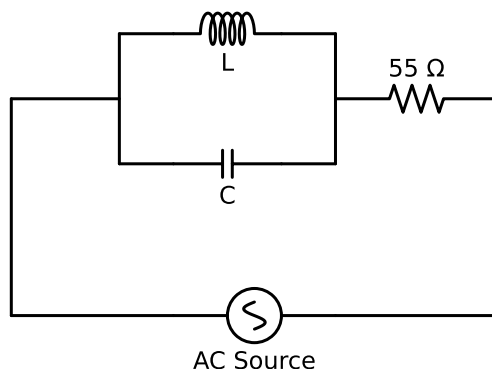
An expression for a dimensionless quantity  $P$  is given by  $P = \frac{\alpha}{\beta} \log_e \left( \frac{kt}{\beta x} \right)$ ; where  $\alpha$  and  $\beta$  are constants,  $x$  is distance;  $k$  is Boltzmann constant and  $t$  is the temperature. Then the dimensions of  $\alpha$  will be:

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

**Q20** Alternating Current **NUMERICAL**

[Step-by-step solution](#) › [prepwiser.in/questions/Zpkf08x1i6](#)

A 110 V, 50 Hz, AC source is connected in the circuit (as shown in figure). The current through the resistance  $55\ \Omega$ , at resonance in the circuit, will be \_\_\_\_\_ A.



**Q21** Electromagnetic Induction **NUMERICAL**

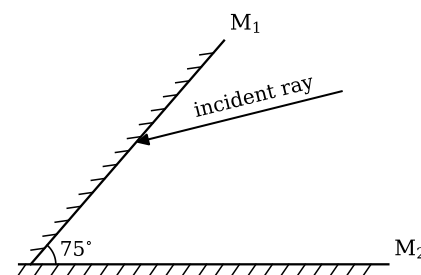
[Step-by-step solution](#) › [prepwiser.in/questions/Q0bYCMctU6](#)

A  $10\ \Omega$ , 20 mH coil carrying constant current is connected to a battery of 20 V through a switch. Now after switch is opened current becomes zero in  $100\ \mu\text{s}$ . The average e.m.f. induced in the coil is \_\_\_\_\_ V.

**Q22** Ray Optics **NUMERICAL**

[Step-by-step solution](#) › [prepwiser.in/questions/SXg\\_i1Ey3U](#)

A light ray is incident, at an incident angle  $\theta_1$ , on the system of two plane mirrors  $M_1$  and  $M_2$  having an inclination angle  $75^\circ$  between them (as shown in figure). After reflecting from mirror  $M_1$  it gets reflected back by the mirror  $M_2$  with an angle of reflection  $30^\circ$ . The total deviation of the ray will be \_\_\_\_\_ degree.



**Q23** Projectile Motion & Relative Motion **NUMERICAL**

[Step-by-step solution](#) › [prepwiser.in/questions/Irwj9\\_Gi9k](#)

A fighter jet is flying horizontally at a certain altitude with a speed of  $200\ \text{ms}^{-1}$ . When it passes directly overhead an anti-aircraft gun, a bullet is fired from the gun, at an angle  $\theta$  with the horizontal, to hit the jet. If the bullet speed is 400 m/s, the value of  $\theta$  will be \_\_\_\_\_  $^\circ$ .

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

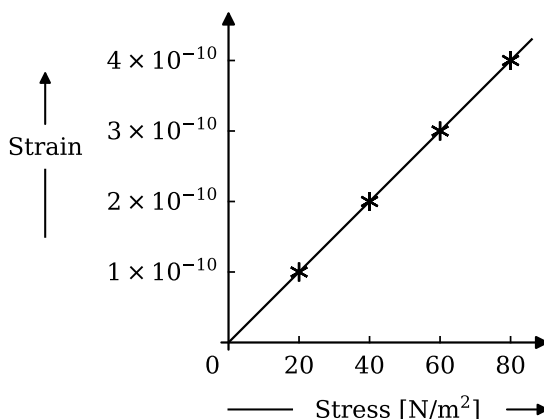
[Step-by-step solution](#) › [prepwiser.in/questions/SXYOolsO9L](#)

A ball of mass 0.5 kg is dropped from the height of 10 m. The height, at which the magnitude of velocity becomes equal to the magnitude of acceleration due to gravity, is \_\_\_\_\_ m. [Use  $g = 10\ \text{m/s}^2$ ]

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**Q25** Elasticity **NUMERICAL**[Step-by-step solution](#) › [prepwiser.in/questions/FdSm0Imowg](https://www.prepwiser.in/questions/FdSm0Imowg)

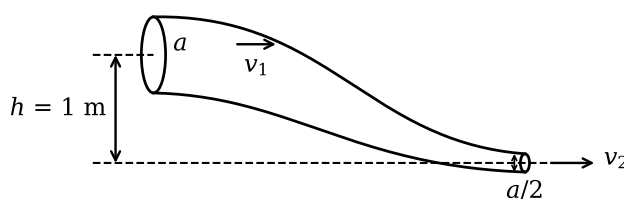
The elastic behaviour of material for linear stress and linear strain, is shown in the figure. The energy density for a linear strain of  $5 \times 10^{-4}$  is \_\_\_\_\_  $\text{kJ/m}^3$ . Assume that material is elastic upto the linear strain of  $5 \times 10^{-4}$ .

**Q26** Elasticity **NUMERICAL**[Step-by-step solution](#) › [prepwiser.in/questions/JhIMT6InaH](https://www.prepwiser.in/questions/JhIMT6InaH)

The elongation of a wire on the surface of the earth is  $10^{-4}$  m. The same wire of same dimensions is elongated by  $6 \times 10^{-5}$  m on another planet. The acceleration due to gravity on the planet will be \_\_\_\_\_  $\text{ms}^{-2}$ . (Take acceleration due to gravity on the surface of earth =  $10 \text{ ms}^{-2}$ )

**Q27** Fluid Mechanics **NUMERICAL**[Step-by-step solution](#) › [prepwiser.in/questions/CDznrPm2g6](https://www.prepwiser.in/questions/CDznrPm2g6)

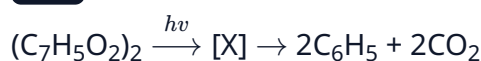
An ideal fluid of density  $800 \text{ kgm}^{-3}$ , flows smoothly through a bent pipe (as shown in figure) that tapers in cross-sectional area from  $a$  to  $\frac{a}{2}$ . The pressure difference between the wide and narrow sections of pipe is  $4100 \text{ Pa}$ . At wider section, the velocity of fluid is  $\frac{\sqrt{x}}{6} \text{ ms}^{-1}$  for  $x =$  \_\_\_\_\_. (Given  $g = 10 \text{ ms}^{-2}$ )

**Q28** Experimental Skills **NUMERICAL**[Step-by-step solution](#) › [prepwiser.in/questions/iKbM1bDqRP](https://www.prepwiser.in/questions/iKbM1bDqRP)

In a vernier callipers, each cm on the main scale is divided into 20 equal parts. If tenth vernier scale division coincides with ninth main scale division. Then the value of vernier constant will be \_\_\_\_\_  $\times 10^{-2} \text{ mm}$ .

**Chemistry Section A · Multiple choice**

Q29 to Q44

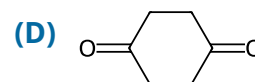
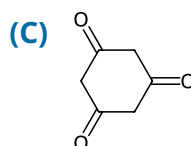
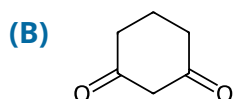
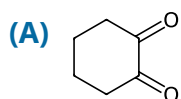
**Q29** General Organic Chemistry (GOC)[Step-by-step solution](#) › [prepwiser.in/questions/bfMIK74259](https://www.prepwiser.in/questions/bfMIK74259)

Consider the above reaction and identify the intermediate 'X'

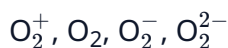
- (A)  $\text{C}_6\text{H}_5 - \overset{\text{O}}{\parallel} \text{C}^{\oplus}$       (B)  $\text{C}_6\text{H}_5 - \overset{\text{O}}{\parallel} \text{C} - \text{O}^{\ominus}$       (C)  $\text{C}_6\text{H}_5 - \overset{\text{O}}{\parallel} \text{C} - \ddot{\text{O}}$       (D)  $\text{C}_6\text{H}_5 - \overset{\text{O}}{\parallel} \text{C} - \ddot{\text{O}}:$

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Which will have the highest enol content?



Consider the ions/molecule



For increasing bond order the correct option is:

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

A chemical which stimulates the secretion of pepsin is:

- (A) Anti histamine (B) Cimetidine (C) Histamine (D) Zantac

Which statement is not true with respect to nitrate ion test?

- (A) A dark brown ring is formed at the junction of two solutions.  
 (B) Ring is formed due to nitroferrous sulphate complex.  
 (C) The brown complex is  $[Fe(H_2O)_5(NO)]SO_4$ .  
 (D) Heating the nitrate salt with conc.  $H_2SO_4$ , light brown fumes are evolved.

The  $\left(\frac{\partial E}{\partial T}\right)_P$  of different types of half cells are as follows:

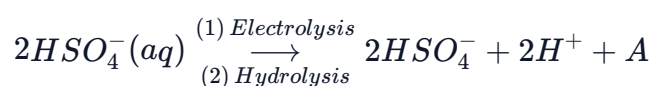
| A                  | B                  | C                    | D                    |
|--------------------|--------------------|----------------------|----------------------|
| $1 \times 10^{-4}$ | $2 \times 10^{-4}$ | $0.1 \times 10^{-4}$ | $0.2 \times 10^{-4}$ |

(Where E is the electromotive force)

Which of the above half cells would be preferred to be used as reference electrode?

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

Consider the following reaction:



The dihedral angle in product A in its solid phase at 110 K is:

- (A)  $104^\circ$  (B)  $111.5^\circ$  (C)  $90.2^\circ$  (D)  $111.0^\circ$

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Given below are two statements:

Statement I : According to Ellingham diagram, any metal oxide with higher  $\Delta G^\circ$  is more stable than the one with lower  $\Delta G^\circ$ .

Statement II : The metal involved in the formation of oxide placed lower in the Ellingham diagram can reduce the oxide of a metal placed higher in the diagram.

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

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

Choose the correct stability order of group 13 elements in their + 1 oxidation state:

- (A)  $\text{Al} < \text{Ga} < \text{In} < \text{Tl}$
- (B)  $\text{Tl} < \text{In} < \text{Ga} < \text{Al}$
- (C)  $\text{Al} < \text{Ga} < \text{Tl} < \text{In}$
- (D)  $\text{Al} < \text{Tl} < \text{Ga} < \text{In}$

The correct order of melting points of hydrides of group 16 elements is:

- (A)  $\text{H}_2\text{S} < \text{H}_2\text{Se} < \text{H}_2\text{Te} < \text{H}_2\text{O}$
- (B)  $\text{H}_2\text{O} < \text{H}_2\text{S} < \text{H}_2\text{Se} < \text{H}_2\text{Te}$
- (C)  $\text{H}_2\text{S} < \text{H}_2\text{Te} < \text{H}_2\text{Se} < \text{H}_2\text{O}$
- (D)  $\text{H}_2\text{Se} < \text{H}_2\text{S} < \text{H}_2\text{Te} < \text{H}_2\text{O}$

Consider the following reaction:



If B is an oxoacid of phosphorus with no P-H bond, then A is:

- (A) White  $\text{P}_4$
- (B) Red  $\text{P}_4$
- (C)  $\text{P}_2\text{O}_3$
- (D)  $\text{H}_3\text{PO}_3$

Which of the following sets are correct regarding polymer?

- (A) Copolymer : Buna-S
- (B) Condensation polymer : Nylon-6,6
- (C) Fibres : Nylon-6,6
- (D) Thermosetting polymer : Terylene
- (E) Homopolymer : Buna-N

Choose the correct answer from given options below:

- (A) (A), (B) and (C) are correct
- (B) (B), (C) and (D) are correct
- (C) (A), (C) and (E) are correct
- (D) (A), (B) and (D) are correct

The correct order of melting point is:

- (A)  $\text{Be} > \text{Mg} > \text{Ca} > \text{Sr}$
- (B)  $\text{Sr} > \text{Ca} > \text{Mg} > \text{Be}$
- (C)  $\text{Be} > \text{Ca} > \text{Mg} > \text{Sr}$
- (D)  $\text{Be} > \text{Ca} > \text{Sr} > \text{Mg}$

**Q42** Mole Concept & Stoichiometry[Step-by-step solution](https://www.prepwiser.in/questions/qUjKx8Z-cC) › prepwiser.in/questions/qUjKx8Z-cC

A commercially sold conc. HCl is 35% HCl by mass. If the density of this commercial acid is 1.46 g/mL, the molarity of this solution is:

(Atomic mass : Cl = 35.5 amu, H = 1 amu)

- (A) 10.2 M                      (B) 12.5 M                      (C) 14.0 M                      (D) 18.2 M

**Q43** Atomic Structure[Step-by-step solution](https://www.prepwiser.in/questions/eu4ozKfqLC) › prepwiser.in/questions/eu4ozKfqLC

If the radius of the 3<sup>rd</sup> Bohr's orbit of hydrogen atom is  $r_3$  and the radius of 4<sup>th</sup> Bohr's orbit is  $r_4$ . Then:

- (A)  $r_4 = \frac{9}{16} r_3$                       (B)  $r_4 = \frac{16}{9} r_3$                       (C)  $r_4 = \frac{3}{4} r_3$                       (D)  $r_4 = \frac{4}{3} r_3$

**Q44** Purification & Characterisation of Organic Compounds[Step-by-step solution](https://www.prepwiser.in/questions/Bm54yEZDgp) › prepwiser.in/questions/Bm54yEZDgp

Given below are two statements:

Statement I : In 'Lassaigne's Test', when both nitrogen and sulphur are present in an organic compound, sodium thiocyanate is formed.

Statement II : If both nitrogen and sulphur are present in an organic compound, then the excess of sodium used in sodium fusion will decompose the sodium thiocyanate formed to give NaCN and Na<sub>2</sub>S.

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

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

**Chemistry Section B · Numerical value**

Q45 to Q53

**Q45** Alcohols, Phenols & Ethers **NUMERICAL**[Step-by-step solution](https://www.prepwiser.in/questions/zbD23_ZwuP) › prepwiser.in/questions/zbD23\_ZwuP

Compound 'P' on nitration with dil. HNO<sub>3</sub> yields two isomers (A) and (B). These isomers can be separated by steam distillation. Isomers (A) and (B) show the intramolecular and intermolecular hydrogen bonding respectively. Compound (P) on reaction with conc. HNO<sub>3</sub> yields a yellow compound 'C', a strong acid. The number of oxygen atoms is present in compound 'C' \_\_\_\_\_.

**Q46** Carbohydrates & Biomolecules **NUMERICAL**[Step-by-step solution](https://www.prepwiser.in/questions/Reyb8Z8T8j) › prepwiser.in/questions/Reyb8Z8T8j

The number of oxygens present in a nucleotide formed from a base, that is present only in RNA is \_\_\_\_\_.

**Q47** Chemical Kinetics **NUMERICAL**[Step-by-step solution](https://www.prepwiser.in/questions/IfAxRojd8P) › prepwiser.in/questions/IfAxRojd8P

A flask is filled with equal moles of A and B. The half lives of A and B are 100 s and 50 s respectively and are independent of the initial concentration. The time required for the concentration of A to be four times that of B is \_\_\_\_\_ s.

(Given :  $\ln 2 = 0.693$ )

**Q48** Coordination Compounds **NUMERICAL**[Step-by-step solution](https://www.prepwiser.in/questions/iAGy8fVGly) › prepwiser.in/questions/iAGy8fVGly

The spin-only magnetic moment value of an octahedral complex among CoCl<sub>3</sub>.4NH<sub>3</sub>, NiCl<sub>2</sub>.6H<sub>2</sub>O and PtCl<sub>4</sub>.2HCl, which upon reaction with excess of AgNO<sub>3</sub> gives 2 moles of AgCl is \_\_\_\_\_ B.M.  
(Nearest integer)

The spin-only magnetic moment value of the most basic oxide of vanadium among  $V_2O_3$ ,  $V_2O_4$  and  $V_2O_5$  is \_\_\_\_\_ B.M. (Nearest integer)

50 mL of 0.1 M  $CH_3COOH$  is being titrated against 0.1 M  $NaOH$ . When 25 mL of  $NaOH$  has been added, the pH of the solution will be \_\_\_\_\_  $\times 10^{-2}$ . (Nearest integer)

(Given :  $pK_a(CH_3COOH) = 4.76$ )

$$\log 2 = 0.30$$

$$\log 3 = 0.48$$

$$\log 5 = 0.69$$

$$\log 7 = 0.84$$

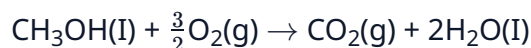
$$\log 11 = 1.04$$

A 0.5 percent solution of potassium chloride was found to freeze at  $-0.24^\circ C$ . The percentage dissociation of potassium chloride is \_\_\_\_\_. (Nearest integer)

(Molal depression constant for water is  $1.80 K kg mol^{-1}$  and molar mass of  $KCl$  is  $74.6 g mol^{-1}$ )

On complete combustion 0.30 g of an organic compound gave 0.20 g of carbon dioxide and 0.10 g of water. The percentage of carbon in the given organic compound is \_\_\_\_\_. (Nearest integer)

For complete combustion of methanol



the amount of heat produced as measured by bomb calorimeter is  $726 kJ mol^{-1}$  at  $27^\circ C$ . The enthalpy of combustion for the reaction is  $-x kJ mol^{-1}$ , where x is \_\_\_\_\_. (Nearest integer)

(Given :  $R = 8.3 JK^{-1} mol^{-1}$ )

## Mathematics Section A · Multiple choice

Q54 to Q72

If the two lines  $l_1 : \frac{x-2}{3} = \frac{y+1}{-2}, z = 2$  and  $l_2 : \frac{x-1}{1} = \frac{2y+3}{\alpha} = \frac{z+5}{2}$  are perpendicular, then an angle between the lines  $l_2$  and  $l_3 : \frac{1-x}{3} = \frac{2y-1}{-4} = \frac{z}{4}$  is:

- (A)  $\cos^{-1}\left(\frac{29}{4}\right)$  (B)  $\sec^{-1}\left(\frac{29}{4}\right)$  (C)  $\cos^{-1}\left(\frac{2}{29}\right)$  (D)  $\cos^{-1}\left(\frac{2}{\sqrt{29}}\right)$

Let the plane  $2x + 3y + z + 20 = 0$  be rotated through a right angle about its line of intersection with the plane  $x - 3y + 5z = 8$ . If the mirror image of the point  $(2, -\frac{1}{2}, 2)$  in the rotated plane is  $B(a, b, c)$ , then:

- (A)  $\frac{a}{8} = \frac{b}{5} = \frac{c}{-4}$  (B)  $\frac{a}{4} = \frac{b}{5} = \frac{c}{-2}$  (C)  $\frac{a}{8} = \frac{b}{-5} = \frac{c}{4}$  (D)  $\frac{a}{4} = \frac{b}{5} = \frac{c}{2}$

**Q56** Applications of Derivatives[Step-by-step solution](#) > [prepwisar.in/questions/cjX6M1O1MC](https://www.prepwisar.in/questions/cjX6M1O1MC)

The sum of the absolute minimum and the absolute maximum values of the function  $f(x) = |3x - x^2 + 2| - x$  in the interval  $[-1, 2]$  is:

- (A)  $\frac{\sqrt{17} + 3}{2}$  (B)  $\frac{\sqrt{17} + 5}{2}$  (C) 5 (D)  $\frac{9 - \sqrt{17}}{2}$

**Q57** Applications of Derivatives[Step-by-step solution](#) > [prepwisar.in/questions/bFH-HbXT5k](https://www.prepwisar.in/questions/bFH-HbXT5k)

Let  $S$  be the set of all the natural numbers, for which the line  $\frac{x}{a} + \frac{y}{b} = 2$  is a tangent to the curve  $\left(\frac{x}{a}\right)^n + \left(\frac{y}{b}\right)^n = 2$  at the point  $(a, b)$ ,  $ab \neq 0$ . Then:

- (A)  $S = \phi$  (B)  $n(S) = 1$  (C)  $S = \{2k : k \in \mathbb{N}\}$  (D)  $S = \mathbb{N}$

**Q58** Inverse Trigonometric Functions[Step-by-step solution](#) > [prepwisar.in/questions/m324ATevzA](https://www.prepwisar.in/questions/m324ATevzA)

Let  $f(x) = 2\cos^{-1}x + 4\cot^{-1}x - 3x^2 - 2x + 10$ ,  $x \in [-1, 1]$ . If  $[a, b]$  is the range of the function  $f$ , then  $4a - b$  is equal to:

- (A) 11 (B)  $11 - \pi$  (C)  $11 + \pi$  (D)  $15 - \pi$

**Q59** Binomial Theorem[Step-by-step solution](#) > [prepwisar.in/questions/ONTxsWiAxs](https://www.prepwisar.in/questions/ONTxsWiAxs)

The remainder when  $(2021)^{2023}$  is divided by 7 is:

- (A) 1 (B) 2 (C) 5 (D) 6

**Q60** Circles[Step-by-step solution](#) > [prepwisar.in/questions/XpI0kCke5L](https://www.prepwisar.in/questions/XpI0kCke5L)

Let  $C$  be a circle passing through the points  $A(2, -1)$  and  $B(3, 4)$ . The line segment  $AB$  is not a diameter of  $C$ . If  $r$  is the radius of  $C$  and its centre lies on the circle  $(x - 5)^2 + (y - 1)^2 = \frac{13}{2}$ , then  $r^2$  is equal to:

- (A) 32 (B)  $\frac{65}{2}$  (C)  $\frac{61}{2}$  (D) 30

**Q61** Complex Numbers[Step-by-step solution](#) > [prepwisar.in/questions/m796kHLWDe](https://www.prepwisar.in/questions/m796kHLWDe)

Let  $A = \left\{z \in \mathbb{C} : \left|\frac{z+1}{z-1}\right| < 1\right\}$  and

$$B = \left\{z \in \mathbb{C} : \arg\left(\frac{z-1}{z+1}\right) = \frac{2\pi}{3}\right\}$$

. Then  $A \cap B$  is:

- (A) a portion of a circle centred at  $\left(0, -\frac{1}{\sqrt{3}}\right)$  that lies in the second and third quadrants only  
(B) a portion of a circle centred at  $\left(0, -\frac{1}{\sqrt{3}}\right)$  that lies in the second quadrant only  
(C) an empty set  
(D) a portion of a circle of radius  $\frac{2}{\sqrt{3}}$  that lies in the third quadrant only

**Q62** Relations & Functions (Basic)[Step-by-step solution](#) > [prepwisar.in/questions/CZltMsZSgr](https://www.prepwisar.in/questions/CZltMsZSgr)

Let  $f(x) = \frac{x-1}{x+1}$ ,  $x \in \mathbb{R} - \{0, -1, 1\}$ . If  $f^{n+1}(x) = f(f^n(x))$  for all  $n \in \mathbb{N}$ , then  $f^6(6) + f^7(7)$  is equal to:

- (A)  $\frac{7}{6}$  (B)  $-\frac{3}{2}$  (C)  $\frac{7}{12}$  (D)  $-\frac{11}{12}$

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$$\lim_{x \rightarrow \frac{1}{\sqrt{2}}} \frac{\sin(\cos^{-1}x) - x}{1 - \tan(\cos^{-1}x)}$$

is equal to:

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

Let  $f, g : \mathbb{R} \rightarrow \mathbb{R}$  be two real valued functions defined as

$$f(x) = \begin{cases} -|x+3| & , \quad x < 0 \\ e^x & , \quad x \geq 0 \end{cases}$$

and

$$g(x) = \begin{cases} x^2 + k_1x & , \quad x < 0 \\ 4x + k_2 & , \quad x \geq 0 \end{cases}$$

, where  $k_1$  and  $k_2$  are real constants. If  $(g \circ f)$  is differentiable at  $x = 0$ , then  $(g \circ f)(-4) + (g \circ f)(4)$  is equal to:

- (A)  $4(e^4 + 1)$  (B)  $2(2e^4 + 1)$  (C)  $4e^4$  (D)  $2(2e^4 - 1)$

Let  $A$  be a  $3 \times 3$  invertible matrix. If  $|\text{adj}(24A)| = |\text{adj}(3 \text{ adj}(2A))|$ , then  $|A|^2$  is equal to:

- (A)  $6^6$  (B)  $2^{12}$  (C)  $2^6$  (D) 1

The ordered pair  $(a, b)$ , for which the system of linear equations

$$3x - 2y + z = b$$

$$5x - 8y + 9z = 3$$

$$2x + y + az = -1$$

has no solution, is:

- (A)  $\left(3, \frac{1}{3}\right)$  (B)  $\left(-3, \frac{1}{3}\right)$  (C)  $\left(-3, -\frac{1}{3}\right)$  (D)  $\left(3, -\frac{1}{3}\right)$

Let the normal at the point on the parabola  $y^2 = 6x$  pass through the point  $(5, -8)$ . If the tangent at  $P$  to the parabola intersects its directrix at the point  $Q$ , then the ordinate of the point  $Q$  is:

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

Let a biased coin be tossed 5 times. If the probability of getting 4 heads is equal to the probability of getting 5 heads, then the probability of getting atmost two heads is:

- (A)  $\frac{275}{6^5}$  (B)  $\frac{36}{5^4}$  (C)  $\frac{181}{5^5}$  (D)  $\frac{46}{6^4}$

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The mean of the numbers  $a, b, 8, 5, 10$  is 6 and their variance is 6.8. If  $M$  is the mean deviation of the numbers about the mean, then  $25M$  is equal to:

- (A) 60 (B) 55 (C) 50 (D) 45

If

$$\vec{a} \cdot \vec{b} = 1, \vec{b} \cdot \vec{c} = 2$$

and  $\vec{c} \cdot \vec{a} = 3$ , then the value of

$$\left[ \vec{a} \times (\vec{b} \times \vec{c}), \vec{b} \times (\vec{c} \times \vec{a}), \vec{c} \times (\vec{b} \times \vec{a}) \right]$$

is:

- (A) 0 (B)  $-6\vec{a} \cdot (\vec{b} \times \vec{c})$  (C)  $-12\vec{c} \cdot (\vec{a} \times \vec{b})$  (D)  $-12\vec{b} \cdot (\vec{c} \times \vec{a})$

The area bounded by the curve  $y = |x^2 - 9|$  and the line  $y = 3$  is:

- (A)  $4(2\sqrt{3} + \sqrt{6} - 4)$  (B)  $4(4\sqrt{3} + \sqrt{6} - 4)$  (C)  $8(4\sqrt{3} + 3\sqrt{6} - 9)$  (D)  $8(4\sqrt{3} + 2\sqrt{6} - 9)$

Let  $R$  be the point  $(3, 7)$  and let  $P$  and  $Q$  be two points on the line  $x + y = 5$  such that  $PQR$  is an equilateral triangle. Then the area of  $\triangle PQR$  is:

- (A)  $\frac{25}{4\sqrt{3}}$  (B)  $\frac{25\sqrt{3}}{2}$  (C)  $\frac{25}{\sqrt{3}}$  (D)  $\frac{25}{2\sqrt{3}}$

## Mathematics Section B · Numerical value

Q73 to Q82

Let  $f(x) = \max \{|x + 1|, |x + 2|, \dots, |x + 5|\}$ . Then  $\int_{-6}^0 f(x) dx$  is equal to \_\_\_\_\_.

The value of the integral

$$\frac{48}{\pi^4} \int_0^{\pi} \left( \frac{3\pi x^2}{2} - x^3 \right) \frac{\sin x}{1 + \cos^2 x} dx$$

is equal to \_\_\_\_\_.

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

$(4 + x^2)dy - 2x(x^2 + 3y + 4)dx = 0$  pass through the origin. Then  $y(2)$  is equal to \_\_\_\_\_.

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Let

$$S = (0, 2\pi) - \left\{ \frac{\pi}{2}, \frac{3\pi}{4}, \frac{3\pi}{2}, \frac{7\pi}{4} \right\}$$

. Let  $y = y(x)$ ,  $x \in S$ , be the solution curve of the differential equation

$$\frac{dy}{dx} = \frac{1}{1 + \sin 2x}, y\left(\frac{\pi}{4}\right) = \frac{1}{2}$$

. If the sum of abscissas of all the points of intersection of the curve  $y = y(x)$  with the curve  $y = \sqrt{2} \sin x$  is  $\frac{k\pi}{12}$ , then  $k$  is equal to \_\_\_\_\_.

Let the common tangents to the curves  $4(x^2 + y^2) = 9$  and  $y^2 = 4x$  intersect at the point Q. Let an ellipse, centered at the origin O, has lengths of semi-minor and semi-major axes equal to OQ and 6, respectively. If  $e$  and  $l$  respectively denote the eccentricity and the length of the latus rectum of this ellipse, then  $\frac{l}{e^2}$  is equal to \_\_\_\_\_.

There are ten boys  $B_1, B_2, \dots, B_{10}$  and five girls  $G_1, G_2, \dots, G_5$  in a class. Then the number of ways of forming a group consisting of three boys and three girls, if both  $B_1$  and  $B_2$  together should not be the members of a group, is \_\_\_\_\_.

The sum of the cubes of all the roots of the equation  $x^4 - 3x^3 - 2x^2 + 3x + 1 = 0$  is \_\_\_\_\_.

Let  $A = \{n \in \mathbb{N} : \text{H.C.F.}(n, 45) = 1\}$  and

Let  $B = \{2k : k \in \{1, 2, \dots, 100\}\}$ . Then the sum of all the elements of  $A \cap B$  is \_\_\_\_\_.

Let  $A = \sum_{i=1}^{10} \sum_{j=1}^{10} \min\{i, j\}$  and  $B = \sum_{i=1}^{10} \sum_{j=1}^{10} \max\{i, j\}$ . Then  $A + B$  is equal to \_\_\_\_\_.

If  $\sin^2(10^\circ) \sin(20^\circ) \sin(40^\circ) \sin(50^\circ) \sin(70^\circ) = \alpha - \frac{1}{16} \sin(10^\circ)$ , then  $16 + \alpha^{-1}$  is equal to \_\_\_\_\_.

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## Physics

|               |              |                |              |                |                |               |              |
|---------------|--------------|----------------|--------------|----------------|----------------|---------------|--------------|
| 1. <b>D</b>   | 2. <b>A</b>  | 3. <b>A</b>    | 4. <b>C</b>  | 5. <b>C</b>    | 6. <b>B</b>    | 7. <b>A</b>   | 8. <b>C</b>  |
| 9. <b>D</b>   | 10. <b>B</b> | 11. <b>C</b>   | 12. <b>A</b> | 13. <b>A</b>   | 14. <b>B</b>   | 15. <b>B</b>  | 16. <b>C</b> |
| 17. <b>C</b>  | 18. <b>C</b> | 19. <b>C</b>   | 20. <b>0</b> | 21. <b>400</b> | 22. <b>210</b> | 23. <b>60</b> | 24. <b>5</b> |
| 25. <b>25</b> | 26. <b>6</b> | 27. <b>363</b> | 28. <b>5</b> |                |                |               |              |

## Chemistry

|                |              |                |              |              |                |               |               |
|----------------|--------------|----------------|--------------|--------------|----------------|---------------|---------------|
| 29. <b>D</b>   | 30. <b>C</b> | 31. <b>A</b>   | 32. <b>C</b> | 33. <b>B</b> | 34. <b>C</b>   | 35. <b>C</b>  | 36. <b>D</b>  |
| 37. <b>A</b>   | 38. <b>A</b> | 39. <b>B</b>   | 40. <b>A</b> | 41. <b>D</b> | 42. <b>C</b>   | 43. <b>B</b>  | 44. <b>A</b>  |
| 45. <b>7</b>   | 46. <b>9</b> | 47. <b>200</b> | 48. <b>3</b> | 49. <b>3</b> | 50. <b>476</b> | 51. <b>98</b> | 52. <b>18</b> |
| 53. <b>727</b> |              |                |              |              |                |               |               |

## Mathematics

|                 |               |                 |                 |               |               |               |              |
|-----------------|---------------|-----------------|-----------------|---------------|---------------|---------------|--------------|
| 54. <b>B</b>    | 55. <b>A</b>  | 56. <b>A</b>    | 57. <b>D</b>    | 58. <b>B</b>  | 59. <b>C</b>  | 60. <b>B</b>  | 61. <b>B</b> |
| 62. <b>B</b>    | 63. <b>D</b>  | 64. <b>D</b>    | 65. <b>C</b>    | 66. <b>C</b>  | 67. <b>B</b>  | 68. <b>D</b>  | 69. <b>A</b> |
| 70. <b>A</b>    | 71. <b>D</b>  | 72. <b>D</b>    | 73. <b>21</b>   | 74. <b>6</b>  | 75. <b>12</b> | 76. <b>42</b> | 77. <b>4</b> |
| 78. <b>1120</b> | 79. <b>36</b> | 80. <b>5264</b> | 81. <b>1100</b> | 82. <b>80</b> |               |               |              |

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