JEE–MAIN EXAMINATION – APRIL 2025

(HELD ON WEDNESDAY 2nd APRIL 2025) **TIME : 3:00 PM TO 6:00 PM**

PHYSICS **TEST PAPER WITH SOLUTION**

SECTION-A

26. Given below are two statements : one is labelled as **Assertion (A)** and the other is labelled as **Reason (R).**

Assertion (A) : Net dipole moment of a polar linear isotropic dielectric substance is not zero even in the absence of an external electric field.

Reason (R) : In absence of an external electric field, the different permanent dipoles of a polar dielectric substance are oriented in random directions.

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

(1) **(A)** is correct but **(R)** is not correct

(2) Both **(A)** and **(R)** are correct but **(R)** is **not** the correct explanation of **(A)**

(3) Both **(A)** and **(R)** are correct and **(R)** is the correct explanation of **(A)**

(4) **(A)** is not correct but **(R)** is correct

Ans. (4)

Sol. A : Since polar dielectrics are randomly oriental $\vec{P}_{net} = \vec{0}$.

R : If $\vec{E}$ is absent, polar dielectric remain polar & are randomly oriented.

27. In a moving coil galvanometer, two moving coils M_1 and M_2 have the following particulars :

$R_1 = 5\ \Omega$, $N_1 = 15$, $A_1 = 3.6 \times 10^{-3}\ m^2$, $B_1 = 0.25$ T

$R_2 = 7\ \Omega$, $N_2 = 21$, $A_2 = 1.8 \times 10^{-3}\ m^2$, $B_2 = 0.50$ T

Assuming that torsional constant of the springs are same for both coils, what will be the ratio of voltage sensitivity of M_1 and M_2 ?

(1) 1 : 1 (2) 1 : 4

(3) 1 : 3 (4) 1 : 2

Ans. (1)

Sol. Voltage sensitivity = $\frac{\theta}{V} = \frac{NAB}{cR}$

$$\text{Ratio} = \left(\frac{N_1A_1B_1}{N_2A_2B_2}\right)\frac{R_2}{R_1} = \frac{15\times3.6\times0.25}{21\times1.8\times0.5}\times\frac{7}{5} = \frac{1}{1}$$

28. The moment of inertia of a circular ring of mass M and diameter r about a tangential axis lying in the plane of the ring is :

(1) $\frac{1}{2}Mr^2$ (2) $\frac{3}{8}Mr^2$

(3) $\frac{3}{2}Mr^2$ (4) $2\ Mr^2$

Ans. (2)

Sol. Diameter is given as R.

$\therefore$ Radius = R/2

$$I_{\tan gent} = \frac{3}{2}m\left(\frac{R}{2}\right)^2 = \frac{3}{8}mR^2$$

29. Two water drops each of radius 'r' coalesce to from a bigger drop. If 'T' is the surface tension, the surface energy released in this process is :

(1) $4\pi r^2T\left[2-2^{\frac{2}{3}}\right]$ (2) $4\pi r^2T\left[2-2^{\frac{1}{3}}\right]$

(3) $4\pi r^2T\left[1+\sqrt{2}\right]$ (4) $4\pi r^2T\left[\sqrt{2}-1\right]$

Ans. (1)

Sol. $2\times\frac{4}{3}\pi R^3 = \frac{4}{3}\pi r^3 \Rightarrow r = 2^{1/3}R$

$U_i = 2 \times 4\pi R^2T$

$U_f = 4\pi r^2T = 4\pi R^2T2^{2/3}$

$\therefore$ Heat lost = $u_i - u_f = 4\pi R^2T[2-2^{2/3}]$

30. An electron with mass 'm' with an initial velocity $(t = 0)\ \vec{v} = v_0\hat{i}\ (v_0 > 0)$ enters a magnetic field $\vec{B} = B_0\hat{j}$. If the initial de-Broglie wavelength at t = 0 is λ_0 then its value after time 't' would be :

(1) $\dfrac{\lambda_0}{\sqrt{1-\dfrac{e^2B_0^2t^2}{m^2}}}$ (2) $\dfrac{\lambda_0}{\sqrt{1+\dfrac{e^2B_0^2t^2}{m^2}}}$

(3) $\lambda_0\sqrt{1+\dfrac{e^2B_0^2t^2}{m^2}}$ (4) λ_0

Ans. (4)

Sol. Magnetic field does not work

$\therefore$ Speed will not charge, so De-Broglie wavelength remains same.

31. A sinusoidal wave of wavelength 7.5 cm travels a distance of 1.2 cm along the x-direction in 0.3 sec. The crest P is at x = 0 at t = 0 sec and maximum displacement of the wave is 2 cm. Which equation correctly represents this wave ?

(1) $y = 2\cos(0.83x - 3.35t)$ cm

(2) $y = 2\sin(0.83x - 3.5t)$ cm

(3) $y = 2\cos(3.35x - 0.83t)$ cm

(4) $y = 2\cos(0.13x - 0.5t)$ cm

Ans. **(1)**

Sol. $v = \frac{\text{distance}}{\text{time}}$

$v = \frac{12}{0.3} = 4 \text{ cm/s}$

$k = \frac{2\pi}{\lambda} = \frac{2\pi}{7.5} = \frac{4\pi}{15} = 0.83$

$v = \frac{\omega}{k} \Rightarrow \omega = vk = 4 \times \frac{4\pi}{15} = 3.35$

So $y = A\cos(kx - \omega t)$

32. Given a charge q, current I and permeability of vacuum μ_0. Which of the following quantity has the dimension of momentum ?

(1) qI/μ_0 (2) $q\mu_0 I$

(3) $q^2 \mu_0 I$ (4) $q\mu_0/I$

Ans. **(2)**

Sol. $Q = AT$

$I = A$

$\mu_0 = MLT^{-2}A^{-2}$

$P = Q^x \mu_0^y I^z = [AT]^x [MLT^{-2}A^{-2}]^y [A]^z$

$MLT^{-1} = M^y L^y T^{x-2y} A^{-2y+z+x}$

Now; $y = 1$

$x - 2y = -1$

$-2y + z = 0$

$\therefore x = y = z = 1$

33. A solenoid having area A and length 'l' is filled with a material having relative permeability 2. The magnetic energy stored in the solenoid is :

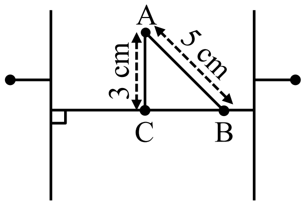
(1) $\frac{B^2Al}{\mu_0}$ (2) $\frac{B^2Al}{2\mu_0}$

(3) B^2Al (4) $\frac{B^2Al}{4\mu_0}$

Ans. **(4)**

Sol. $\frac{U}{V} = \frac{B^2}{2\mu_r u_0} \Rightarrow U = \frac{B^2}{4\mu_0}V = \frac{B^2}{4\mu_0}A\ell$

34. Two large plane parallel conducting plates are kept 10 cm apart as shown in figure. The potential difference between them is V. The potential difference between the points A and B (shown in the figure) is :

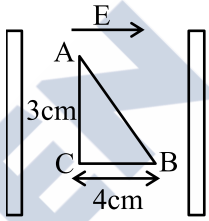


(1) $\frac{1}{4}$V (2) $\frac{2}{5}$V

(3) $\frac{3}{4}$V (4) 1 V

Ans. **(2)**

Sol.



Using $\Delta V = E(\Delta d)$

$V = E(10)$

$V_{AB} = E.4 = \frac{V}{10} \times 4 = \frac{2V}{5}$

35. Identify the characteristics of an adiabatic process in a monoatomic gas.

(A) Internal energy is constant.

(B) Work done in the process is equal to the charge in internal energy.

(C) The product of temperature and volume is a constant.

(D) The product of pressure and volume is a constant.

(E) The work done to change the temperature from T_1 to T_2 is proportional to $(T_2 - T_1)$

Choose the **correct** answer from the options given below :

(1) (A), (C), (D) only (2) (A), (C), (E) only

(3) (B), (E) only (4) (B), (D) only

Ans. **(3)**

Sol. $Q = \Delta U + W = 0 \Rightarrow -\Delta U = W$

$WD = -nC_v\Delta T \Rightarrow |WD| = nC_v\Delta T \propto T_2 - T_1$

$\therefore$ B & E [Only possibility]

36. Assuming the validity of Bohr's atomic model for hydrogen like ions the radius of Li^{++} ion in its ground state is given by $\frac{1}{X}a_0$, where X = ______.

(Where a_0 is the first Bohr's radius.)

(1) 2 (2) 1

(3) 3 (4) 9

Ans. (3)

Sol. $r = r_0 \frac{n^2}{z}$ & z = 3 for Li^{+2} and n = 1

$\therefore r = r_0 \frac{1^2}{3} = \frac{r_0}{3}$ $\therefore x = 3$

37. Energy released when two deuterons ($_1H^2$) fuse to form a helium nucleus ($_2He^4$) is :

(Given : Binding energy per nucleon of $_1H^2$ = 1.1 MeV and binding energy per nucleon of $_2He^4$ = 7.0 MeV)

(1) 8.1 MeV (2) 5.9 MeV

(3) 23.6 MeV (4) 26.8 MeV

Ans. (3)

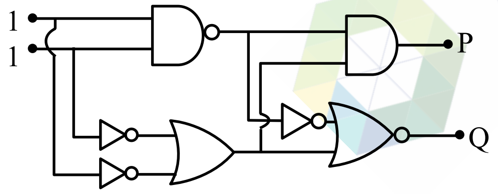
Sol. $\underset{1.1\text{MeV}}{_1H^2} + {_1H^2} \rightarrow \underset{7.0\text{MeV}}{_1He^4}$

$E_B = BE_{reactant} - BE_{product}$

$= 1.1 \times 2 + 1.1 \times 2 - 7 \times 4 = -23.6$ MeV

$= Q = 23.6$ MeV

38. In the digital circuit shown in the figure, for the given inputs the P and Q values are :

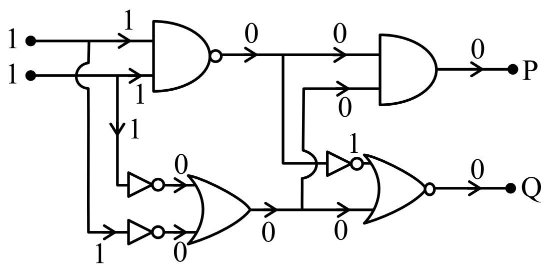


(1) P = 1, Q = 1 (2) P = 0, Q = 0

(3) P = 0, Q = 1 (4) P = 1, Q = 0

Ans. (2)

Sol.



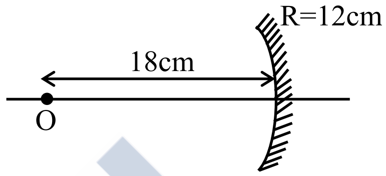
39. Two identical objects are placed in front of convex mirror and concave mirror having same radii of curvature of 12 cm, at same distance of 18 cm from the respective mirrors. The ratio of sizes of the images formed by convex mirror and by concave mirror is :

(1) 1/2 (2) 2

(3) 3 (4) 1/3

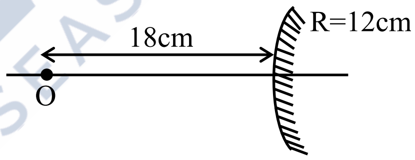
Ans. (1)

Sol.



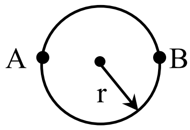
Using $m = \frac{f}{u-f}$

$m_1 = \frac{6}{18-6} = \frac{1}{2}$



$m_2 = \frac{6}{18+6} = \frac{1}{4}$ $\therefore \frac{m_2}{m_1} = \frac{1}{2}$

40. A sportsman runs around a circular track of radius r such that he traverses the path ABAB. The distance travelled and displacement, respectively, are



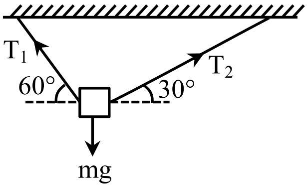
(1) 2r, 3πr (2) 3πr, πr

(3) πr, 3r (4) 3πr, 2r

Ans. (4)

Sol. Displacement = 2r

Distance = 2πr + πr = 3πr

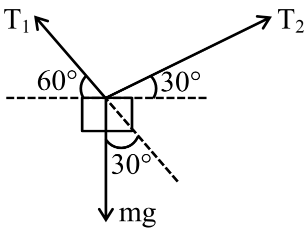
41. 

A body of mass 1kg is suspended with the help of two strings making angles as shown in figure. Magnitude of tensions T_1 and T_2, respectively, are (in N) :

(1) $5,\ 5\sqrt{3}$ (2) $5\sqrt{3}$, 5

(3) $5\sqrt{3},\ 5\sqrt{3}$ (4) 5, 5

Ans. **(2)**

Sol. 

$T_1 = mg\cos30°$

$T_2 = mg\sin30°$

42. A bi–convex lens has radius of curvature of both the surfaces same as 1/6 cm. If this lens is required to be replaced by another convex lens having different radii of curvatures on both sides ($R_1 \neq R_2$), without any change in lens power then possible combination of R_1 and R_2 is :

(1) $\frac{1}{3}$cm and $\frac{1}{3}$cm (2) $\frac{1}{5}$cm and $\frac{1}{7}$cm

(3) $\frac{1}{3}$cm and $\frac{1}{7}$cm (4) $\frac{1}{6}$cm and $\frac{1}{9}$cm

Ans. **(2)**

Sol. This will happen when

$$\frac{1}{f_1} = \frac{1}{f_2}$$

$$(\mu - 1)\left(\frac{1}{R_1} - \frac{1}{-R_2}\right) = (\mu - 1)\left(\frac{2}{R}\right)$$

$$\frac{1}{R_1} + \frac{1}{R_2} = \frac{2}{R}$$

43. If μ_0 and ε_0 are the permeability and permittivity of free space, respectively, then the dimension of $\left(\frac{1}{\mu_0\varepsilon_0}\right)$ is :

(1) L/T^2 (2) L^2/T^2

(3) T^2/L (4) T^2/L^2

Ans. **(2)**

Sol. $C = \frac{1}{\sqrt{\mu_0\varepsilon_0}} \Rightarrow \frac{1}{\mu_0\varepsilon_0} = C^2 = L^2T^{-2}$

44. Match **List-I with List-II**.

List-I	**List-II**
(A) Heat capacity of body	(I) $J\ kg^{-1}$
(B) Specific heat capacity of body	(II) JK^{-1}
(C) Latent heat	(III) $J\ kg^{-1}\ K^{-1}$
(D)Thermal conductivity	(IV) $Jm^{-1}K^{-1}s^{-1}$

Choose the **correct** answer from the options given below :

(1) (A)–(III), (B)–(I), (C)–(II), (D)–(IV)

(2) (A)–(IV), (B)–(III), (C)–(II), (D)–(I)

(3) (A)–(III), (B)–(IV), (C)–(I), (D)–(II)

(4) (A)–(II), (B)–(III), (C)–(I), (D)–(IV)

Ans. **(4)**

Sol. $C' = \frac{\Delta Q}{\Delta T} = JK^{-1}$

$$S = \frac{\Delta Q}{m\Delta T} = Jkg^{-1}K^{-1}$$

$$L = \frac{\Delta Q}{m} = Jkg^{-1}$$

$$\Delta Q = \frac{KA\Delta T}{L} \Rightarrow K = \frac{\Delta Q(L)}{A\Delta T} = Jm^{-1}K^{-1}s^{-1}$$

45. Consider a circular loop that is uniformly charged and has a radius $a\sqrt{2}$. Find the position along the positive z–axis of the cartesian coordinate system where the electric field is maximum if the ring was assumed to be placed in xy–plane at the origin :

(1) $\frac{a}{\sqrt{2}}$ (2) $\frac{a}{2}$

(3) a (4) 0

Ans. (3)

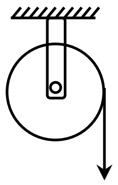
Sol. $E = \dfrac{KQr}{(x^2 + R^2)^{3/2}}$

$\dfrac{dE}{dx} = 0$

$\therefore x = \dfrac{R}{\sqrt{2}} = \dfrac{\sqrt{2}a}{\sqrt{2}} = a$

SECTION-B

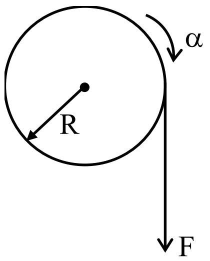
46.



A wheel of radius 0.2 m rotates freely about its center when a string that is wrapped over its rim is pulled by force of 10 N as shown in figure. The established torque produces an angular acceleration of 2 rad/s^2. Moment of inertia of the wheel is ________ kg m^2.

(Acceleration due to gravity = 10 m/s^2)

Ans. (1)



Sol.

$FR = I\alpha$

$\Rightarrow I = \dfrac{FR}{\alpha} = \dfrac{10 \times 0.2}{2} = 1$ kg–m^2

47. The internal energy of air in 4 m × 4 m × 3 m sized room at 1 atmospheric pressure will be ___ × 10^6 J. (Consider air as diatomic molecule)

Ans. (12)

Sol.

To find the internal energy of gas in the room.

$U = nC_vT = n\dfrac{5RT}{2}$

$= \dfrac{5}{2}PV = \dfrac{5}{2} \times 10^5 \times 48 = 12 \times 10^6$ J

48. A ray of light suffers minimum deviation when incident on a prism having angle of the prism equal to 60°. The refractive index of the prism material is $\sqrt{2}$. The angle of incidence (in degrees) is _____.

Ans. (45)

Sol. $\mu = \dfrac{\sin\left(\dfrac{A + \delta_m}{2}\right)}{\sin\left(\dfrac{A}{2}\right)}$, since A = 60° $\therefore$ δm = 30°

$\delta_m = 2i - A$ [as i = e]

$\Rightarrow i = 45°$

49. The length of a light string is 1.4 m when the tension on it is 5 N. If the tension increases to 7 N, the length of the string is 1.56 m. The original length of the string is _____ m.

Ans. (1)

Sol. $T = K(\ell - \ell_0)$

$\Rightarrow 5 = K(1.4 - \ell_0)$

$\Rightarrow 7 = K(1.56 - \ell_0)$

$\Rightarrow \dfrac{5}{1.4 - \ell_0} = \dfrac{7}{1.56 - \ell_0}$

$\therefore \ell_0 = 1$m

50. A satellite of mass 1000 kg is launched to revolve around the earth in an orbit at a height of 270 km from the earth's surface. Kinetic energy of the satellite in this orbit is ________ × 10^{10} J.

(Mass of earth = 6 × 10^{24} kg, Radius of earth = 6.4 × 10^6 m, Gravitational constant = 6.67 × 10^{-11} Nm^2 kg^{-2})

Ans. (3)

Sol. $KE = \dfrac{1}{2}mv^2 = \dfrac{1}{2}m\dfrac{GM_e}{r} = \dfrac{GM_e m}{2r} = \dfrac{GM_e m}{2(R_E + h)}$

$= \dfrac{6.67 \times 10^{-11} \times 6 \times 10^{24} \times 6.4 \times 10^6}{2(6.4 \times 10^6 + 2.7 \times 10^5)} = 3 \times 10^{10}$ J