# JEE Main April 2026

## Question Paper With Text Solution

## 02 April | Shift-1

# PHYSICS

MATRIX

JEE Main & Advanced | XI-XII Foundation| VI-X Pre-Foundation

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# JEE MAIN APRIL 2026 | 02 APRIL SHIFT-1

## SECTION – A

Question ID : 69112126

26. The dimensional formula of $\frac{1}{2}\epsilon_o E^2$ ($\epsilon_o$ = permittivity of vacuum and E = electric field) is $M^a L^b T^c$. The value of $2a - b + c =$ _________ .

(1) 0
(2) 1
(3) –1
(4) 2

**Ans.** (2)

**Sol.** The term $\frac{1}{2}\epsilon_0 E^2$ represents the energy density (energy per unit volume) of an electric field. By analyzing the dimensions of energy and volume, we can find the dimensions of the given expression.

Dimensional formula of Energy $[E] = M^1 L^2 T^{-2}$

Dimensional formula of Volume $[V] = L^3$

Energy density $u = \frac{\text{Energy}}{\text{Volume}}$.

$$[u] = \frac{M^1 L^2 T^{-2}}{L^3} = M^1 L^{-1} T^{-2}$$

Comparing this with the given dimensional formula $M^a L^b T^c$, we get :

a = 1
b = –1
c = –2
2a – b + c :
2 (1) – (–1) + (–2) = 2 + 1 – 2 = 1
Final Answer: 1

Question ID : 69112127

27. The diameter of a wire measured by a screw gauge of least count 0.001 cm is 0.08 cm. The length measured by a scale of least count 0.1 cm is 150 cm. When a weight of 100 N is applied to the wire, the extension in length is 0.5 cm, measured by a micrometer of least count 0.001 cm. The error in the

measured Young's modulus is $\alpha \times 10^9\ N/m^2$. The value of $\alpha$ is __________ .

(Ignore the contribution of the load to Young's modulus error calculation)

(1) 1.3 (2) 1.65

(3) 0.13 (4) 0.25

**Ans.** (2)

**Sol.** Young's Modulus is given by $Y = \frac{F \cdot L}{A \cdot \Delta L} = \frac{4FL}{\pi d^2 \Delta L}$. The fractional error in Young's modulus, (ignoring load error as given), is expressed as $\frac{\Delta Y}{Y} = \frac{\Delta L_0}{L_0} + 2\frac{\Delta d}{d} + \frac{\Delta(\Delta L)}{\Delta L}$

Load F = 100 N

Length $L = 150\,cm = 1.5\,m, \Delta L = 0.1\,cm$

Diameter $d = 0.08\,cm = 8 \times 10^{-4}\,m, \Delta d = 0.001\,cm$

Extension $x = 0.5\,cm = 5 \times 10^{-3}\,m, \Delta x = 0.001\,cm$

$$Y = \frac{4 \times 100 \times 1.5}{\pi \times \left(8 \times 10^{-4}\right)^2 \times \left(5 \times 10^{-3}\right)} = \frac{600}{\pi \times 64 \times 10^{-8} \times 5 \times 10^{-3}} = \frac{15}{8\pi} \times 10^{11}\ N/m^2$$

$$\frac{\Delta Y}{Y} = \frac{0.1}{150} + 2\left(\frac{0.001}{0.08}\right) + \frac{0.001}{0.5}$$

$$\frac{\Delta Y}{Y} = \frac{1}{1500} + \frac{1}{40} + \frac{1}{500} = \frac{2 + 75 + 6}{3000} = \frac{83}{3000}$$

$$\Delta Y = Y \times \frac{83}{3000} = \left(\frac{15}{8\pi} \times 10^{11}\right) \times \frac{83}{3000} = \frac{83}{1600\pi} \times 10^{11} = \frac{83}{16\pi} \times 10^9\ N/m^2$$

$$\alpha = \frac{83}{16 \times 3.14159} \approx \frac{83}{50.265} \approx 1.65$$

Question ID : 69112128

28. The velocity of a particle is given as $\vec{v} = -x\hat{i} + 2y\hat{j} - z\hat{k}\,\text{m/s}$. The magnitude of acceleration at point (1, 2, 4) is __________ $m/s^2$.

(1) $\sqrt{6}$ (2) 9

(3) $\sqrt{33}$ (4) 0

**Ans.** (2)

**Sol.** $a = v_x\frac{dv_x}{dx} + v_y\frac{dv_y}{dv} + v_z\frac{dv_z}{dz}$

$v = x\hat{i} + 2y\hat{j} - z\hat{k}$

$\frac{dv_x}{dx} = -\hat{i},\quad \frac{dv_y}{dy} = 2\hat{j},\quad \frac{dv_z}{dz} = -\hat{k}$

$a = (-x)(-\hat{i}) + (2y)(2\hat{j}) + (-z)(-\hat{k}) = x\hat{i} + 4y\hat{j} + z\hat{k}$

Evaluate acceleration at the specified point (1, 2, 4) :

$a = (1)\hat{i} + 4(2)\hat{j} + (4)\hat{k} = \hat{i} + 8\hat{j} + 4\hat{k}$

$|a| = 1^2 + 8^2 + 4^2 = 1 + 64 + 16 = \overline{81} = 9\,\text{m/s}^2$

Final Answer: 9

Question ID : 69112129

29. The position of an object having mass 0.1 kg as a function of time t is given as $\vec{r} = \left(10t^2\hat{i} + 5t^3\hat{j}\right)\text{m}$. At t = 1s, which of the following statements are correct?

A. The linear momentum $\vec{p} = (2\hat{i} + 1.5\hat{j})\,\text{kg.m/s}$.

B. The force acting on the object $\vec{F} = (2\hat{i} + 3\hat{j})\,\text{N}$.

C. The angular momentum of the object about its origin $\vec{L} = 15\hat{k}\,\text{Js}$.

D. The torque acting on the object about its origin $\vec{\tau} = 20\hat{k}\,\text{Nm}$.

Choose the correct answer from the options given below:

(1) A, B and C only (2) B, C and D only

(3) A, C and D only (4) A, B and D only

**Ans.** (4)

**Sol.** Given $r = 10t^2\hat{i} + 5t^3\hat{j}$ and $m = 0.1kg$

$$v = \frac{dr}{dt} = 20t\hat{i} + 15t^2\hat{j}$$

$$a = \frac{dv}{dt} = 20\hat{i} + 30t\hat{j}$$

Evaluate all vectors at t = 1s :

$$r = 10\hat{i} + 5\hat{j}$$

$$v = 20\hat{i} + 15\hat{j}$$

$$a = 20\hat{i} + 30\hat{j}$$

Statement A : $p = mv = 0.1(20\hat{i} + 15\hat{j}) = 2\hat{i} + 1.5\hat{j}\,kg\,m/s$ (Statement A is Correct).

Statement B : $F = ma = 0.1(20\hat{i} + 30\hat{j}) = 2\hat{i} + 3\hat{j}\,N$. (Statement B is Correct).

Statement C: $L = r \times p = (10\hat{i} + 5\hat{j}) \times (2\hat{i} + 1.5\hat{j})$

$$L = (10)(1.5)(\hat{i} \times \hat{j}) + (5)(2)(\hat{j} \times \hat{i}) = 15\hat{k} - 10\hat{k} = 5\hat{k}Js$$

(Statement C is Incorrect)

Statement D : $\tau = r \times F = (10\hat{i} + 5\hat{j}) \times (2\hat{i} + 3\hat{j})$

$$\tau = (10)(3)(\hat{i} \times \hat{j}) + (5)(2)(\hat{j} \times \hat{i}) = 30\hat{k} - 10\hat{k} = 20\hat{k}Nm.$$

(Statement D is Correct) .

Final Answer: A, B and D only

Question ID : 69112130

30. A planet ($P_1$) is moving around the star of mass 2M in the orbit of radius R. Another planet ($P_2$) is moving around another star of mass 4M in a orbit of radius 2R. Ratio of time periods of revolution of $P_2$ and $P_1$ is __________.

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

(2) 2

(3) 4

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

**Ans.** (2)

**Sol.** $T = 2\pi\sqrt{\frac{R^3}{GM}}$, meaning $T \propto \sqrt{\frac{R^3}{M}}$

For Planet 1 ($P_1$) : Radius $R_1$ = R, Central Mass $M_1$ = 2M.

$$T_1 \propto \sqrt{\frac{R^3}{2M}}$$

For Planet 2 ($P_2$) : Radius $R_2 = 2R$, Central Mass $M_2 = 4M$.

$$T_2 \propto \sqrt{\frac{(2R)^3}{4M}} = \sqrt{\frac{8R^3}{4M}} = \sqrt{\frac{2R^3}{M}}$$

Divide $T_2$ by $T_1$ to find the ratio:

$$\frac{T_2}{T_1} = \sqrt{\frac{\frac{2R^3}{M}}{\frac{R^3}{2M}}} = \sqrt{\frac{2}{\frac{1}{2}}} = \sqrt{4} = 2$$

Final Answer: 2

Question ID : 69112131

31. A particle is rotating in a circular path and at any instant its motion can be described as $\theta = \frac{5t^4}{40} - \frac{t^3}{3}$.

The angular acceleration of the particle after 10 seconds is __________ rad/s$^2$.

(1) 150
(2) 120
(3) 130
(4) 170

**Ans.** (3)

**Sol.** $\theta = \frac{5t^4}{40} - \frac{t^3}{3} = \frac{t^4}{8} - \frac{t^3}{3}$

$$\omega = \frac{d\theta}{dt} = \frac{4t^3}{8} - \frac{3t^2}{3} = 0.5t^3 - t^2$$

$$\alpha = \frac{d\omega}{dt} = 1.5t^2 - 2t$$

Substitute t = 10 seconds

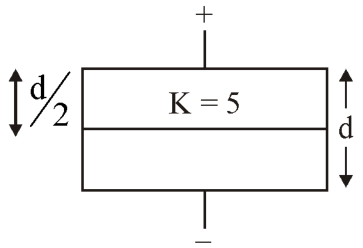
$$\alpha = 1.5(10)^2 - 2(10)$$

$$\alpha(10) = 1.5(100) - 20 = 150 - 20 = 130$$

Final Answer: 130

Question ID : 69112132

32. A parallel plate air capacitor has a capacitance C. When it is half filled as show in figure with a dielectric constant K = 5, the percentage increase in the capacitance is __________.




(1) 33.34
(2) 66.67
(3) 200
(4) 400

**Ans.** (2)

**Sol.** The initial capacitance with air (K = 1) is $C=\frac{\epsilon_0 A}{d}$.

The new configuration consists of two capacitors in series: $C_1$ (with dielectric K = 5 and thickness $\frac{d}{2}$) and $C_2$ (with air K = 1 and thickness $\frac{d}{2}$).

$$C_1=\frac{5\epsilon_0 A}{d/2}=10\frac{\epsilon_0 A}{d}=10C$$

$$C_2=\frac{1\epsilon_0 A}{d/2}=2\frac{\epsilon_0 A}{d}=2C$$

$$C_{eq}=\frac{C_1C_2}{C_1+C_2}=\frac{(10C)(2C)}{10C+2C}=\frac{20C^2}{12C}=\frac{5}{3}C$$

$$\text{Percentage Increase }=\frac{C_{eq}-C}{C}\times 100=\left(\frac{5/3C-C}{C}\right)\times 100=\frac{2}{3}\times 100$$

$$\text{P ercentage Increase }\approx 66.67$$

Final Answer: 66.67

Question ID : 69112133

33. Heat is supplied to a diatomic gas at constant pressure. Then the ratio of ΔQ : ΔU : ΔW is_________.

(1) 2 : 3 : 5 (2) 5 : 3 : 2

(3) 2 : 5 : 7 (4) 7 : 5 : 2

**Ans.** (4)

**Sol.** For an ideal gas, the First Law of Thermodynamics states $\Delta Q = \Delta U + \Delta W$. For an isobaric (constant pressure) process, heat supplied is $\Delta Q = nC_P\Delta T$, change in internal energy is $\Delta U = nC_V\Delta T$, and work done is $\Delta W = nR\Delta T$. A diatomic gas has 5 degrees of freedom at standard temperatures.

For a diatomic gas, the molar heat capacity at constant volume is $C_V = \frac{5}{2}R$ and at constant pressure is $C_P = \frac{7}{2}R$.

$$\Delta Q = n\left(\frac{7}{2}R\right)\Delta T$$

$$\Delta U = n\left(\frac{5}{2}R\right)\Delta T$$

$$\Delta W = nR\Delta T$$

$$\Delta Q : \Delta U : \Delta W : = \frac{7}{2} : \frac{5}{2} : 1$$

$$\text{Ratio} = 7 : 5 : 2$$

Question ID : 69112134

34. Two charged conducting spheres $S_1$ and $S_2$ of radii 8 cm and 18 cm are connected to each other by a wire. After equilibrium is established, the ratio of electric fields on $S_1$ and $S_2$ spheres are $E_{SI}$ and $E_{S2}$ respectively. The value of $\frac{E_{S1}}{E_{S2}}$ is __________ .

(1) $\frac{3}{2}$ (2) $\frac{2}{3}$

(3) $\frac{4}{9}$ (4) $\frac{9}{4}$

**Ans.** (4)

**Sol.** When two conducting spheres are connected by a wire, charge flows until they reach the same electrical potential ($V_1 = V_2$). The electric field at the surface of a conducting sphere is given by $E = \frac{V}{R}$.

$$V_1 = V_2 \Rightarrow \frac{kQ_1}{R_1} = \frac{kQ_2}{R_2}$$

electric field on each sphere's surface in terms of potential:

$$E_{S1} = \frac{kQ_1}{R_1^2} = \frac{V_1}{R_1}$$

$$E_{S2} = \frac{kQ_2}{R_2^2} = \frac{V_2}{R_2}$$

$$\frac{E_{S1}}{E_{S2}} = \frac{V_1 / R_1}{V_2 / R_2}$$

Since $V_1 = V_2$

$$\frac{E_{S1}}{E_{S2}} = \frac{R_2}{R_1}$$

$$\frac{E_{S1}}{E_{S2}} = \frac{18}{8} = \frac{9}{4}$$

Final Answer: 9/4

Question ID : 69112135

35. The equation of a plane progressive wave is given by $y = 5\cos\pi\left(200t - \frac{x}{150}\right)$ where x and y are in cm and t is in second. The velocity of the wave is __________ m/s.

(1) 120
(2) 150
(3) 200
(4) 300

**Ans.** (4)

**Sol.** $$y = 5\cos\left(\pi\left(200t - \frac{x}{150}\right)\right)$$

$$y = 5\cos\left(200\pi t - \frac{\pi x}{150}\right)$$

$$\omega = 200\pi$$

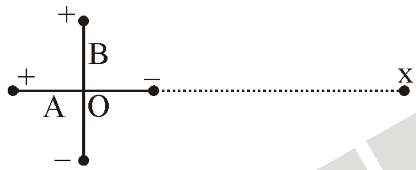
$$k = \frac{\pi}{150} = \frac{\omega}{k} = \frac{200\pi}{\pi/150} = 200 \times 150 = 30000\,cm$$

$$v = 300\,m/s$$

Final Answer: 300

Question ID : 69112136

36. Two short electric dipoles A and B having dipole moment $p_1$ and $p_2$ respectively are placed with their axis mutually perpendicular as shown in the figure. The resultant electric field at a point x is making an angle of 60° with the line joining points O and x. The ratio of the dipole moments $p_2 / p_1$ is _________.




(1) $\frac{\sqrt{3}}{2}$  (2) $2\sqrt{3}$

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

**Ans.** (2)

**Sol.** Assume Dipole A (moment $p_1$) lies along the x-axis, and Dipole B (moment $p_2$) lies along the y-axis (mutually perpendicular).

Point X lies on the axial line of Dipole A and the equatorial line of Dipole B.

The electric field due to A at point X is $E_A = \frac{2kp_1}{r^3}$ (directed horizontally).

The electric field due to B at point X is $E_B = \frac{kp_2}{r^3}$ (directed vertically).

The resultant electric field makes an angle of 60° with the line OX. Therefore,

$$\tan(60^\circ) = \frac{E_B}{E_A}$$

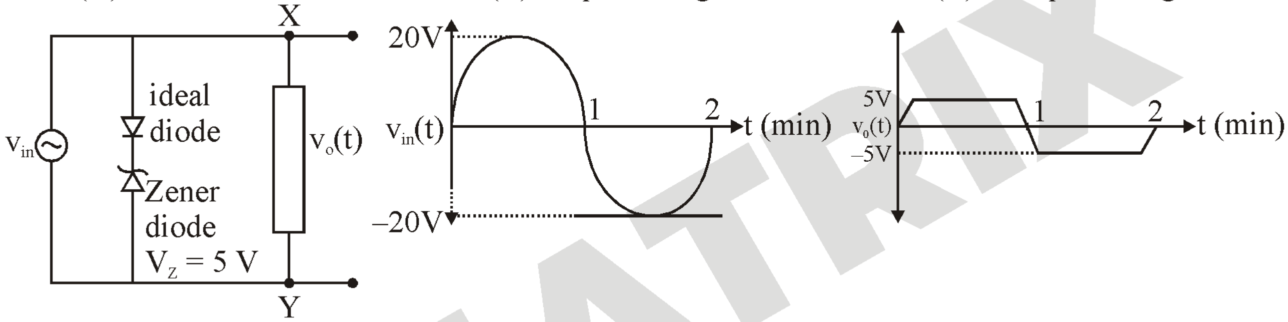
$$\sqrt{3} = \frac{\frac{kp_2}{r^3}}{\frac{2kp_1}{r^3}} = \frac{p_2}{2p_1}$$

$$\frac{p_2}{p_1} = 2\sqrt{3}$$

Final Answer : $2\sqrt{3}$

Question ID : 69112137

37. For the given circuit (shown in part (A)) the time dependent input voltage $v_{in}(t)$ and corresponding output $v_0(t)$ are shown in part (B) and part (C), respectively. Identify the components that are used in the circuit between points X and Y.




(1) 

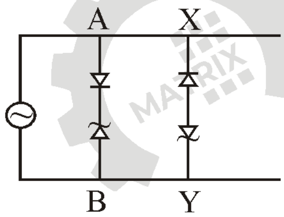

(2) 


(3) 


(4) 


**Ans.** (2)

**Sol.**




In positive half cycle, branch AB gives constant 5 V output. In negative half cycle, branch xy gives constant 5 V output.

Question ID : 69112138

38. When a coil is placed in a time dependent magnetic field the power dissipated in it is P. The number of turns, area of the coil and radius of the coil wire are N, A and r respectively. For a second coils number of turns, area of the coil and radius of the coil wire are 2N, 2A and 3r respectively. When the first coil is replaced with second coil the power dissipated in it is $\sqrt{2}\,\alpha\,P$. The value of $\alpha$ is ________ .

(1) 36
(2) $128\sqrt{2}$
(3) 16
(4) 64

**Ans.** (1)

**Sol.** Induced EMF: $\varepsilon = -NA\frac{dB}{dt}$

Power Dissipated: $P = \frac{\varepsilon^2}{R}$

The resistance of the coil is $R = \rho\frac{l}{A_{wire}}$. The total length of the wire *l* is proportional to the number of turns N and the loop circumference. Since Area $A \propto R_{loop}^2$, the circumference is proportional to $\sqrt{A}$.

Therefore, $R \propto \frac{N\sqrt{A}}{r^2}$, where r is the wire radius.

Substitute EMF and R into the power equation:

$$P \propto \frac{(NA)^2}{\frac{N\sqrt{A}}{r^2}} = NA^{3/2}r^2$$

For the second coil, $P' \propto (2N)(2A)^{3/2}(3r)^2$

$$P' \propto (2N)\left(2\sqrt{2}A^{3/2}\right)\left(9r^2\right) = 36\sqrt{2}\left(NA^{3/2}r^2\right)$$

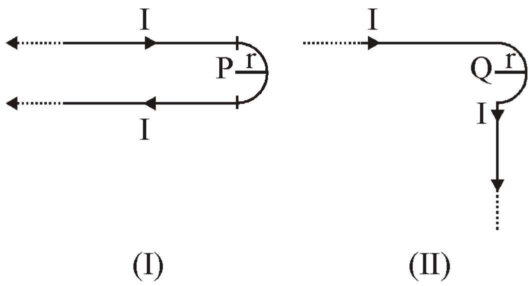
$$P' = 36\sqrt{2}P$$

$\alpha = 36$

Final Answer: 36

Question ID : 69112139

39. Two identical long current carrying wires are bent into the shapes shown in the following figures. If the magnitude of magnetic fields at the centres P and Q of a semicircular arc are $B_1$ and $B_2$ respectively, then the ratio $\frac{B_1}{B_2}$ is ________ .



(1) $\frac{2+\pi}{1+\pi}$ (2) $\frac{1+\pi}{1-\pi}$

(3) $\frac{2+\pi}{1-\pi}$ (4) $\frac{1+\pi}{2-\pi}$

**Ans.** (1)

**Sol.** Both semi-infinite straight segments and the semicircular arc produce magnetic fields in the same direction at the center point P.

$$B_1 = B_{\text{straight 1}} + B_{\text{straight 2}} + B_{\text{arc}} = \frac{\mu_0 I}{4\pi r} + \frac{\mu_0 I}{4\pi r} + \frac{\mu_0 I}{4r} = \frac{\mu_0 I}{4\pi r}(2+\pi)$$

The outgoing wire segment produces no magnetic field at center Q (since d$l$ × r = 0). Only one semi-infinite straight wire and the arc contribute.

$$B_2 = B_{\text{straight 1}} + 0 + B_{\text{arc}} = \frac{\mu_0 I}{4\pi r} + \frac{\mu_0 I}{4r} = \frac{\mu_0 I}{4\pi r}(1+\pi)$$

$$\frac{B_1}{B_2} = \frac{B_1}{B_2} = \frac{\frac{\mu_0 I}{4\pi r}(2+\pi)}{\frac{\mu_0 I}{4\pi r}(1+\pi)} = \frac{2+\pi}{1+\pi}$$

Final answer : $\frac{2+\pi}{1+\pi}$

Question ID : 69112140

40. For a thin symmetric prism made of glass (refractive index 1.5), the ratio of incident angle and minimum deviation will be __________ .

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

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

**Ans.** (2)

**Sol.** Minimum Deviation $(\delta_m) : \delta_m = (\mu - 1)A$

At minimum deviation, the angle of incidence ($i$) equals the angle of emergence (e). Total deviation relates to prism angle A by $i + e = A + \delta$.

Calculate the minimum deviation for glass $(\mu = 1.5)$ :

$$\delta_m = (1.5-1)A = 0.5A = \frac{A}{2}$$

Apply the condition for minimum deviation (i = e) :

$$i + i = A + \delta_m$$

$$2i = A + \frac{A}{2} = \frac{3A}{2}$$

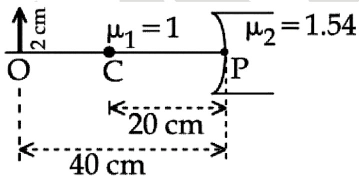
$$i = \frac{3A}{4}$$

$$\text{Ratio} = \frac{i}{\delta_m} = \frac{\frac{3A}{4}}{\frac{A}{2}} = \frac{3}{2}$$

Final Answer: 3:2

Question ID : 69112141

41. Refer the figure given below. $\mu_1$ and $\mu_2$ are refractive indices of air and lens material. The height of image will be __________ cm.




(1) 1
(2) 0.5
(3) 1.2
(4) 0.25

**Ans.** (1)

**Sol.** $$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$$

$$m = \frac{h_i}{h_o} = \frac{\mu_1 v}{\mu_2 u}$$

so u = –40 cm

R = –20 cm

$$\mu_2 = 1.54$$

$$\frac{1.54}{v} - \frac{1}{-40} = \frac{1.54 - 1}{-20}$$

$$\frac{1.54}{v}+0.025=\frac{0.54}{-20}$$

$$\frac{1.54}{v}+0.025=-0.027$$

$$\frac{1.54}{v}=-0.052 \Rightarrow v \approx -29.6\,\text{cm}$$

$$m=\frac{1\times(-29.6)}{1.54\times(-40)} \approx 0.48$$

$$h_i = m\times h_o = 0.48\times 2\,\text{cm} \approx 0.96\,\text{cm}$$

Final Answer: 1

Question ID : 69112142

42. For a certain metal, when monochromatic light of wavelength $\lambda$ is incident, the stopping potential for photoelectrons is $3V_0$. When the same metal is illuminated by light of wavelength $2\lambda$, then the stopping potential becomes $V_0$. The threshold wavelength for photoelectric emission for the given metal is $\alpha\lambda$. The value of $\alpha$ is __________.

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

**Ans.** (2)

**Sol.** $\frac{hc}{\lambda}=\Phi+eV_s$

The threshold wavelength ($\lambda_0$) is related to the work function by $\Phi=\frac{hc}{\lambda_0}$.

For the incident wavelength $\lambda$, the stopping potential is $3V_0$ :

$$\frac{hc}{\lambda}=\frac{hc}{\lambda_0}+3eV_0 - (\text{ Equation 1})$$

For the incident wavelength $2\lambda$, the stopping potential is $V_0$ :

$$\frac{hc}{2\lambda}=\frac{hc}{\lambda_0}+eV_0 - (\text{Equation 2})$$

multiply Equation 2 by 3 :

$\frac{3hc}{2\lambda}=\frac{3hc}{\lambda_0}+3eV_0-$(Equation 3)

Subtract Equation 1 from Equation 3:

$\frac{3hc}{2\lambda}-\frac{hc}{\lambda}=\frac{3hc}{\lambda_0}-\frac{hc}{\lambda_0}$

$\frac{hc}{2\lambda}=\frac{2hc}{\lambda_0}$

$\lambda_0=4\lambda$

$\alpha=4$

Final Answer: 4

Question ID : 69112143

43. An electromagnetic wave travelling in x-direction is described by field equation $E_y=300\sin\omega\left(t-\frac{x}{c}\right)$. If the electron is restricted to move in y-direction only with speed of $1.5\times10^6\ m/s$ then ratio of maximum electric and magnetic forces acting on the electron is __________ .

(1) 200 (2) 150

(3) 400 (4) 300

**Ans.** (1)

**Sol.** The magnitudes of the electric field ($E_0$) and magnetic field ($B_0$) in an electromagnetic wave are related by $c=\frac{E_0}{B_0}$.

$E_y=300\sin\omega\left(t-\frac{x}{c}\right)$, meaning the wave propagates in the x -direction and the electric field oscillates in the y -direction.

Therefore, the magnetic field must oscillate in the z-direction to satisfy $E \times B \parallel v_{wave}$.

The electron moves purely in the y-direction with velocity $v=1.5\times10^6\ m/s$.

The maximum electric force is $F_{e(max)}=eE_0$.

Since the velocity $(\hat{j})$ is completely perpendicular to the magnetic field $(\hat{k})$, the maximum magnetic force is $F_{m(max)}=evB_0\sin(90^\circ)=evB_0$.

$$\text{Ratio } = \frac{F_{e(max)}}{F_{m(max)}} = \frac{eE_0}{evB_0}$$

$$\text{Ratio } = \frac{eE_0}{ev\left(\frac{E_0}{c}\right)} = \frac{c}{v} = \frac{3\times10^8}{1.5\times10^6} = 200$$

Final Answer : 200

Question ID : 69112144

44. Angular momentum of an electron in a hydrogen atom is $\frac{3h}{\pi}$, then the energy of the electron is __________ eV.

(1) –1.51
(2) –0.85
(3) –0.38
(4) –0.28

**Ans.** (3)

**Sol.** $\frac{nh}{2\pi} = \frac{3h}{\pi}$

$$n = \frac{3h\times2\pi}{\pi\times h} = 6$$

$$E_6 = -\frac{13.6}{6^2}eV = -\frac{13.6}{36}eV$$

$$E_6 \approx -0.377eV$$

–0.377 eV to two decimal places gives –0.38 eV, which correlates perfectly

Finl Answer : –0.38

Question ID : 69112145

45. A liquid drop of diameter 2 mm breaks into 512 droplets. The change in surface energy is $\alpha\times10^{-6}$ J. The value of $\alpha$ is __________ . (Take surface tension of liquid =0.08 N/m)

(1) 10
(2) 7
(3) 8
(4) 11

**Ans.** (2)

**Sol.** The diameter of the large drop is 2 mm , so its initial radius is R = 1 mm = $10^{-3}$ m.

Equating initial and final volumes for n = 512 droplets:

$$\frac{4}{3}\pi R^3 = 512\times\frac{4}{3}\pi r^3$$

$$R^3 = 512r^3 \quad \Rightarrow r = \frac{R}{\sqrt[3]{512}} = \frac{R}{8}$$

Calculate the initial surface area ($A_i$) and the total final surface area ($A_f$) :

$$A_i = 4\pi R^2$$

$$A_f = 512\times 4\pi r^2 = 512\times 4\pi\left(\frac{R}{8}\right)^2 = 512\times 4\pi\left(\frac{R^2}{64}\right) = 8\times 4\pi R^2$$

$$\Delta A = A_f - A_i = 8\left(4\pi R^2\right) - 4\pi R^2 = 28\pi R^2$$

Calculate the change in surface energy using $T = 0.08\,N/m$

$$\Delta U = 0.08\times 28\pi\times\left(10^{-3}\right)^2$$

$$\Delta U = 0.08\times 28\times 3.1415\times 10^{-6}$$

$$\Delta U \approx 7.03\times 10^{-6}\,J$$

Final Answer: 7

Question ID : 69112146

46. In single slit diffraction pattern, the wavelength of light used is 628 nm and slit width is 0.2 mm, the angular width of central maximum is $\alpha\times 10^{-2}$ degrees. The value of $\alpha$ is _________ .

**Ans.** (36)

**Sol.** In a single slit diffraction pattern, the angular width of the central maximum $(2\theta)$ is H-is given by the formula:

$$2\theta = \frac{2\lambda}{a}$$

$$\lambda = 628\,nm = 628\times 10^{-9}\,m$$

Given slit width, $a = 0.2\,mm = 0.2\times 10^{-3}\,m$

The angular width in radians is: $\Delta\theta = \frac{2\times 628\times 10^{-9}}{0.2\times 10^{-3}} = \frac{1256\times 10^{-9}}{2\times 10^{-4}} = 6280\times 10^{-6} = 6.28\times 10^{-3}\,rad$

$$\Delta\theta\,(\text{in degrees}) = 6.28\times 10^{-3}\times\frac{180}{\pi}$$

$$\Delta\theta = 6.28\times10^{-3}\times\frac{180}{3.14} = 2\times10^{-3}\times180 = 360\times10^{-3} = 36\times10^{-2} \text{ degrees}$$

$\alpha = 36$

Final Answer: 36

Question ID : 69112147

47. A vessel contains $0.15\,m^3$ of a gas at pressure 8 bar and temperature 140 °C with $c_p = 3R$ and $c_v = 2R$. It is expanded adiabatically till pressure falls to 1 bar. The work done during this process is _______k J. (R is gas constant)

**Ans.** (120)

**Sol.** $W = \frac{P_1V_1 - P_2V_2}{\gamma - 1}$

initial state variables: $P_1 = 8\,\text{bar} = 8\times10^5$ Pa, $V_1 = 0.15\,m^3$

adiabatic index $\gamma$ : $c_p = 3R$ and $c_v = 2R$, so $\gamma = \frac{3R}{2R} = 1.5 = \frac{3}{2}$.

final state pressure: $P_2 = 1\,\text{bar} = 1\times10^5$ Pa

$$P_1V_1^{\gamma} = P_2V_2^{\gamma} \Rightarrow (8\times10^5)(0.15)^{1.5} = (1\times10^5)V_2^{1.5}$$

$$8 = \left(\frac{V_2}{0.15}\right)^{1.5} \Rightarrow \frac{V_2}{0.15} = 8^{\frac{2}{3}} = (2^3)^{\frac{2}{3}} = 4$$

$$V_2 = 4\times0.15 = 0.6\,m^3$$

$$W = \frac{(8\times10^5)(0.15)-(1\times10^5)(0.6)}{1.5-1} = \frac{1.2\times10^5 - 0.6\times10^5}{0.5} = \frac{0.6\times10^5}{0.5} = 1.2$$

$$W = 120\,kJ$$

Final Answer : 120

Question ID : 69112148

48. $1\mu C$ charge moving with velocity $\vec{v} = (\hat{i} - 2\hat{j} + 3\hat{k})m/s$ in the region of magnetic field $\vec{B} = (2\hat{i} + 3\hat{j} - 5\hat{k})T$. The magnitude of force acting on it is $\sqrt{\alpha}\times10^{-6}$ N. The value of α is ________.

**Ans.** (171)

**Sol.** $q = 1\ \mu C = 10^{-6} C$

$\vec{v} = \hat{i} - 2\hat{j} + 3\hat{k}\ m/s$

$\vec{B} = 2\hat{i} + 3\hat{j} - 5\hat{k}\ T$

$\vec{v} \times \vec{B} = \hat{i}(10-9) - \hat{j}(-5-6) + \hat{k}(3+4) = \hat{i} + 11\hat{j} + 7\hat{k}$

$|\vec{v} \times \vec{B}| = \sqrt{1^2 + 11^2 + 7^2} = \sqrt{1+121+49} = \sqrt{171}$

Calculate the magnitude of the force:

$F = q|\vec{v} \times \vec{B}| = 10^{-6} \times \sqrt{171} = \sqrt{171} \times 10^{-6}\ N$

Compare with the given format $\sqrt{\alpha} \times 10^{-6}\ N$

$\alpha = 171$

Final Answer: 171

Question ID : 69112149

49. A uniform wire of length $\ell$ of weight w is suspended from the roof with a weight of W at the other end. The stress in the wire at $\frac{\ell}{3}$ distance from the top is $\left(\frac{W}{A} + \frac{2}{\gamma}\frac{w}{A}\right)$, where, A is the cross sectional area of the wire. The value of $\gamma$ is ________.

**Ans.** (3)

**Sol.** The point of interest is at a distance of $\frac{\ell}{3}$ from the top.

Therefore, the length of the wire hanging below this point is $\ell - \frac{\ell}{3} = \frac{2\ell}{3}$.

Since the weight of the wire is uniformly distributed, the weight of this lower portion of the wire is $\frac{2}{3}w$.

The total force (F) acting downwards at this cross-section is the sum of the weight suspended at the bottom (W) and the weight of the wire below the point:

$$F = W + \frac{2}{3}w$$

$$\text{Stress} = \frac{F}{A} = \frac{W + \frac{2}{3}w}{A} = \frac{W}{A} + \frac{2}{3}\frac{w}{A}$$

$\left(\frac{W}{A}+\frac{2}{\gamma}\frac{w}{A}\right)$, we can equate the $\frac{2}{\gamma}=\frac{2}{3}\Rightarrow\gamma=3$

Final Answer: 3

Question ID : 69112150

50. A tub is filled with water and a wooden cube $10\,cm\times10\,cm\times10\,cm$ is placed in the water. The wooden cube is found to float on the water with a part of it submerged in water. When a metal coin is placed on the wooden cube, the submerged part is increased by 3.87 cm. The mass of the metal coin is __________ gram. (Take water density as 1 g/$cm^3$ and density of wood as 0.4 g/ $cm^3$)

**Ans.** (387)

**Sol.** According to Archimedes' principle, the buoyant force on a floating object is equal to the weight of the fluid it displaces. When an additional mass is placed on the object, the additional buoyant force generated by the newly submerged volume exactly balances the weight of the added mass.

The dimensions of the wooden cube are $10\,cm\times10\,cm\times10\,cm$.

The cross-sectional area (A) of the cube's base is $10\,cm\times10\,cm=100\,cm^2$.

When the coin is added, the submerged depth increases by $\Delta x=3.87\,cm$.

the additional volume of water displaced ($\Delta V$) :

$$\Delta V=A\times\Delta x=100\,cm^2\times3.87\,cm=387\,cm^3$$

By Archimedes' principle, the weight of the metal coin equals the weight of the additionally displaced water:

$$m_{coin}g=\left(\Delta V\times\rho_{water}\right)g$$

$$m_{coin}=\Delta V\times\rho_{water}$$

$$m_{coin}=387\,cm^3\times1\,g/cm^3=387\,g$$

Final Answer : 387