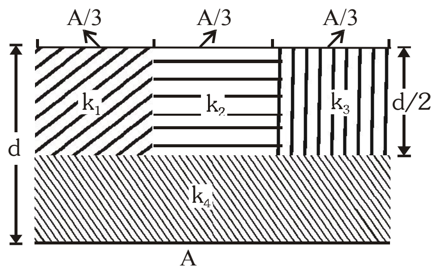
NEET–II (2016) TEST PAPER WITH ANSWER & SOLUTIONS (HELD ON SUNDAY 24th JULY, 2016)

91. A parallel-plate capacitor of area A, plate separation d and capacitance C is filled with four dielectric materials having dielectric constants k_1, k_2, k_3 and k_4 as shown in the figure below. If a single dielectric material is to be used to have the same capacitance C in this capacitor, then its dielectric constant k is given by :-



(1) $\frac{2}{k} = \frac{3}{k_1 + k_2 + k_3} + \frac{1}{k_4}$

(2) $\frac{1}{k} = \frac{1}{k_1} + \frac{1}{k_2} + \frac{1}{k_3} + \frac{3}{2k_4}$

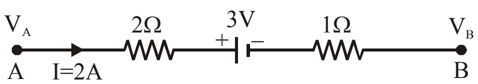
(3) $k = k_1 + k_2 + k_3 + 3k_4$

(4) $k = \frac{2}{3}(k_1 + k_2 + k_3) + 2k_4$

Ans. (1)

Sol. Put $k_1 = k_2 = k_3 = k_4$ and check answer

92. The potential difference $(V_A - V_B)$ between the points A and B in the given figure is :-

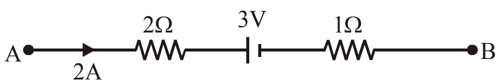


(1) + 6 V (2) + 9 V

(3) – 3 V (4) + 3 V

Ans. (2)

Sol.



$V_B = V_A - (2 \times 2) - 3 - (2 \times 1)$

$\Rightarrow V_A - V_B = 9V$

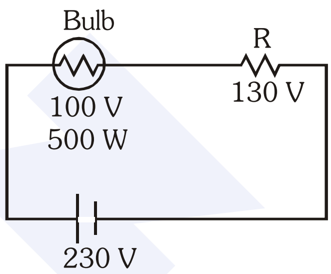
93. A filament bulb (500 W, 100 V) is to be used in a 230 V main supply. When a resistance R is connected in series, it works perfectly and the bulb consumes 500 W. The value of R is :-

(1) 26 Ω (2) 13 Ω

(3) 230 Ω (4) 46 Ω

Ans. (1)

Sol.



Current through bulb $= \frac{P}{V} = \frac{500W}{100V} = 5A$

Therefore $R = \frac{130V}{5A} = 26\Omega$

94. A long wire carrying a steady current is bent into a circular loop of one turn. The magnetic field at the centre of the loop is B. It is then bent into a circular coil of n turns. The magnetic field at the centre of this coil of n turns will be :-

(1) 2nB (2) $2n^2B$

(3) nB (4) n^2B

Ans. (4)

Sol. Since $\ell = 2\pi R = n(2\pi r) \Rightarrow r = \frac{R}{n}$

For one turn $B = \frac{\mu_0 i}{2R}$ and

For n turn $B' = \frac{\mu_0 ni}{2r}$

$\Rightarrow B' = \frac{\mu_0 n^2 i}{2R} = n^2B$

95. A bar magnet is hung by a thin cotton thread in a uniform horizontal magnetic field and is in equilibrium state. The energy required to rotate it by 60° is W. Now the torque required to keep the magnet in this new position is :-

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

(3) $\frac{W}{\sqrt{3}}$ (4) $\sqrt{3}\,W$

Ans. (4)

Sol. $\tau = MB \sin 60°$ .....(1)

$W = MB\,(1 - \cos 60°)$ .....(2)

From (1) and (2)

$$\frac{\tau}{W} = \frac{\sqrt{3}/2}{1/2} \Rightarrow \tau = W\sqrt{3}$$

96. An electron is moving in a circular path under the influence of a transverse magnetic field of 3.57×10^{-2} T. If the value of e/m is 1.76×10^{11} C/kg, the frequency of revolution of the electron is :-

(1) 62.8 MHz (2) 6.28 MHz

(3) 1 GHz (4) 100 MHz

Ans. (3)

Sol. $f = \frac{eB}{2\pi m}$

$$f = \frac{1.76 \times 10^{11} \times 3.57 \times 10^{-2}}{2 \times 3.14}\ \text{Hz}$$

$f = 10^9$ Hz or 1 GHz

97. Which of the following combinations should be selected for better tuning of an L-C-R circuit used for communication ?

(1) R = 15 Ω, L = 3.5 H, C = 30 μF

(2) R = 25 Ω, L = 1.5 H, C = 45 μF

(3) R = 20 Ω, L = 1.5 H, C = 35 μF

(4) R = 25 Ω, L = 2.5 H, C = 45 μF

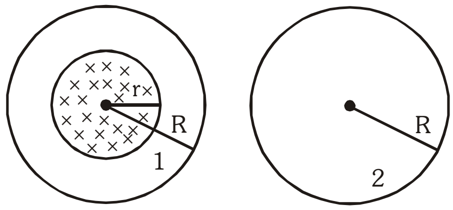
Ans. (1)

Sol. For better tuning, Q-factor must be high.

$$\therefore\ Q = \frac{\omega_0 L}{R} = \frac{1}{\sqrt{LC}}\left(\frac{L}{R}\right) = \frac{1}{R}\sqrt{\frac{L}{C}}$$

R and C should be small and L should be high.

98. A uniform magnetic field is restricted within a region of radius r. The magnetic field changes with time at a rate $\frac{d\vec{B}}{dt}$. Loop 1 of radius R > r encloses the region r and loop 2 of radius R is outside the region of magnetic field as shown in the figure below. Then the e.m.f. generated is :-



(1) $-\frac{d\vec{B}}{dt}\pi R^2$ in loop 1 and zero in loop 2

(2) $-\frac{d\vec{B}}{dt}\pi r^2$ in loop 1 and zero in loop 2

(3) Zero in loop 1 and zero in loop 2

(4) $-\frac{d\vec{B}}{dt}\pi r^2$ in loop 1 and $-\frac{d\vec{B}}{dt}\pi r^2$ in loop 2

Ans. (2)

Sol. For Loop 1

$$\varepsilon_{ind} = -\frac{d\phi}{dt} = -A\left(\frac{dB}{dt}\right)\cos 0° = -\pi r^2\left(\frac{dB}{dt}\right)$$

For Loop 2, $\varepsilon_{ind} = 0$ as no flux linkage

99. The potential differences across the resistance, capacitance and inductance are 80 V, 40 V and 100 V respectively in an L-C-R circuit. The power factor of this circuit is :-

(1) 0.8 (2) 1.0 (3) 0.4 (4) 0.5

Ans. (1)

Sol. $\tan\phi = \frac{V_L - V_C}{V_R} = \frac{100 - 40}{80} = \frac{3}{4}$ or $\phi = 37°$

Power factor = $\cos\phi = \cos 37° = \frac{4}{5}$ or 0.8

100. A 100 Ω resistance and a capacitor of 100 Ω reactance are connected in series across a 220 V source. When the capacitor is 50% charged, the peak value of the displacement current is :-

(1) 4.4 A (2) $11\sqrt{2}$ A (3) 2.2 A (4) 11 A

Ans. (3)

Sol. $(i_d)_{max} = (i_c)_{max} = i_0 = \frac{\varepsilon_0}{Z} = \frac{220\sqrt{2}}{\sqrt{100^2 + 100^2}} = 2.2\text{A}$

As we are asked amplitude of displacement current. So, need not worry about charge on capacitor.

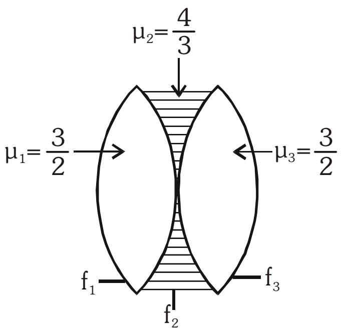
101. Two identical glass ($\mu_g = 3/2$) equiconvex lenses of focal length f each are kept in contact. The space between the two lenses is filled with water ($\mu_w = 4/3$). The focal length of the combination is :-

(1) 4f/3 (2) 3f/4

(3) f/3 (4) f

Ans. (2)

Sol.



$$f_1 = f_3 = \frac{R}{2\left(\frac{3}{2}-1\right)} = R = f \text{ (given)}$$

$$f_2 = \frac{-R}{2\left(\frac{4}{3}-1\right)} = \frac{-3}{2}R = -\frac{3}{2}f$$

$$\frac{1}{f_{eq}} = \frac{1}{f_1}+\frac{1}{f_2}+\frac{1}{f_3} = \frac{1}{f}+\left(-\frac{2}{3f}\right)+\frac{1}{f}$$

$$\Rightarrow \frac{1}{f_{eq}} = \frac{4}{3f} \Rightarrow f_{eq} = \frac{3f}{4}$$

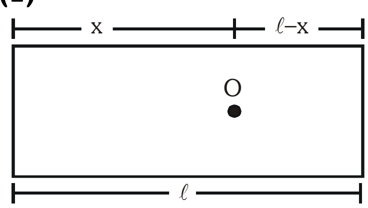
102. An air bubble in a glass slab with refractive index 1.5 (near normal incidence) is 5 cm deep when viewed from one surface and 3 cm deep when viewed from the opposite face. The thickness (in cm) of the slab is :-

(1) 12 (2) 16

(3) 8 (4) 10

Ans. (1)

Sol.



$$\frac{x}{\mu} = 5\text{cm} \quad .....(i)$$

$$\frac{\ell - x}{\mu} = 3\text{cm} \quad .....(ii)$$

From (i) and (ii)

$\ell = (5+3)\mu = 12\text{cm}$

103. The interference pattern is obtained with two coherent light sources of intensity ratio n. In the interference pattern, the ratio $\frac{I_{max}-I_{min}}{I_{max}+I_{min}}$ will be :-

(1) $\frac{\sqrt{n}}{(n+1)^2}$ (2) $\frac{2\sqrt{n}}{(n+1)^2}$

(3) $\frac{\sqrt{n}}{n+1}$ (4) $\frac{2\sqrt{n}}{n+1}$

Ans. (4)

Sol. Let $\frac{I_1}{I_2} = \frac{n}{1}$

$$\frac{I_{max}-I_{min}}{I_{max}+I_{min}} = \frac{\left(\sqrt{I_1}+\sqrt{I_2}\right)^2-\left(\sqrt{I_1}-\sqrt{I_2}\right)^2}{\left(\sqrt{I_1}+\sqrt{I_2}\right)^2+\left(\sqrt{I_1}-\sqrt{I_2}\right)^2} = \frac{4\sqrt{I_1 I_2}}{2(I_1+I_2)}$$

Dividing numerator and denominator by I_2

$$\text{required ratio} = \frac{2\sqrt{I_1/I_2}}{\left(\frac{I_1}{I_2}+1\right)} = \frac{2\sqrt{n}}{n+1}$$

104. A person can see clearly objects only when they lie between 50 cm and 400 cm from his eyes. In order to increase the maximum distance of distinct vision to infinity, the type and power of the correcting lens, the person has to use, will be :-

(1) concave, – 0.2 diopter

(2) convex, + 0.15 diopter

(3) convex, + 2.25 diopter

(4) concave, – 0.25 diopter

Ans. (4)

Sol. As we want to correct myopia. So, far point must go to infinity.

$v = -4$ m, $u = -\infty$, $P = ?$

$$P = \frac{1}{f} = \frac{1}{v} - \frac{1}{u} = \frac{1}{-4} - \frac{1}{\infty} = -0.25 \text{ D}$$

(–) implies concave mirror

105. A linear aperture whose width is 0.02 cm is placed immediately in front of a lens of focal length 60 cm. The aperture is illuminated normally by a parallel beam of wavelength 5×10^{-5} cm. The distance of the first dark band of the diffraction pattern from the centre of the screen is :-

(1) 0.20 cm (2) 0.15 cm

(3) 0.10 cm (4) 0.25 cm

Ans. (2)

Sol. $f = D = 60$ cm

For first minima,

$$y = \frac{\lambda D}{a} = \frac{5\times10^{-7}\times60}{2\times10^{-2}\times10^{-2}} = \frac{5\times10^{-3}\times60}{2} = 0.15 \text{ cm}$$

106. Electrons of mass m with de-Broglie wavelength λ fall on the target in an X-ray tube. The cutoff wavelength (λ_0) of the emitted X-ray is :-

(1) $\lambda_0 = \frac{2m^2c^2\lambda^3}{h^2}$ (2) $\lambda_0 = \lambda$

(3) $\lambda_0 = \frac{2mc\lambda^2}{h}$ (4) $\lambda_0 = \frac{2h}{mc}$

Ans. (3)

Sol. $\lambda = \frac{h}{p} \Rightarrow p = \frac{h}{\lambda}$

KE of electrons $= E = \frac{p^2}{2m} = \frac{h^2}{2m\lambda^2}$

Also in X-ray $\lambda_0 = \frac{hc}{E} \Rightarrow \lambda_0 = \frac{2mc\lambda^2}{h}$

107. Photons with energy 5 eV are incident on a cathode C in a photoelectric cell. The maximum energy of emitted photoelectrons is 2 eV. When photons of energy 6 eV are incident on C, no photoelectrons will reach the anode A, if the stopping potential of A relative to C is :-

(1) – 1 V (2) – 3 V

(3) + 3 V (4) + 4 V

Ans. (2)

Sol. $eV_s = \frac{1}{2}mv_{max}^2 = h\nu - \phi_0$

$2 = 5 - \phi_0 \Rightarrow \phi_0 = 3$ eV

In second case

$eV_s = 6 - 3 = 3$ eV $\Rightarrow V_s = 3$ V.

$\therefore \quad V_{AC} = -3$ V

108. If an electron in a hydrogen atom jumps from the 3rd orbit to the 2nd orbit, it emits a photon of wavelength λ. When it jumps from the 4th orbit to the 3rd orbit, the corresponding wavelength of the photon will be :-

(1) $\frac{20}{7}\lambda$ (2) $\frac{20}{13}\lambda$

(3) $\frac{16}{25}\lambda$ (4) $\frac{9}{16}\lambda$

Ans. (1)

Sol. Transition : $3 \to 2 \Rightarrow$ Wavelength λ.
Transition : $4 \to 3 \Rightarrow$ Wavelength $\lambda' = ?$

$$\frac{\frac{1}{\lambda} = RZ^2\left(\frac{1}{2^2} - \frac{1}{3^2}\right)}{\frac{1}{\lambda'} = RZ^2\left(\frac{1}{3^2} - \frac{1}{4^2}\right)} \Rightarrow \frac{\lambda'}{\lambda} = \frac{20}{7} \Rightarrow \lambda' = \frac{20\lambda}{7}$$

109. The half-life of a radioactive substance is 30 minutes. The time (in minutes) taken between 40% decay and 85% decay of the same radioactive substance is :-

(1) 45 (2) 60 (3) 15 (4) 30

Ans. (2)

Sol. decay 40% $\to$ 85%
Remaining 60% $\to$ 15%

$60\% \xrightarrow{t_{1/2}} 30\% \xrightarrow{t_{1/2}} 15\%$

$\therefore t = 2t_{1/2} = 60$ min.

110. For CE transistor amplifier, the audio signal voltage across the collector resistance of 2 kΩ is 4 V. If the current amplification factor of the transistor is 100 and the base resistance is 1 kΩ, then the input signal voltage is :-

(1) 30 mV (2) 15 mV

(3) 10 mV (4) 20 mV

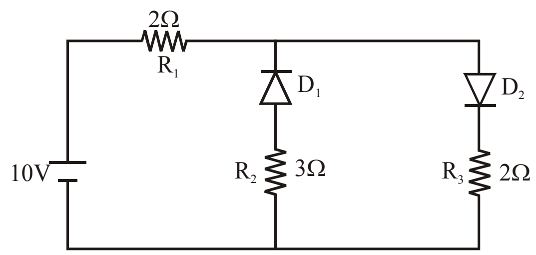
Ans. (4)

Sol. $\beta = 100$; $V_0 = 4V$; $R_i = 10^3\,\Omega$;
$R_0 = 2 \times 10^3\,\Omega$; $V_i = ?$

$A_V = \frac{V_0}{V_i} = \beta\frac{R_0}{R_i} \Rightarrow \frac{4}{V_i} = 100 \times \frac{2\times 10^3}{10^3}$

$\Rightarrow V_i = 20$ mV

111. The given circuit has two ideal diodes connected as shown in the figure below. The current flowing through the resistance R_1 will be :-



(1) 1.43 A (2) 3.13 A

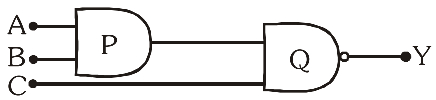
(3) 2.5 A (4) 10.0 A

Ans. (3)

Sol. Current will not flow through D_1 as it is reverse biased. Current will flow through cell, R_1, D_2 and R_3.

$\therefore \quad i = \frac{10}{2+2} = 2.5$ A

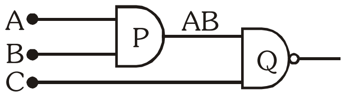
112. What is the output Y in the following circuit, when all the three inputs A,B,C are first 0 and then 1 ?



(1) 1,0 (2) 1,1 (3) 0,1 (4) 0.0

Ans. (1)

Sol.



$y = \overline{(AB)C}$

for A = B = C = 0 ; y = 1

for A = B = C = 1 ; y = 0

113. Planck's constant (h), speed of light in vacuum (c) and Newton's gravitational constant (G) are three fundamental constants. Which of the following combinations of these has the dimension of length?

(1) $\sqrt{\frac{hc}{G}}$ (2) $\sqrt{\frac{Gc}{h^{3/2}}}$ (3) $\frac{\sqrt{hG}}{c^{3/2}}$ (4) $\frac{\sqrt{hG}}{c^{5/2}}$

Ans. (3)

Sol. $\ell \propto h^x G^y c^z$

$M^0L^1T^0 = (ML^2T^{-1})^x (M^{-1}L^3T^{-2})^y (LT^{-1})^z$

$= M^{x-y}\, L^{2x+3y+z}\, T^{-x-2y-z}$

Equating :

$$\left.\begin{aligned} x - y &= 0 \\ 2x + 3y + z &= 1 \\ -x - 2y - z &= 0 \end{aligned}\right\} \Rightarrow x = \frac{1}{2}; y = \frac{1}{2}; z = -\frac{3}{2}$$

$$\Rightarrow \ell \propto \frac{\sqrt{hG}}{c^{3/2}}$$

114. Two cars P and Q start from a point at the same time in a straight line and their positions are represented by $x_p(t) = at + bt^2$ and $x_Q(t) = ft - t^2$. At what time do the cars have the same velocity ?

(1) $\frac{a+f}{2(1+b)}$ (2) $\frac{f-a}{2(1+b)}$

(3) $\frac{a-f}{1+b}$ (4) $\frac{a+f}{2(b-1)}$

Ans. (2)

Sol. $x_P(t) = at + bt^2$ $\qquad x_Q(t) = ft - t^2$

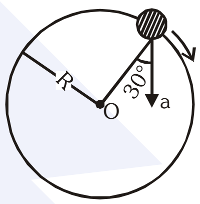
$v_P = a + 2bt$ $\qquad v_Q = f - 2t$

as $v_P = v_Q$

$a + 2bt = f - 2t$

$\Rightarrow t = \frac{f-a}{2(1+b)}$

115. In the given figure, a = 15 m/s² represents the total acceleration of a particle moving in the clockwise direction in a circle of radius R = 2.5 m at a given instant of time. The speed of the particle is :-



(1) 5.7 m/s (2) 6.2 m/s

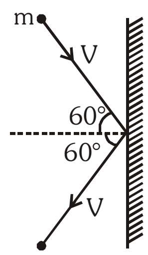
(3) 4.5 m/s (4) 5.0 m/s

Ans. (1)

Sol. Centripetal acceleration = $\frac{v^2}{R} = a\cos 30°$

$\Rightarrow v = \sqrt{aR\cos 30°} = \sqrt{15 \times 2.5 \times \frac{\sqrt{3}}{2}} = 5.7\text{m/s}$

116. A rigid ball of mass m strikes a rigid wall at 60° and gets reflected without loss of speed as shown in the figure below. The value of impulse imparted by the wall on the ball will be :-



(1) $\frac{mV}{2}$ (2) $\frac{mV}{3}$ (3) mV (4) 2mV

Ans. (3)

Sol. Impulse $= |\Delta \vec{p}| = m|\Delta \vec{V}| = m(2V\cos 60°) = mV$

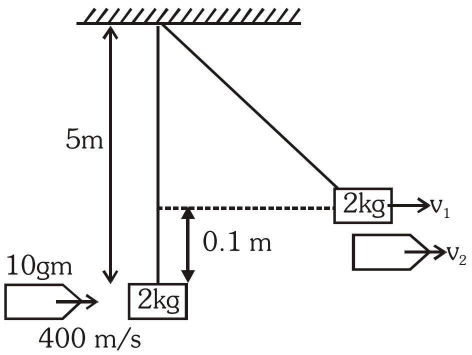
117. A bullet of mass 10g moving horizontally with a velocity of 400 ms^{-1} strikes a wooden block of mass 2 kg which is suspended by a light inextensible string of length 5 m. As a result, the centre of gravity of the block is found to rise a vertical distance of 10 cm. The speed of the bullet after it emerges out horizontally from the block will be :-

(1) 120 ms^{-1} (2) 160 ms^{-1}

(3) 100 ms^{-1} (4) 80 ms^{-1}

Ans. (1)

Sol.



Applying momentum conservation

$$\frac{10}{1000}\times 400 + 0 = 2\times v_1 + \frac{10}{1000}\times v_2$$

$\Rightarrow$ $4 = 2v_1 + 0.01v_2$ ......(1)

Applying work energy theorem for block

$W = \Delta KE$

$\Rightarrow$ $2\times 10\times 0.1 = \frac{1}{2}\times 2\times {v_1}^2$

$\Rightarrow$ $v_1 = \sqrt{2} = 1.4$ m/s

Putting the value of v_1 in equation (1)

$4 = 2\times 1.4 + 0.01\ v_2 \Rightarrow v_2 = 120$ m/s

118. Two identical balls A and B having velocities of 0.5 m/s and –0.3 m/s respectively collide elastically in one dimension. The velocities of B and A after the collision respectively will be :-

(1) –0.3 m/s and 0.5 m/s

(2) 0.3 m/s and 0.5 m/s

(3) –0.5 m/s and 0.3 m/s

(4) 0.5 m/s and –0.3 m/s

Ans. (4)

Sol. Since both bodies are identical and collision is elastic. Therefore velocities will be interchanged after collision.

$v_A = -0.3$ m/s and $v_B = 0.5$ m/s

119. A particle moves from a point $(-2\hat{i}+5\hat{j})$ to $(4\hat{j}+3\hat{k})$ when a force of $(4\hat{i}+3\hat{j})$ N is applied. How much work has been done by the force ?

(1) 5 J (2) 2 J (3) 8 J (4) 11 J

Ans. (1)

Sol. $\vec{s} = \vec{r}_f - \vec{r}_i = 2\hat{i}-\hat{j}+3\hat{k}$

$$W = \vec{F}.\vec{s} = \left(4\hat{i}+3\hat{j}\right).\left[2\hat{i}-\hat{j}+3\hat{k}\right] = 8-3 = 5J$$

120. Two rotating bodies A and B of masses m and 2m with moments of inertia I_A and I_B ($I_B > I_A$) have equal kinetic energy of rotation. If L_A and L_B be their angular momenta respectively, then :-

(1) $L_B > L_A$ (2) $L_A > L_B$

(3) $L_A = \frac{L_B}{2}$ (4) $L_A = 2L_B$

Ans. (1)

Sol. $K_A = K_B \Rightarrow \frac{L_A^2}{2I_A} = \frac{L_B^2}{2I_B}$

As $I_B > I_A$ So, $L_A^2 < L_B^2 \Rightarrow L_A < L_B$

121. A solid sphere of mass m and radius R is rotating about its diameter. A solid cylinder of the same mass and same radius is also rotating about its geometrical axis with an angular speed twice that of the sphere. The ratio of their kinetic energies of rotation (E_{sphere} / $E_{cylinder}$) will be :-

(1) 1 : 4 (2) 3 : 1 (3) 2 : 3 (4) 1 : 5

Ans. (4)

Sol.

$$E_{sphere} = \frac{1}{2}I_s\omega^2 = \frac{1}{2}\times\frac{2}{5}MR^2\times\omega^2$$

$$E_{cylinder} = \frac{1}{2}I_c(2\omega)^2 = \frac{1}{2}\times\frac{MR^2}{2}\times 4\omega^2$$

$$\frac{E_{sphere}}{E_{cylinder}} = \frac{1}{5}$$

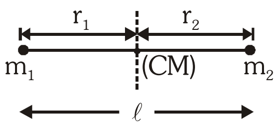
122. A light rod of length ℓ has two masses m_1 and m_2 attached to its two ends. The moment of inertia of the system about an axis perpendicular to the rod and passing through the centre of mass is :-

(1) $(m_1 + m_2)\ell^2$ (2) $\sqrt{m_1 m_2}\,\ell^2$

(3) $\dfrac{m_1 m_2}{m_1 + m_2}\ell^2$ (4) $\dfrac{m_1 + m_2}{m_1 m_2}\ell^2$

Ans. (3)

Sol.



$$r_1 = \frac{m_2\ell}{m_1 + m_2},\quad r_2 = \frac{m_1\ell}{m_1 + m_2}$$

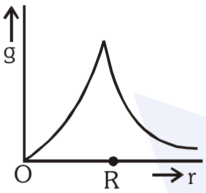
$$I_{cm} = m_1 r_1^2 + m_2 r_2^2 = \frac{m_1 m_2}{m_1 + m_2}\ell^2$$

OR

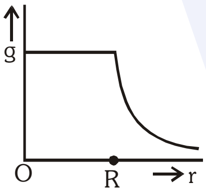
$$I_{cm} = \mu\ell^2 = \frac{m_1 m_2}{m_1 + m_2}\ell^2$$

123. Starting from the centre of the earth having radius R, the variation of g (acceleration due to gravity) is shown by :-

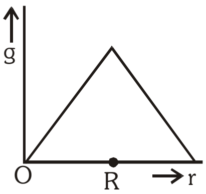
(1)



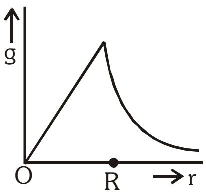
(2)



(3)



(4)



Ans. (4)

Sol. $g = \left(\dfrac{GM_e}{R_e^3}\right) r$ for $0 < r \le R_e \Rightarrow$ $\mathbf{g \propto r}$

$g = \dfrac{GM_e}{r^2}$ for $r \ge R_e$ $\Rightarrow$ $\mathbf{g \propto \dfrac{1}{r^2}}$

124. A satellite of mass m is orbiting the earth (of radius R) at a height h from its surface. The total energy of the satellite in terms of g_0, the value of acceleration due to gravity at the earth's surface, is :-

(1) $\dfrac{2mg_0R^2}{R+h}$ (2) $-\dfrac{2mg_0R^2}{R+h}$

(3) $\dfrac{mg_0R^2}{2(R+h)}$ (4) $-\dfrac{mg_0R^2}{2(R+h)}$

Ans. (4)

Sol. Total energy $= -\dfrac{GM_e m}{2(R+h)}$

$\because\ g_0 = \dfrac{GM_e}{R^2} \Rightarrow M_e = \dfrac{g_0R^2}{G}$

$\therefore$ Energy $= -\dfrac{mg_0R^2}{2(R+h)}$

125. A rectangular film of liquid is extended from (4 cm × 2 cm) to (5 cm ×4 cm). If the work done is 3×10^{-4} J, the value of the surface tension of the liquid is :-

(1) 0.2 Nm^{-1} (2) 8.0 Nm^{-1}

(3) 0.250 Nm^{-1} (4) 0.125 Nm^{-1}

Ans. (4)

Sol. $W = T(2\Delta A)$ { $\Delta A = (20 - 8)\ cm^2$ }

$$\Rightarrow T = \frac{W}{2\Delta A} = \frac{3 \times 10^{-4}}{2 \times 12 \times 10^{-4}} = 0.125\ Nm^{-1}$$

126. Three liquids of densities ρ_1, ρ_2 and ρ_3 (with $\rho_1 > \rho_2 > \rho_3$), having the same value of surface tension T, rise to the same height in three identical capillaries. The angles of contact θ_1, θ_2 and θ_3 obey:-

(1) $\frac{\pi}{2} < \theta_1 < \theta_2 < \theta_3 < \pi$

(2) $\pi > \theta_1 > \theta_2 > \theta_3 > \frac{\pi}{2}$

(3) $\frac{\pi}{2} > \theta_1 > \theta_2 > \theta_3 \geq 0$

(4) $0 \leq \theta_1 < \theta_2 < \theta_3 < \frac{\pi}{2}$

Ans. (4)

Sol. $h = \frac{2T\cos\theta}{\rho g r}$

As r, h, T are same, $\frac{\cos\theta}{\rho} = \text{constant}$

$\Rightarrow \frac{\cos\theta_1}{\rho_1} = \frac{\cos\theta_2}{\rho_2} = \frac{\cos\theta_3}{\rho_3}$

As $\rho_1 > \rho_2 > \rho_3$

$\Rightarrow \cos\theta_1 > \cos\theta_2 > \cos\theta_3 \Rightarrow \theta_1 < \theta_2 < \theta_3$

As water rises so θ must be acute

So, $0 \leq \theta_1 < \theta_2 < \theta_3 < \pi/2$

127. Two identical bodies are made of a material for which the heat capacity increases with temperature. One of these is at 100 °C, while the other one is at 0°C. If the two bodies are brought into contact, then, assuming no heat loss, the final common temperature is :-

(1) less than 50 °C but greater than 0 °C

(2) 0 °C

(3) 50 °C

(4) more than 50 °C

Ans. (4)

Sol. Let θ be the final common temperature. Further, let s_c and s_h be the average heat capacities of the cold and hot (initially) bodies respectively (where $s_c < s_h$ given)

From, principle of calorimetry,

heat lost = heat gained

$s_h(100°C - \theta) = s_c\theta$

$\therefore \theta = \frac{s_h}{(s_h + s_c)} \times 100°C = \frac{100°C}{\left(1 + \frac{s_c}{s_h}\right)}$

$\because s_c / s_h < 1 \qquad \therefore 1 + s_c / s_h < 2$

$\therefore \theta > \frac{100°C}{2}$ or $\theta > 50°C$

OR

Body at 100°C has more heat capacity then body at 0°C so final temperature must be greater than 50°C.

128. A body cools from a temperature 3T to 2T in 10 minutes. The room temperature is T. Assume that Newton's law of cooling is applicable. The temperature of the body at the end of next 10 minutes will be :-

(1) $\frac{4}{3}T$ (2) T

(3) $\frac{7}{4}T$ (4) $\frac{3}{2}T$

Ans. (4)

Sol. Newton's laws of cooling

$$\frac{T_1 - T_2}{t} = k\left(\frac{T_1 + T_2}{2} - T\right)$$

$$\frac{3T - 2T}{10} = k\left(\frac{5T - 2T}{2}\right) \Rightarrow \frac{T}{10} = k\left(\frac{3T}{2}\right) \quad ...(i)$$

$$\frac{2T - T'}{10} = k\left(\frac{2T + T'}{2} - T\right) \Rightarrow \frac{2T - T'}{10} = k\left(\frac{T'}{2}\right) \quad ...(ii)$$

By solving (i) and (ii) $T' = \frac{3}{2}T$

129. One mole of an ideal monatomic gas undergoes a process described by the equation PV^3 = constant. The heat capacity of the gas during this process is

(1) 2 R (2) R (3) $\frac{3}{2}R$ (4) $\frac{5}{2}R$

Ans. (2)

Sol. PV^x = constant (Polytropic process)

Heat capacity in polytropic process is given by

$$\left[C = C_V + \frac{R}{1-x}\right]$$

Given that PV^3 = constant $\Rightarrow x = 3$ ...(1)

also gas is monoatomic so $C_V = \frac{3}{2}R$ ...(2)

by formula

$$C = \frac{3}{2}R + \frac{R}{1-3} = \frac{3}{2}R - \frac{R}{2} = R$$

130. The temperature inside a refrigerator is t_2°C and the room temperature is t_1°C. The amount of heat delivered to the room for each joule of electrical energy consumed ideally will be :-

(1) $\frac{t_2+273}{t_1-t_2}$ (2) $\frac{t_1+t_2}{t_1+273}$

(3) $\frac{t_1}{t_1-t_2}$ (4) $\frac{t_1+273}{t_1-t_2}$

Ans. (4)

Sol. Heat delivered = Q_1

$$COP(\beta) = \frac{Q_2}{W} = \frac{Q_1 - W}{W} = \frac{Q_1}{W} - 1 = \frac{T_2}{T_1 - T_2}$$

$$\Rightarrow \frac{Q_1}{W} = 1 + \frac{t_2+273}{t_1-t_2} = \frac{t_1+273}{t_1-t_2}$$

131. A given sample of an ideal gas occupies a volume V at a pressure P and absolute temperature T. The mass of each molecule of the gas is m. Which of the following gives the density of the gas ?

(1) P/(kTV) (2) mkT

(3) P/(kT) (4) Pm/(kT)

Ans. (4)

Sol. $\frac{P}{\rho} = \frac{RT}{M_w}$ (Ideal gas equation)

$$\Rightarrow \rho = \frac{PM_w}{RT} = \frac{P\times(mN_A)}{kN_AT} = \frac{Pm}{kT}$$

132. A body of mass m is attached to the lower end of a spring whose upper end is fixed. The spring has negligible mass. When the mass m is slightly pulled down and released, it oscillates with a time period of 3s. When the mass m is increased by 1 kg, the time period of oscillations becomes 5 s. The value of m in kg is :-

(1) $\frac{16}{9}$ (2) $\frac{9}{16}$ (3) $\frac{3}{4}$ (4) $\frac{4}{3}$

Ans. (2)

Sol. $T = 2\pi\sqrt{\frac{m}{k}}$

$$3 = 2\pi\sqrt{\frac{m}{k}} \quad ...(1)$$

$$5 = 2\pi\sqrt{\frac{m+1}{k}} \quad ...(2)$$

$$\frac{(1)^2}{(2)^2} \Rightarrow \frac{9}{25} = \frac{m}{m+1} \Rightarrow m = \frac{9}{16}$$

133. The second overtone of an open organ pipe has the same frequency as the first overtone of a closed pipe L metre long. The length of the open pipe will be

(1) $\frac{L}{2}$ (2) 4 L (3) L (4) 2 L

Ans. (4)

Sol. For second overtone (3rd harmonic) in open organ pipe,

$$\frac{3\lambda}{2} = \ell_0 \Rightarrow \lambda = \frac{2\ell_0}{3}$$

for first overtone (3rd harmonic) in closed organ pipe,

$$\frac{3\lambda}{4} = \ell_C \Rightarrow \lambda = \frac{4\ell_C}{3} = \frac{4L}{3}$$

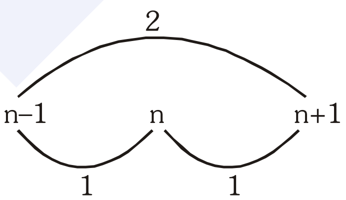
$$\text{So, } \frac{2\ell_0}{3} = \frac{4L}{3} \Rightarrow \ell_0 = 2L$$

134. Three sound waves of equal amplitudes have frequencies (n – 1), n, (n + 1). They superimpose to give beats. The number of beats produced per second will be :-

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

Ans. (2)

Sol.



Now divide 1 second into 1, 1, 2 equal divisions

$\frac{1}{1}$

$\frac{1}{1}$

$\frac{1}{2}$ $\frac{2}{2}$

By eliminating common time instants, total maxima in one second is 2.
So, two beats per second will be heard.

135. An electric dipole is placed at an angle of 30° with an electric field intensity 2×10^5 N/C. It experiences a torque equal to 4 Nm. The charge on the dipole, if the dipole length is 2 cm, is :-

(1) 5 mC (2) 7 μC (3) 8 mC (4) 2 mC

Ans. (4)

Sol. τ = PE sinθ
$\tau = q\ell E \sin\theta$
$4 = q \times 2 \times 10^{-3} \times 2 \times 10^5 \sin 30°$
$\Rightarrow$ q = 2 mC