JEE MAIN SEP 2020 (MEMORY BASED) | 2ND SEP SHIFT-1

Note: The answers are based on memory based questions which may be incomplete and incorrect.

1. Which of the following combination should be selected for better tuning of an L.C.R circuit used for communication ?

(A) R = 25Ω, L = 1.5H, C = 45μF

(B) R = 25Ω, L = 1.5H, C = 35μF

(C) R = 25Ω, L = 2.5H, C = 45μF

(D) R = 15Ω, L = 3.5H, C = 30μF

Ans (D)

Sol. For better tuning, we need higher quality factor.

$$Q = \frac{1}{R}\sqrt{\frac{L}{C}}$$

2. A star of mass 'm' revolves in radius 'R' in galaxy in with mass density varies with distance 'r' as $\rho = \frac{k}{r}$, where k is a constant.

Find the relation between time period and radius 'R'.

(A) $T \alpha R^{3/2}$ (B) $T \alpha R^{1/2}$

(C) $T \alpha R^{7/2}$ (D) $T \alpha R$

Ans (B)

Sol. $$M = \int_0^R k 4\pi r^2 dr$$

$$= \int_0^R \frac{K}{r} 4\pi r^2 dr$$

$$= 2\pi KR^2$$

$$T = \frac{2\pi R^{\frac{3}{2}}}{\sqrt{G \times 2\pi R R^2}}$$

$$T \alpha R^{\frac{1}{2}}$$

3. Order of resistance for Tungsten, Copper, Aluminium, Mercury

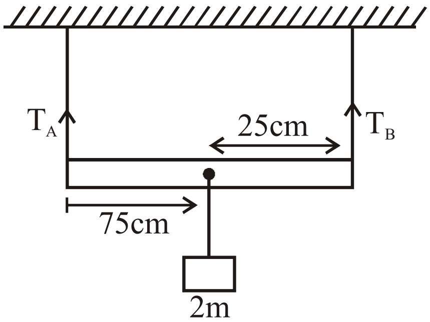
(A) $R_{Cu} < R_W$
(B) $R_{al} > R_W$
(C) $R_{Cu} > R_{Hg}$
(D) $R_{al} > R_{Hg}$

Ans (A)

Sol. This is a fact based question

$R_{Cu} < R_{Al} < R_W < R_{Hg}$

4. A block of mass 2m is suspended by a meter scale rod of mass as shown in figure. If the tension in string A is equal to kmg in equilibrium, then value of k will be :

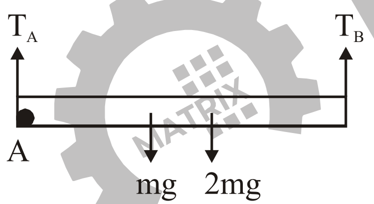


(A) 5/4
(B) 4/5
(C) 3/5
(D) 1

Ans (D)

Sol. Considering translation equilibrium :

$T_A + T_B = 3mg$



Considering rotational equilibrium :

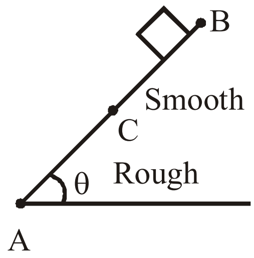
$\sum \tau_{\text{about A}} = 0$

mg × (50 cm) + 2mg × (75 cm) – T_B × (100 cm) = 0

$T_B = 2mg$

$T_A = mg$

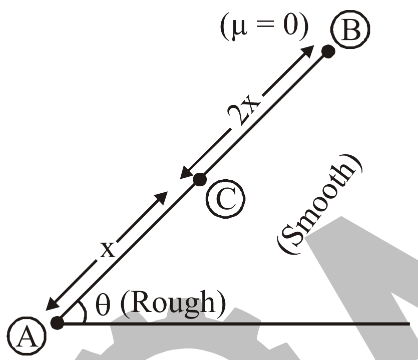
5. A block of mass m start Slipping from top of inclined plane at B and comes to rest when reaches to lowest point A of the inclined plane, if BC = 2 AC & friction cofficient of part AC is $\mu = k \tan\theta$ then, find the value of k.



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

Ans (C)

Sol.



Given
BC = 2AC [Let AC length = x]
$\mu = K \tan\theta$
From B to C ($a = g\sin\theta$)

$V_C^2 = 0 + 2(g\sin\theta)\times 2x$

$V_C^2 = 4gx\sin\theta$

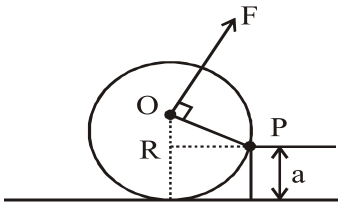
From A to C
$a = \mu g\cos\theta - g\sin\theta$
also

$O = V_C^2 - 2(\mu g\cos\theta - g\sin\theta)x$

$\Rightarrow \mu gx\sin\theta = 2\mu g\omega\ \theta x - 2g\sin\theta x$

$\Rightarrow \mu = 3\tan\theta$

6. Find minimum value of F applied perpendicular to line OP where O is centre of the ball of mass m and radius R required to lift the ball (a < R)

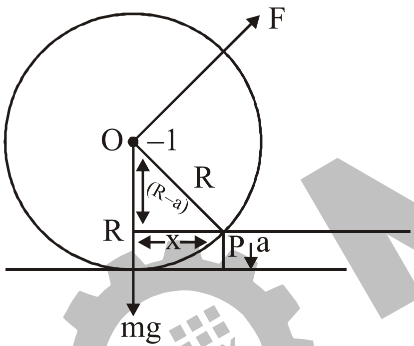


(A) $\frac{mg\sqrt{2aR+a^2}}{R}$ (B) $\frac{mg\sqrt{2aR-a^2}}{R}$

(C) $\frac{mg\sqrt{2aR-a^2}}{a}$ (D) $\frac{mg\sqrt{2aR+a^2}}{a}$

Ans (B)

Sol.



For minimum value of F, the force F will be h'r to the line OP

$x^2 + (R - a)^2 = R$

$x^2 = R^2 - R^2 - a^2 + 2Ra$

$x = \sqrt{2Ra - a^2}$

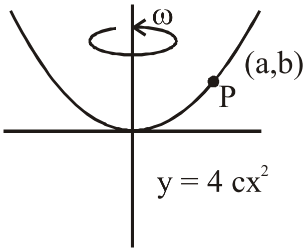
$\tau_0 = 0$

$\Rightarrow FR = mg\,x$

$\Rightarrow F_{min} = \frac{mg}{R}.x$

$\Rightarrow F_{min} = \frac{mg}{R}\sqrt{2Ra - a^2}$

7. Angular velocity of smooth parabolic wire y= $4cx^2$ about axis of parabola in vertical plane if bead of mass m does not slip at (a, b) will be.

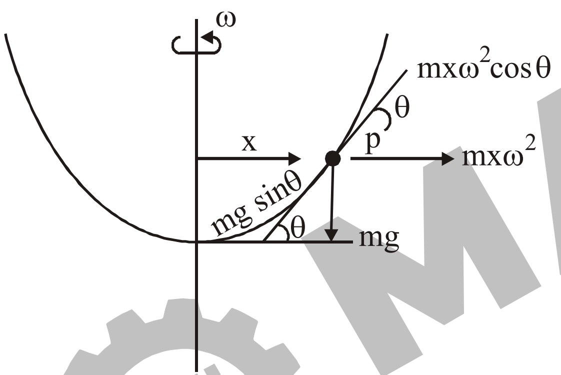


(A) $2\sqrt{2gc}$ (B) $\sqrt{gc}$

(C) $\sqrt{g/c}$ (D) $\sqrt{g}$

Ans (A)

Sol.



$y = 4cx^2$

$\tan\theta = \frac{dy}{dx} = 8cx$

Let particle as al rest then

$mg \sin\theta = mr\omega^2 \cos\theta$

$\Rightarrow g \tan\theta = x\omega^2$

$\Rightarrow g \times (8cx) = x\omega^2$

$\omega^2 = \sqrt{8gc}$

$\omega^2 = 2\sqrt{2gc}$

—— option A

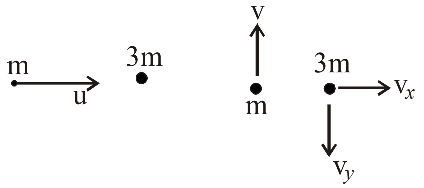
8. A body of mass m moving with velocity $u\hat{i}$ collides elastically with a body at rest of mass 3m and then the final velocity of body mass m is $v\hat{j}$. Find the relation between v and u.

(A) u = 2v (B) u = v/2

(C) $u = \sqrt{2}v$ (D) $u = \frac{v}{\sqrt{2}}$

Ans (C)

Sol.



Momentum Conservation in x & y

x-direction

$mu + 0 = 0 + 3mv_x$

$\Rightarrow v_x = 4/3$

y-direction

$0 = mv - 2mv_y$

$\Rightarrow v = 3v_y$

also $k_i = k_f$ (as collision is elastic)

$$\frac{1}{2}mu^2 = \frac{1}{2}mv^2 + \frac{1}{2}3m(v_x^2 + v_y^2)$$

$$\Rightarrow u^2 = v^2 + 3\left[\frac{4^2}{9} + \frac{v^2}{9}\right]$$

$$\Rightarrow u^2 = v^2 + \frac{4^2}{3} + \frac{v^2}{3} \quad \Rightarrow \frac{2}{3}u^2 = \frac{4}{3}v^2$$

$$\Rightarrow u = \sqrt{2}v$$

option (4)

9. A capacitor of capacity 5μF is charged up 220 Volt, & is disconnected from battery. Now charged 5μF capacitance is connected by another uncharged capacitor of 2.5 μF capacitor. Find heat loss in the process.

(A) $\frac{121}{3} \times 10^{-3}$ J

(B) $\frac{1210}{5} \times 10^{-3}$ J

(C) 200×10^{-3} J

(D) $\frac{1210}{3} \times 10^{-3}$ J

Ans (B)

Sol. $C_1 = 5\mu F$ $\quad V_1 = 220$ Volt

$C_2 = 2.55\mu F$ $\quad V_2 = 0$

Heat loss; $\Delta H = U_i - U_f = \frac{1}{2}\frac{C_1C_2}{C_1 + C_2}(V_1 - V_2)^2$

$$= \frac{1}{2} \times \frac{5 \times 2.5}{(5 + 2.5)}(220 - 0)^2 \mu J$$

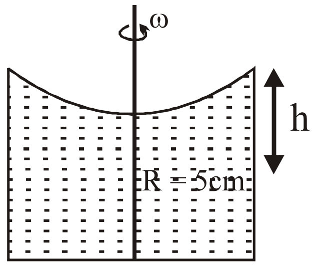
$$\frac{5}{2 \times 3} \times 22 \times 22 \times 100 \times 10^{-6} J$$

$$\frac{5 \times 11 \times 22}{3} \times 10^{-4} J$$

$$\frac{55\times22}{3}\times10^{-4}\,J$$

$$\frac{1210}{3}\times10^{-4}\,J=\frac{1210}{3}\times10^{-3}\,J$$

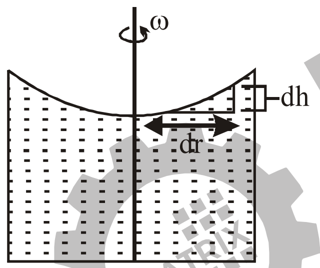
10. A cylindrical container rotates with constant angular speed ω . Radius of cylinder is R. Find height h as shown at which water is in equilibrium with respect to container



(A) $\frac{\omega^2R^2}{g}$ (B) $\frac{\omega^2R^2}{2g}$ (C) $\frac{2\omega^2R^2}{g}$ (D) $\frac{3\omega^2R^2}{2g}$

Ans (B)

Sol.



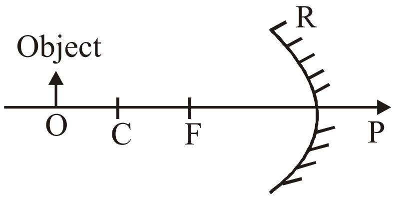
$$\rho dr\omega^2 r=\rho g dh$$

$$\omega^2\int_0^R r\,dr=g\int_0^h dh$$

$$\frac{\omega^2R^2}{2}=gh$$

$$h=\frac{\omega^2R^2}{2g}$$

11. Discuss the properties of image formed by shown mirror of a real object place beyond centre of curvature ?



(A) Real, magnified and inverted

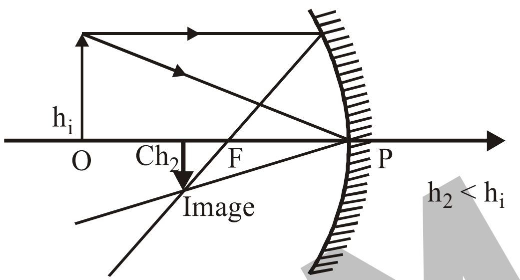
(B) Virtual, diminished and inverted

(C) Real, diminished and inverted

(D) Virtual, magnified and inverted

Ans (C)

Sol.

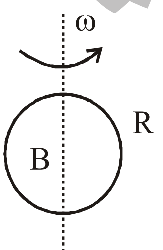


12. A coil of radius 'R' rotating about a diametrical axis with angluar velocity 'ω' in a uniform magnetic field 'B'

Find the value of maximum voltage developed.

$R = 10$ cm, $B = 5 \times 10^{-5}$ T

For half rotation it takes a time of 0.2 second.



(A) 3×10^{-5} V (B) 5×10^{-6} V

(C) 2.5×10^{-5} V (D) 5×10^{-5} V

Ans (C)

Sol. Flux as function of time $\phi = \vec{A}.\vec{B} = AB\cos(\omega t)$

Emf induced.

$$e = -\frac{d\phi}{dt} = AB\omega \sin(\omega t)$$

$$\text{Max. value of Emf} = AB\omega$$

$$= \pi R^2 B\omega$$

$$= 3.14 \times 0.1 \times 0.1 \times 5 \times 10^{-5} \times \frac{\pi}{0.2}$$

$$= 2.46 \times 10^{-5}\,V$$

$$= 2.5 \times 10^{-5}\,V$$

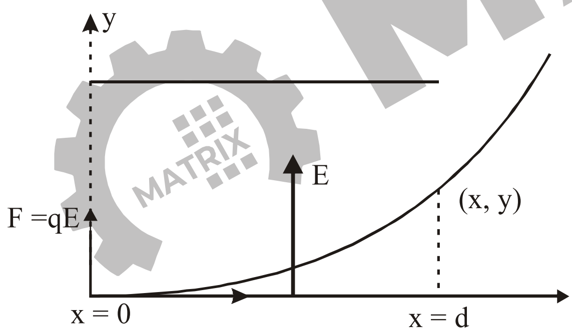
13. A charge particle having charge q and V is moving in xy plane in x directions. It enters in a region of uniform electric field directed in y direction and extended up to x = 0 to x = d. Then what is equation of path terms of d.

(A) $y = \frac{qEd^2}{2mv^2}$ (B) $y = \frac{qEd^2}{mv^2}$

(C) $y = \frac{2qEd^2}{3mv^2}$ (D) $y = \frac{2qEd^2}{mv^2}$

Ans (A)

Sol.



x = Vt

$$y = y = \frac{1}{2}at^2 \frac{1}{2}\frac{qE}{m}t^2$$

$$y = \frac{1}{2}\frac{qE}{m}\frac{x^2}{v^2}$$

$$y = \frac{1}{2}\frac{qE}{m}\frac{d^2}{v^2}$$

14. If force, velocity and area is considered as a fundamental physical quantities then find the dimensional formula of Young modulus of elasticity :

(A) $Y = F^1A^0V^{-1}$ (B) $Y = F^{-1}A^1V^{-1/2}$

(C) $Y = F^1V^{-1}A^{-1/2}$ (D) $Y = F^1A^1V^{1/2}$

Ans (A)

Sol. $Y \propto F^a V^b A^c \quad Y = \left(\frac{F}{A}\right)$

$$\frac{MLT^{-2}}{L^2} \propto \left(M^1L^1T^{-2}\right)^a \left(L^1T^{-1}\right)^b \left(L^2\right)^c$$

$M^1L^{-1}T^{-2} \propto M^aL^{a+b+2c}T^{-2a-b}$

$a + b + 2c = -1$

$-2a + b = -2$

$a = 1, b = 0, c = -1$

$Y = F^1v^0A^{-1}$

15. The Fundamental frequency of two identical strings x and y are 450 Hz and 300 Hz respectively, then ratio of tension in string x an y will be.

(A) $\sqrt{\frac{2}{3}}$ (B) $\frac{9}{4}$

(C) $\sqrt{\frac{4}{3}}$ (D) $\sqrt{\frac{3}{2}}$

Ans (B)

Sol. $f_x = \frac{1}{2\ell}\sqrt{\frac{T_x}{\mu}}$

$f_y = \frac{1}{2\ell}\sqrt{\frac{T_y}{\mu}}$

$\frac{f_x}{f_y} = \frac{450}{300} = \sqrt{\frac{T_x}{T_y}}$

$\Rightarrow T_x / T_y = 9/4$

16. Stopping potential of emitted photo electron is V when mono chromatic light of wavelength λ incident on a metal surface. If wavelength of light incident becomes $\lambda/3$ stopping potential of photo electrons becomes $\frac{V}{4}$ then, the threshold wavelength of metal is $k\lambda$ then k will be.

(A) 6 (B) 6

(C) 9 (D) 2

Ans (C)

Sol. $\frac{hc}{\lambda}=\phi+eV$ .... (1)

$\frac{hc}{3\lambda}=\phi+\frac{eV}{4}$ .... (2)

from (1) & (2)

$\frac{hc}{\lambda}\left(1-\frac{1}{3}\right)=\frac{3}{4}eV$

$\frac{hc}{\lambda}\frac{2}{3}=\frac{3}{4}eV$

$eV=\frac{8}{9}\frac{hc}{\lambda}$

$\frac{hc}{\lambda}=\phi+\frac{8}{9}\frac{hc}{\lambda}$

$\phi=\frac{hc}{9\lambda}=\frac{hc}{\lambda_{th}}$

$\lambda_{th}=9\lambda$

$\therefore k=9$

17. 3 mole of O_2 mixed with 5 mole Argon at temperature T. Find total internal energy of system.
(A) 12RT (B) 19RT (C) 15RT (D) 10RT

Ans (C)

Sol. $U=\frac{f_1}{2}n_1RT+\frac{f_2}{2}n_2RT$

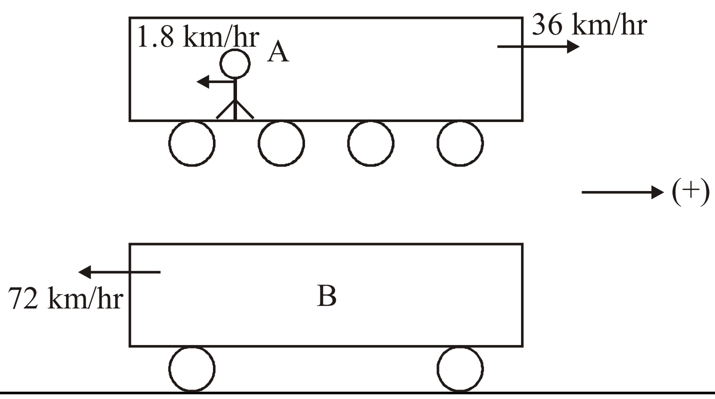
$=\frac{5}{2}(3)(R)T+\frac{3}{2}(5)RT$

$=15RT$

18. Two train A and B moving with speed of 36 km/hr and 72 km/hr respectively in opposite direction. A man moving in train A with speed of 1.8 km/hr opposite to direction of train. Find velocity of man as seen from train B (in m/s).
(A) 32m/s (B) 29.5m/s (C) 32.5m/s (D) 28m/s

Ans (B)

Sol.



$V_A = 36$ km/hr = 10 m/s
$V_B = -72$ km/hr = – 20 m/s
$V_{MA} = -1.8$ km/hr = – 0.5 m/s
$V_{man, B} = V_{man, A} + V_{A, B}$
$= V_{man, A} + V_A - V_B$
$= -0.5 + 10 - (-20)$
$= -0.5 + 30$
= 29.5 m/s

19. Amplitude of carries wave and massage wave are 5 unit and 3 unit respectively, then ratio of maximum and minimum amplitude of modulated wave.
(A) 2 (B) 4 (C) 6 (D) 8

Ans (B)

Sol. $\frac{A_{max}}{A_{min}} = \frac{A_m + A_c}{A_m - A_c} = \frac{5+3}{5-3} = \frac{8}{2} = 4$

20. A proton enter in a uniform magnetic field of 2.0 mT at an angle of 60º with the magnetic field with speed 10 m/s. Find the pitch of path.
(A) 30πμm (B) 50πμm (C) 80πμm (D) 10πμm

Ans (B)

Sol. Pitch = (Vcosθ)T

$$= (V\cos\theta)\frac{2\pi m}{eB}$$

$$= (10\cos 60°)\frac{2\pi}{2\times 10^{-3}}\left(\frac{m}{e}\right) \qquad \therefore \frac{m}{e} = \frac{10^{-27}}{10^{-19}} = 10^{-8}$$

$$= \frac{5\pi}{10^{-3}}\times 10^{-8} = 5\pi\times 10^{-5} = 50\pi\mu m$$

21. There are two magnets P and T ; P is used as permanent magnet while T is used in transformers ; Then correct options are –
(A) P has high retentivity and low coercivity
(B) P has low retentivity and high coercivity
(C) T has low retentivity and low coercivity
(D) T has high retentivity and high coercivity

Ans (C)

Sol. Based on theory

22. In a standard YDSE slit width is 1 mm and distance of screen from the slit is 1m. If wavelength of light is 632 nm and bright fringe formed at y = 1.270 mm. Then find the path difference for the point.
(A) 1.27μm (B) 2.45μm (C) 0.27μm (D) 2.27μm

Ans (A)

Sol. $\Delta P = d\sin\theta$
$= d\theta$

$$= \frac{dy}{D} = \frac{10^{-3}\times 1.270mm}{1m} = 1.270\mu m$$