14. One end of a long metallic wire of length L is tied to the ceiling . The other end is tied to a massless spring of spring constant K. A mass ***m*** hangs freely from the free end of spring .The area of crass-section and young's modulus of wire are ***A*** and ***Y*** respectively. If the mass is slightly pulled down and released ,it will oscillate with a time period "T" equal to

A) $2\pi\left(\frac{m}{k}\right)^{\frac{1}{2}}$ B) $2\pi\sqrt{\frac{m(YA+KL)}{YAK}}$ C) $2\pi\left[\left(\frac{mYA}{KL}\right)^{\frac{1}{2}}\right]$ D) $2\pi\left[\left(\frac{mL}{YA}\right)^{\frac{1}{2}}\right]$

15. An electric bulb of power 30π W has an efficiency of 10% and it can be assumed to behave like a point source of light .At a distance of 3m from the bulb, the peak value of the electric field in the light produced by the bulb is [Take $\varepsilon_0 9\times10^{-12}$ $C^2N^{-1}m^{-2}$]

A) $\frac{100}{9}Vm^{-1}$ B) $\frac{10}{9}Vm^{-1}$ C) $\frac{10}{9\sqrt{2}}Vm^{-1}$ D) $\frac{100}{9\sqrt{2}}Vm^{-1}$

16. A rigid bar of mass 15Kg is supported symmetrically by three wires, each of length 2m. The wires at the endpoints are made of copper and the middle one is made of steel.If the tension in each wire is the same,then the ratio of the diameter of copper wire to the diameter of steel wire is (Given $Y_{COPPER}=1.1X10^{11}$ N m^{-2} and $Y_{STEEL}=1.9X10^{11}$N m^{-2})

A) $\sqrt{\frac{19}{11}}$ B) $\sqrt{\frac{11}{19}}$ C) $\frac{11}{19}$ D) $\frac{19}{11}$

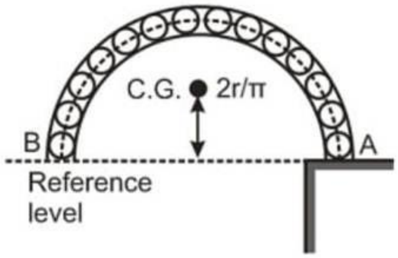
17. Zener diodes have higher dopant densities as compared to ordinary p-n junction diodes this
A) Decreases the width of depletion layer as well as electric field.
B) Increases the width of depletion layer as well as electric field.
C) Decreases the width of depletion layer But increases the electric field
D) Increases the width of depletion layerBut decreases the electric field

18. A metal sphere of radius ***r*** and specific heat S is rotated about an axis passing through its centre, at a speed of its, nrotations per second . It is suddenly stopped and 50% of its energy is used in increasing its temperature then, rise in temperature of sphere is

A) $\frac{2\pi^2n^2r^2}{5S}$ B) $\frac{\pi^2n^2}{10r^2S}$ C) $\frac{7}{8}\pi r^2n^2S$ D) $\frac{5(\pi rn)^2}{14S}$

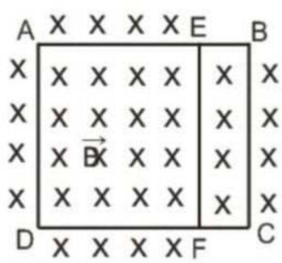
19. The dimensional formula for magnetic flux is
A) $[ML^2T^{-1}A^2]$ B)$[M^0L^{-2}T^2A^{-2}]$ C)$[ML^3T^{-2}A^{-2}]$ D)$[ML^2T^{-2}A^{-1}]$

20. A heavy ,flexible uniform chain of length ***πr*** and mass ***λ π***r lies in a smooth semi-circular tube AB of the radius ***r*** assuming a slight disturbance to start the chain in motion, find the velocity ***v*** with which it will emerge from the end B of tube



A) $\sqrt{4gr\left(\frac{3}{\pi}+\frac{\pi}{2}\right)}$ B) $\sqrt{3gr\left(\frac{2}{\pi}+\frac{\pi}{5}\right)}$ C) $\sqrt{2gr\left(\frac{2}{\pi}+\frac{\pi}{2}\right)}$ D) $\sqrt{5gr\left(\frac{4}{\pi}+\frac{\pi}{3}\right)}$

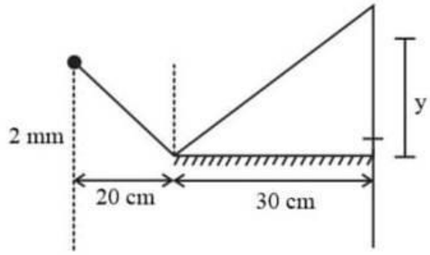
21. A rectangular frame ABCD made of a uniform metal wire has a straight connection between E and F made of the same wire as shown in the figure. AEFD is a square of side 1m &EB=FC=0.5m. the entire circuit is placed in a steadily increasing uniform magnetic field directed into the plain of the paper. The radius of change of the magnetic field is 1T S^{-1}, the resistance per unit length of the wire is $1\,\Omega\,m^{-1}$.If the current in the segments AE and EF are $\boldsymbol{I_{AE}}$ and $\boldsymbol{I_{EF}}$ respectively, then what is the value of $\frac{IAE}{IEf}$?



22. A rectangular tank filled with some liquid is accelerated along a horizontal surface at $\frac{40}{3}ms-2$ .Inside the liquid, a laser pointer is fixed a the centre of the tank which shoots a thin laser beam in the vertically upward direction. If after refraction from the liquid surface, the laser beam moves along the surface of the liquid, then what is the refractive index of the liquid ?

23. A uniform ball of radius ***r*** is placed on the top of a sphere of radius R=10r.It is given a slight push duo to which it starts rolling down the sphere without slipping. The spin angular velocity of the ball when it breaks off from the sphere $\omega=\sqrt{\frac{p}{q}\left(\frac{g}{r}\right)}$,is, where is the acceleration duo togravity and p and q are the smallest integers. what is the value of p+q ?

24. A plane mirror of length 30cm is placed horizontally along with a vertical screen. A monochromatic point source of light is placed 20cm to the left off the left edge of the mirror, at a height of 2mm above the plane of the mirror.If the wavelength of light used is 6400 $\overset{0}{A}$, then find the number of complete bright fringes formed.



25. A string of length 1.5m with its two ends clamped is vibrating in the fundamental mode.the amplitude at the centre of the string is 4mm.the minimum distance between the two points having amplitude of 2mm is:

SOLUTIONS

PHYSICS

14. Equivalent force constant for a wire is given by

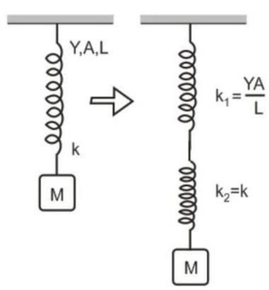
$$k = \frac{YA}{L}$$

$$F = \frac{YA}{L}\Delta L$$

$$F = K\Delta\chi.$$

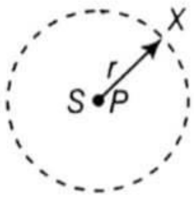
$$Comparing\ this\ two, we\ find\ k\ of\ wire = \frac{YA}{L}$$

$$K_{eq} = \frac{K_1 K_2}{K_1 + K_2}$$



$$\because T = 2\pi\sqrt{\frac{m}{k_{eq}}} = 2\pi\sqrt{\frac{m(YA + LK)}{YAK}}$$

15.



Intencity at the distance ***r*** from a point source,

$$I = \frac{P}{4\pi r^2}$$

$$Efficiency,\ n = \frac{Output}{Input} = \frac{p}{p^1}$$

$$p^1 = \eta p$$

$$I = \frac{1}{2} C_{eo}\, Eo^2$$

16.

$$Y = \frac{\frac{F}{A}}{\Delta \frac{l}{l}}$$

$$\frac{Y_1}{Y_2} = \left(\frac{d_2}{d_1}\right)^2$$

$$\frac{d_1}{d_2} = \sqrt{\frac{y_2}{y_1}}$$

17. Due to high doping, electric field in the depletion layer increases.

18.

$$I = \frac{2}{5} mr^2,\ \omega = 2\pi n$$

$$k = \frac{1}{2} I\omega^2 = \frac{1}{2} \times \frac{2}{5} mr^2 \times 4\pi^2 n^2$$

$$= \frac{4}{5} \pi^2 mr^2 n^2$$

$$\Delta\theta = \frac{\Delta Q}{mS} = \frac{\frac{k}{2}}{mS}$$

$$= \frac{2}{5} \frac{\pi^2 mr^2 n^2}{mS}$$

$$= \frac{2\pi^2 r^2 n^2}{5S}$$

19. According to Faraday's law of electromagnetic induction, E.M.F = $-\dfrac{d\phi}{dt}$

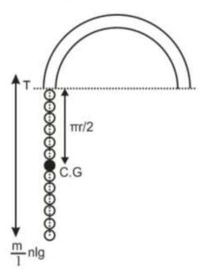
So
$$\theta = [EMF][T] = \left[\frac{W}{q}\right][T]$$
$$\theta = \left[\frac{ML^2T^{-2}}{AT}\right][T] = [ML^2T^{-2}A^{-1}]$$

20. Since friction absent, we can apply the law of conservation of energy. Centre of gravity of a semicircular arc is at a distance $\left(\dfrac{2\pi}{r}\right)$ from the centre.

Initial potential energy = $(\lambda\pi r)\ g\left(\dfrac{2r}{\pi}\right)$

Final potential energy =

When the chain is completely slipped off the tube, all the links of the chain have the same velocity υ

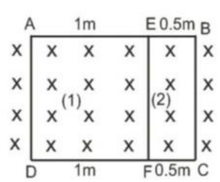


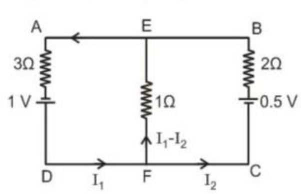
Kinetic energy of chain = $\dfrac{1}{2}(\lambda\pi r)\upsilon^2$

From COE, $\lambda\pi rg\left(\dfrac{2\pi}{r}\right) = (\lambda\pi r)\,g\left(\dfrac{-\pi r}{2}\right) + \dfrac{1}{2}(\lambda\pi r)\upsilon^2$

From which we find, $\upsilon = \sqrt{2gr\left(\dfrac{2}{\pi} + \dfrac{\pi}{2}\right)}$

21.





$$e_1 = A\frac{dB}{dt} = 1\times1\times1 = 1V$$

$$e_2 = 0.5V$$

From loop AEFDA

$$1(I_1 - I_2) - 1 + 3I_1 = 0 \Rightarrow 4I_1 - I_2 = 1 \text{ ....(1)}$$

From loop FCBEF

$$0.5 - 2I_2 + \left(I_1 - I_2\right) = 0 \Rightarrow -I_1 + 3I_2 = 0.5 \text{ ....(2)}$$

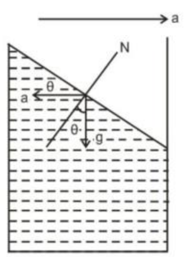
From (1) and (2)

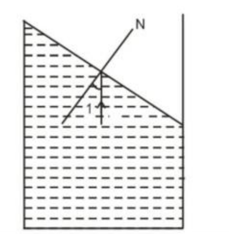
$$I_1 = \frac{7}{22}A,\ I_2 = \frac{3}{11}A,\ I_1 - I_2 = \frac{1}{22}A$$

$$I_{AE} = \frac{7}{22}A,\ I_{BE} = \frac{3}{11}A,\ I_{EF} = \frac{1}{22}A$$

$$\frac{I_{AE}}{I_{EF}} = 7$$

22.





$$\tan\theta = \frac{a}{g} = \frac{4}{3}$$

$$\Rightarrow \sin\theta = \frac{4}{5}$$

Using snell's law we get

$$\mu\sin\theta = 1$$

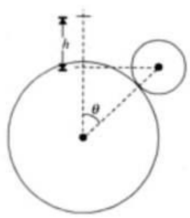
$$\mu = \frac{1}{\sin\theta} = \frac{5}{4} = 1.25$$

23.

$$\frac{mv^2}{(R+r)} = mg\cos\theta$$

$$mgh = \frac{1}{2}mv^2 + \frac{1}{2}l\omega^2$$

$$mg(R+r)(1-\cos\theta) = \frac{1}{2}mv^2 + \frac{1}{5}mv^2 = \frac{7}{10}mv^2$$



$$\frac{10}{7}mg(1-\cos\theta) = mg\cos\theta$$

$$mv^2 = \frac{10}{7}mg(R+r)(1-\cos\theta)\frac{10}{7} = \frac{17}{7}\cos\theta$$

$$v = \sqrt{g(R+r)\cos\theta} = \sqrt{\frac{10}{17}g(R+r)}$$

$$and\ \omega = \frac{v}{r} = \sqrt{\frac{10g(R+r)}{17r^2}} = \sqrt{\frac{110g}{17r}}$$

$$\Rightarrow p+q = 127$$

24.

$$y = (30\,cm)\tan\theta$$

$$= (30\,cm)\frac{0.2}{20} = 0.3cm = 3cm$$

$$= \frac{\lambda D}{d}$$

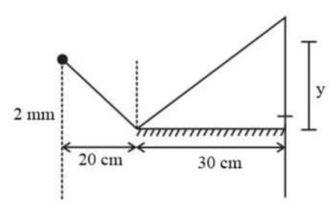
$$= \frac{6400\times10^{-10}\times0.5}{4\times10^{-3}}$$

$$= 800\times10^{-7}$$

$$= 0.08\ mm$$

$$n = \frac{y}{w} = \frac{3}{0.08} = \frac{300}{8} = \frac{75}{2}$$

= 37.5



So no. of complete fringe will be 37. (take a note first bright fringe will be at a distance of $\frac{w}{2}$ above edge)

25. $\lambda = 2L = 3m$ Equation of standing wave

$y = 2A\sin kx \cos \omega t$

$y = A \, as \, amplitude \; is \; 2A.$

$A = 2A \sin \; kr$

$\frac{2\pi}{\lambda} x_1 = \frac{\pi}{6} \Rightarrow x_1 = \frac{1}{4} m$

$And \; \frac{2\pi}{\lambda} x_2 = \frac{5\pi}{6} \Rightarrow x_2 = 1.25m \Rightarrow x_2 - x_1 = 1m$