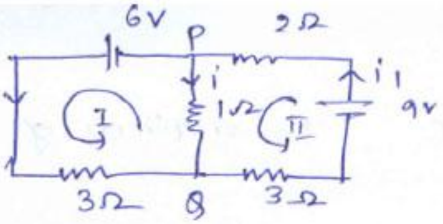
JEE Main 2015

Answer Sheet (Code-C)-Physics

31)



Using Kirchoff's law in loop - II and loop - I.

$9 - i_1(2) - i - 3i_1 = 0$ — ① $9 = 5i_1 + i$ → in loop

$6 - 3(i_1 - i) + i = 0$ — ② → from loop ②

Substituting i_1 in ② from ①

$6 = 3\left(\frac{9-i}{5}\right) - 4i$

$\Rightarrow i = \frac{-3}{23} A = -0.13 A \Rightarrow i = 0.13$ flows from Q to P

32)

C.M lies on 'z' axis

$dm = \rho dA$ $dA = \pi z^2 \tan\theta \, dz$

$$CM\ z = \frac{\int dm\, z}{\int dm} = \frac{\int_0^h z^3 dz \, \tan\theta}{\int_0^h z^2 dz (\tan\theta)} = \frac{3}{4}h$$

from top.

33) Theoritical

A – (ii) B – (i) C – (iii)

34)

$$T = 2\pi\sqrt{\frac{L}{g}}$$

$$\frac{\Delta g}{g} = \frac{2\Delta T}{T} + \frac{\Delta L}{L}$$

$$\% \left(\frac{\Delta g}{g}\right) \times 100 = 2\left(\frac{1}{90} + \frac{0.1}{20}\right) \times 100$$

$$= 2.7\% \simeq 3\%.$$

35) Intensity at 1m $= \frac{P}{4\pi R^2}$

$$\frac{P}{4\pi R^2} = \frac{1}{2}\epsilon_0 E_0^2 c$$

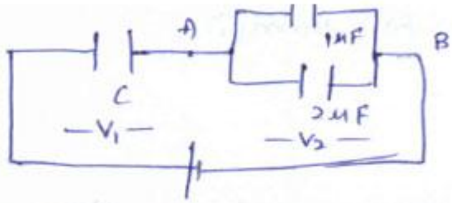
$E_0 \rightarrow$ amplitude of Electric field.

Substituting values

$$E_0^2 = 6\,(V/m)^2$$

$$\Rightarrow E_0 = \sqrt{6}\ V/m = 2.45\ V/m$$

36)



$V_1 \rightarrow$ potential across C

$V_2 \rightarrow$ potential across points A & B shown in figure

$$V_2 = \frac{E}{\frac{3}{C}+1}$$

$$Q_{\text{on } 2\mu F} = \frac{2E}{\frac{3}{C}+1} = 2E\left(\frac{C}{C+3}\right)$$

↳ graph. is concave upwards.

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37) Consider a part of Ei wire. of length 'l'

F due to other wire

$$= \frac{\mu_0 I_1 I_2}{(2L\sin\theta)} l$$

$$T\cos\theta = (\lambda l)\, g$$

$$T\sin\theta = \frac{\mu_0 I^2 l}{(2L\sin\theta)}$$ Eliminating T

$$I = 2\sin\theta\sqrt{\frac{\pi\lambda g L}{\mu_0\cos\theta}}$$

38) Conserving momentum

$$m(2v\hat{i}) + 2m(v\hat{j}) = 3m\vec{v}$$

$$\vec{v} = \frac{2v\hat{i} + 2v\hat{j}}{3}$$

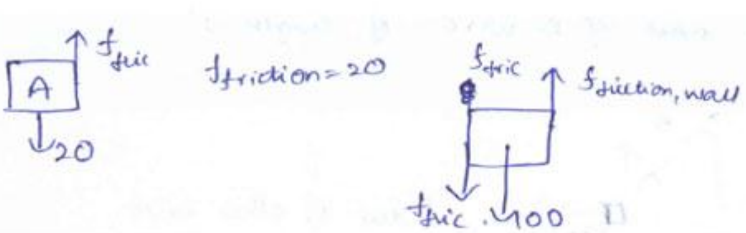
Initial energy $= \frac{1}{2}m(2v)^2 + \frac{1}{2}(2m)v^2$

Final energy $= \frac{1}{2}(3m)\left(\left(\frac{2v}{3}\right)^2 + \left(\frac{2v}{3}\right)^2\right)$

$$\% \text{ loss} = \frac{\frac{1}{2}m(2v)^2 + \frac{1}{2}(2m)v^2 - \frac{1}{2}(3m)\left(\frac{8v^2}{9}\right)}{\frac{1}{2}(6mv^2)} \times 100$$

$$= \frac{18-8}{18} \times 100 = 56\%$$

39)



40) Adiabatic process

PV^{γ} = constant $TV^{\gamma-1}$ = constant.

$P = \frac{m(2v_{rms})}{\Delta t}$ $\Delta t \rightarrow$ average time of collision

$\frac{m(2v_{rms})V^{\gamma}}{\Delta t}$ = const.

$\Rightarrow \frac{m}{\Delta t}\sqrt{\frac{T}{m}}\,V^{\gamma}$ = const

$\frac{\sqrt{T}}{\Delta t}V^{\gamma}$ = Const. $T \propto V^{\frac{1}{\gamma-1}}$

$\Delta t \propto \frac{V^{\gamma}}{V^{\frac{\gamma-1}{2}}}$ $\Delta t \propto V^{\frac{\gamma+1}{2}}$.

41) Theoritical

$\vec{\tau} = \vec{M} \times \vec{B}$

$\vec{M}$ and $\vec{B}$ in same direction stable equilibrium.

and in opposite direction it is unstable equilibrium

42) In adiabatic process $dQ = 0$

$$dU + PdV = 0$$

$$dU + \frac{U}{3V} dV = 0$$

$$\frac{dU}{U} + \frac{1}{3}\frac{dV}{V} = 0 \Rightarrow U^3 V = \text{const.}$$

and $U \propto VT^4$

$$(VT^4)^3 V = \text{const}$$

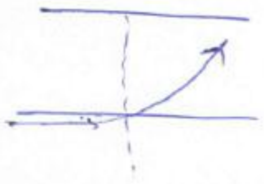
$$\Rightarrow V^4 T^{12} = \text{const} \qquad V = \tfrac{4\pi}{3} R^3$$

$$\Rightarrow (R^{12} T^{12}) = \text{const} \Rightarrow \boxed{T \propto \frac{1}{R}}$$

43) Theoretical

P.E, Total energy decreases, K.E increases

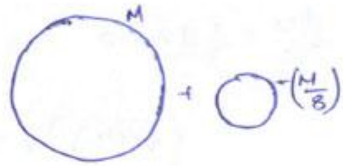
44)



as (μ) increases as we move upwards the light towards the normal so it bends upwards.

45)

Using Superposition.



→ Negative mass

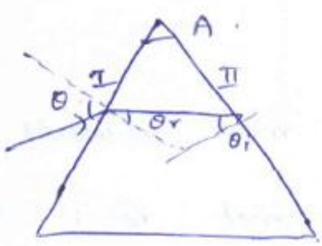
Potential inside a solid sphere at a distance 'r'

$$= -\frac{GM}{R}\left(\frac{3}{2} - \frac{1}{2}\frac{r^2}{R^2}\right)$$

Total potentiona $= -\frac{GM}{R}\left(\frac{3}{2} - \frac{1}{8}\right) + \frac{GM}{8R}$.

$$= -\frac{GM}{R}$$

46)



$\theta_r + \theta_i = A$.

At interface I $\mu \sin\theta_r = \sin\theta$.

For the light to be transmitted $\mu \sin\theta_i < 1$

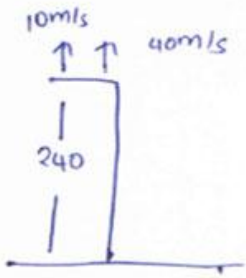
$$\mu \sin(A - \theta_r) < 1$$

$$A - \theta_r < \sin^{-1}\left(\frac{1}{\mu}\right)$$

$$\sin\left(A - \sin^{-1}\left(\frac{1}{\mu}\right)\right) < \frac{\sin\theta}{\mu}$$

$$\theta > \sin^{-1}\left(\mu \sin\left(A - \sin^{-1}\left(\frac{1}{\mu}\right)\right)\right)$$

47)



for both stones

$240 = -40t + 5t^2$

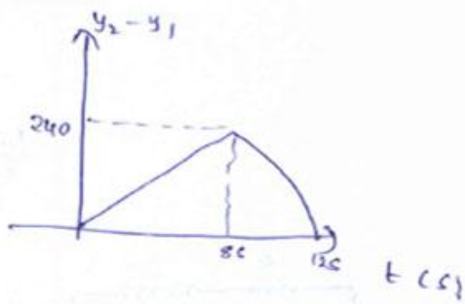
$240 = -10t + 5t^2$

$t = 12s$ → for stone with $v = 40m/s$

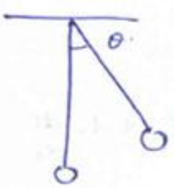
$t = 8s$ for stone with $v = 10m/s$

So till 8s $a_{rel} = 0$ $v_{rel} = 30$

after 8s $a_{rel} = g$ so



48)



$\theta = \theta_0 \sin\omega t$ $\omega = \sqrt{\frac{g}{R}}$

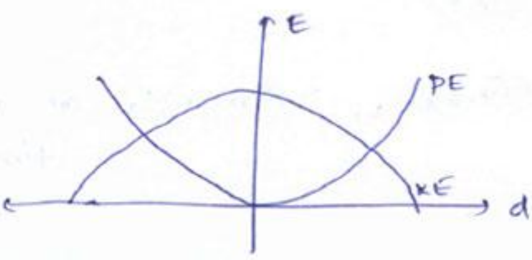
$v = R\omega$ $\frac{1}{2}mv^2 = KE = v_0^2(\cos^2\omega t)$

$= v_0^2(1 - \sin^2\omega t)$

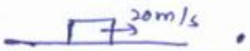
$= v_0^2\left(1 - \frac{d^2}{R^2}\right)$

∵ $PE + KE$ = constant

$P.E \propto v_0^2\left(\frac{d^2}{R^2}\right)$



49) $f = 1000\,Hz$



$$\hookrightarrow f_{before} = \frac{f_0 (v_s)}{(v_s - 20)}$$

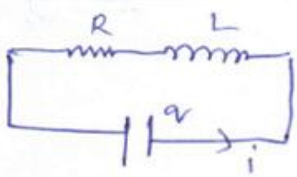
$f = 1000\,Hz$

$$f_{after} = \frac{f_0 (v_s)}{(v_s + 20)}$$

$$\text{change} = \frac{f\left(\frac{v_s}{v_s - 20}\right) - f\left(\frac{v_s}{v_s + 20}\right)}{f\left(\frac{v_s}{v_s - 20}\right)} \times 100$$

$$= \frac{40}{340} \times 100 \approx 12\,\%$$

50)



$$i = \frac{dq}{dt}$$

Kirchoff's law

$$\frac{q}{c} = iR + L\frac{di}{dt}$$

when q is max

$$\frac{q}{c} = \frac{dq}{dt}R + L\frac{d^2q}{dt^2}$$

$$\frac{dq_{max}}{dt} = 0$$

$$\frac{Q_{max}}{C} = \frac{d^2 Q_{max}}{dt^2}$$

$$Q_{max} = Q_0 e^{-\frac{1}{\sqrt{LC}} t}$$

$\Rightarrow L_1 > L_2 \Rightarrow (Q_{max})_{L_1} > (Q_{max})_{L_2}$ at a given time.

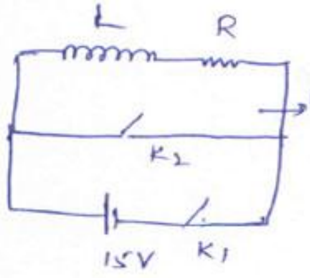
51) Constant heat capacity = 1

$\because$ Entropy is state function. Entropy change for both cases is same

and $\Delta S = \int \frac{dq_{rev}}{T} = \int \frac{C\,dT}{T} = \ln\frac{200}{100}$ $\because C = 1$

$= \ln 2$ SI unit.

52)



Initially I in circuit $I_0 = \frac{15}{150} = 0.1\,A$.

after switch is closed

$-L\frac{dI}{dt} - IR = 0$ using kirchoffs law in loop - I

$-(3\times10^{-1})\frac{dI}{dt} = i(150)$

$\frac{di}{dt} = i(-500)$

$i = i_0 e^{-5000t}$

$\Rightarrow i = (0.1)e^{-5000t}\,A$ substitute at given value.

$\Rightarrow i = \frac{0.1}{150}\,A = 0.67\,mA$.

53)

$r < R \qquad V = V_0\left(\frac{3}{2} - \frac{r^2}{2R^2}\right)$

$r > R \qquad V = \frac{V_0 r}{R}$

So $r = 0 \Rightarrow V = \frac{3V_0}{2} \qquad R_1 = 0$

$\frac{5V_0}{4} = V_0\left(\frac{3}{2} - \frac{r^2}{2R^2}\right) \Rightarrow R_2 = \frac{R}{\sqrt{2}}$

$\frac{3V_0}{4} = V_0\left(\frac{r}{R}\right) \Rightarrow R_3 = \frac{4R}{3}$

$\frac{V_0}{4} = V_0\left(\frac{r}{R}\right) \Rightarrow R_4 = 4R$

$R_1 = 0$ and $R_4 > 2R$ and $R_4 - R_3 > R_2$

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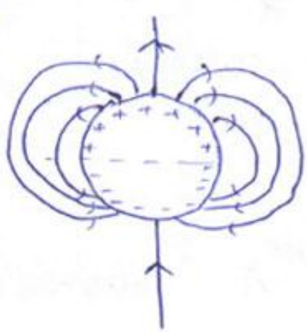
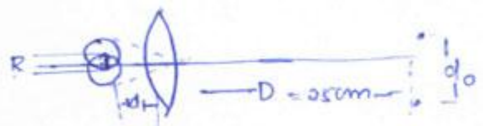
54) Theoritical



55)



$$\frac{d_0}{D} = \frac{R}{d} \quad \text{and} \quad R = \left(\frac{1.22\lambda}{D_{\text{iameter of aperture}}}\right) \times d$$

$$\Rightarrow \frac{d_0}{25\times10^{-2}} = \frac{1.22 \times 500\times10^{-9}}{0.5\times10^{-2}\, m} \times m$$

$$d_0 = (25) \times 1.22 \times 10^{-6}\, m$$

$$d_0 \simeq 30.5\, \mu m \approx 30 \mu m$$

56) Theoritical

frequency of resultant wave will, 2005 KHz, 2000 KHz, 1995 KHz

57)

$\vec{F_2} = 0$ ($\because \vec{B} = 0$ outside the solenoid)

and on inner solenoid $\vec{F_1} = 0$

$\because$ force on an element of coils will be radially outward.

$\therefore$ Total force on loop will be zero.

$\therefore \vec{F_1} = 0$

58)

$$T = 2\pi\sqrt{\frac{l}{g}}$$

$$T_M = 2\pi\sqrt{\frac{l'}{g}}$$

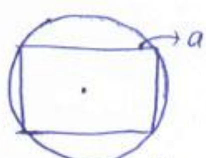
$$\frac{l'}{l} = \frac{T_M^2}{T^2}$$

$$\frac{l'-l}{l} = \left(\frac{T_M}{T}\right)^2 - 1$$

$$\frac{\text{stress}}{\text{strain}} = Y \qquad \frac{Mg}{A\left(\frac{l'-l}{l}\right)} = Y$$

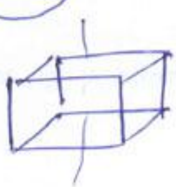
$$\Rightarrow \quad \frac{1}{Y} = \left(\left(\frac{T_M}{T}\right)^2 - 1\right)\frac{A}{Mg}$$

59)



a is length of cube

$2R = \sqrt{3}a$.



$$I = M'\left(\frac{a^2}{12} + \frac{a^2}{12}\right) \quad \rho.$$

$$= \frac{M'a^2}{6} \qquad (M' = \rho a^3)$$

$$= \frac{\rho(a^3)a^2}{6} \qquad \text{substitute} \quad a = \frac{2R}{\sqrt{3}}$$

$$\text{and} \quad \rho\left(\frac{4}{3}\pi R^3\right) = M$$

$$= \frac{4M}{9\sqrt{3}\pi} R^2$$

60)

$E = \rho J$

$J = neV_d$. $V_d \to$ drift velocity

$\rho = \dfrac{E}{ne\,v_d}$ substituting values $E = V/d$

$= \dfrac{5\times10^{-4}}{(0.1)(8\times10^{28}\times1.6\times10^{-19}\times2.5\times10^{-4})}\ \Omega m$

$= \dfrac{5\times10^{-4}}{4(5)(1.6)}\ \Omega m = 1.56\times10^{-5}\ \Omega m \approx 1.6\times10^{-5}\ \Omega m$

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