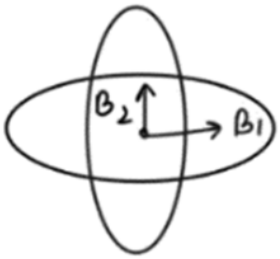
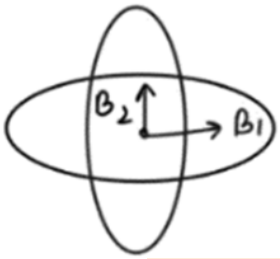
JEE-Mains-06-04-2023 [Memory Based] [Morning Shift]

Physics

Question: Current $\sqrt{2I}$ in both rings, find resultant B?



Solution:



Current $=\sqrt{2}I$

$$B_1 = B_2 = \frac{\mu_0\left(\sqrt{2}I\right)}{2a}$$

So,

$$B_N = \sqrt{B_1^2 + B_2^2}$$

$$= \frac{\mu_0}{2a}\left(\sqrt{2}I\right)\sqrt{2} = \left(\frac{\mu_0 I}{a}\right)$$

Question: If rate of heat supplied to the system is 1000 watt and the rate of work done by the system is 200 watt. Find rate of change of internal energy.

Answer: 800.00

Solution:

$\frac{dQ}{dt} = +1000 \text{ watt}$

$\frac{dw}{dt} = +200 \text{ watt}$

$\frac{dQ}{dt} = \frac{dw}{dt} + \frac{du}{dt}$

$+1000 = +200 + \frac{dw}{dt}$

$\frac{dw}{dt} = +800 \text{ watt}$

Question: Find the ratio of energy density of E and B in EM waves.
Options:
(a) 1 : 1
(b) 1 : 2
(c) 2 : 1
(d) None of these
Answer: (a)
Solution:

Average electric field energy density = $\frac{1}{2}\varepsilon_0 E^2$

Average magnetic field energy density = $\frac{B^2}{2\mu_0}$

As both are equal

$\frac{\frac{1}{2}\varepsilon_0 E^2}{\frac{B^2}{2\mu_0}} = 1$

Question: Percentage error in equivalent resistance if connected in parallel (10 ± 0.5) ohm and (15 ± 0.5) ohm
Options:
(a) 13 %
(b) 3 %
(c) 13/5 %
(d) 13/3 %
Answer: (d)
Solution:

$$\frac{\Delta R_{eq}}{R_{eq}^2}=\frac{\Delta R_1}{\Delta R_1^2}+\frac{\Delta R_2}{\Delta R_2^2}$$

$$\frac{\Delta R_{eq}}{R_{eq}}=\left(\frac{0.5}{10^2}+\frac{0.5}{15^2}\right)\times\frac{15\times10}{15+10}$$

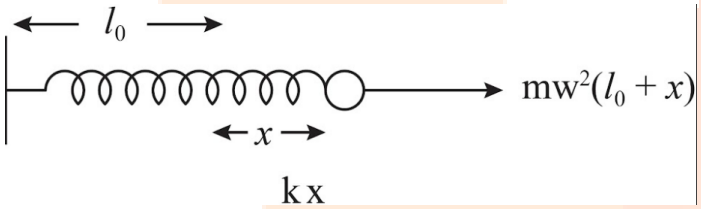
$$=0.5\left(\frac{1}{10^2}+\frac{1}{15^2}\right)\times\frac{150}{25}$$

$$=3\left(\frac{1}{100}+\frac{1}{225}\right)=3\left(\frac{225+100}{225\times100}\right)$$

$$\frac{\Delta R}{R}\times100=\frac{3\times325}{225\times100}\times100=\frac{13}{3}\%$$

Question: Assertion: Earth has atmosphere while moon does not.
Reason: Escape velocity in moon is very small than earth.
Options:
(a) A correct, R correct & R is correct explanation
(b) A correct, R correct but not correct explanation
(c) A correct, R false
(d) A false, R false
Answer: (a)
Solution: A correct, R correct & R is correct explanation

Question: A mass of 100 g is rotated with a spring of natural length 20 cm, with angular velocity 5 $rads^{-1}$. Find tension in spring [R = spring constant 7.5 nm^{-1}]
Answer: 0.75
Solution:



$$T=kx=m\omega^2(l_0+x)$$

$$7.5x=\frac{1}{10}\times25(0.2+x)$$

$$3x=0.2+x$$

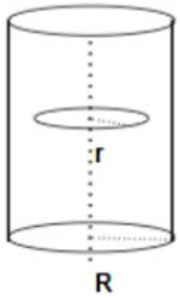
$$x=0.1$$

so $T=kx=7.5\times0.1=0.75\,\text{N}$

Question: A solid infinite cylindrical wire with radius a is carrying current I find the graph of magnetic field inside & outside the wire.

Answer:

Solution:

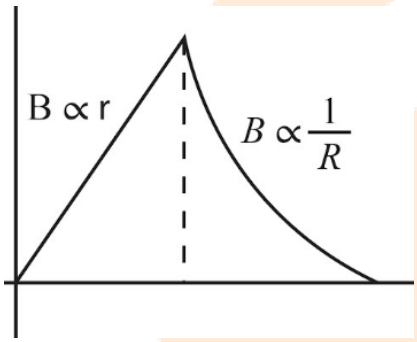


Dependency of magnetic fixed in solid current carrying wire

$$B_{out} = \frac{\mu_0 i}{2\pi r}$$

$$B_{surface} = \frac{\mu_o i}{2\pi R}$$

B_{inside}



Current through h loop

$$i_1 = \frac{i}{\pi R^2} \times \pi r^2$$

$$\oint B \cdot dl = \mu_o i$$

$$B.2\pi r = \mu_o \frac{i \times \pi r^2}{\pi R^2}$$

$$B = \frac{\mu_o i}{2\pi R^2} \times r$$

$$B \propto r$$

Question: A: range is max at θ = 45°
R : range is max when sin 2θ = 1

Options:

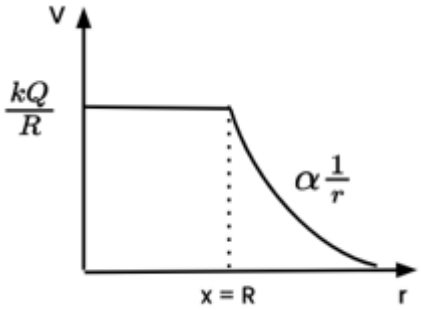
(a) R : true A : False
(b) R : true A : True
(c) R : False A : False
(d) R : False A : True

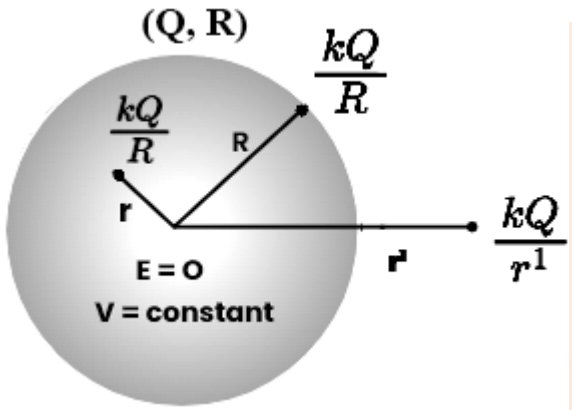
Answer: (b)

Question: Graph of electric potential inside conducting solid sphere is

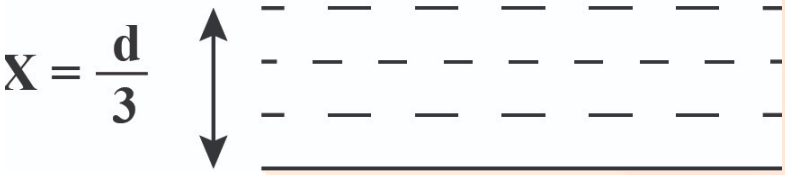
Solution:

$$v_{\text{inside}} = v_{\text{surface}} = \frac{kQ}{R} = \text{constant}$$



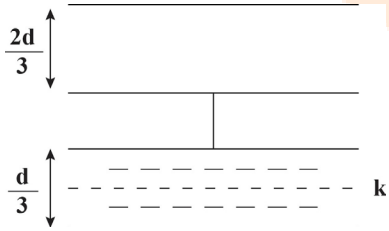


Question: In a capacitor when liquid of dielectric constant 'k' is filled upto height d/3 then capacitance is 2μF. Find capacitance when it is filled till $x = 2d/3$ Take $k = 2$



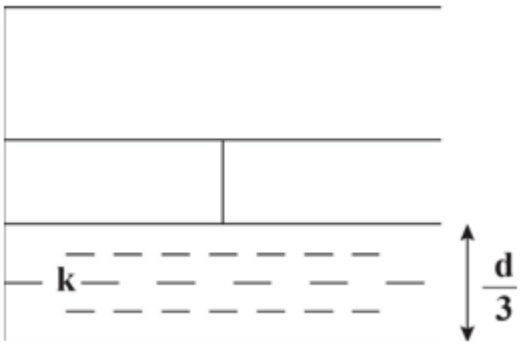
Answer: 2.5

Solution:



$$C_{eq} = \frac{\frac{3Ak\varepsilon}{d} \cdot \frac{3A\varepsilon_0}{2d}}{3\frac{A\varepsilon_0}{d}\left[k + \frac{1}{2}\right]}$$

$$2 = \frac{3K}{\left(K + \frac{1}{2}\right)} \frac{A\varepsilon_0}{2d} \Rightarrow 2 = \frac{3 \times 2}{\frac{5}{2}} \frac{A\varepsilon_0}{2d} \Rightarrow \frac{A\varepsilon_0}{d} = \frac{10}{6}$$



$$C_{eq}=\frac{\frac{3AK\varepsilon_0}{2d}\cdot\frac{3A\varepsilon_0}{d}}{\frac{3A\varepsilon_0}{d}\left[\frac{k}{2}+1\right]}=\frac{3A\varepsilon_0}{2d}\frac{k}{\left[\frac{k}{2}+1\right]}$$

$$C_{eq}=\frac{3}{2}\left(\frac{10}{6}\right)\left[\frac{2}{2}\right]=2.5F$$

Question: If retardation of a body of mass 10 gram is given as $2x$, where x is the position of the particle starting from origin at rest. If loss of kinetic energy is $\left[\frac{10}{x}\right]^{-n}$ find n .

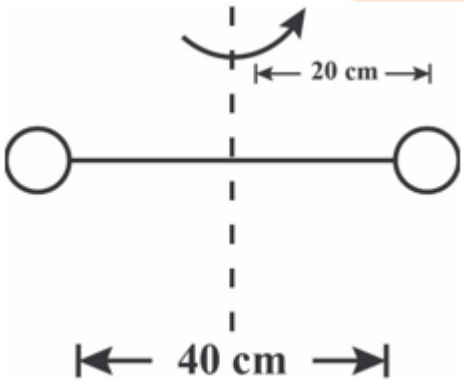
Answer: 2.00
Solution:

$$\Delta KE=W=\int_0^x mad\,x$$

$$\Delta KE=\frac{10}{100}\int_0^x(-2x)\,dx=-\frac{1}{100}.x^2=-\left[\frac{x^2}{100}\right]=\left(\frac{10}{x}\right)^{-2}$$

So n = 2.

Question: Two spheres of mass 2 kg each placed on the ends of a light rod and r = 10 cm and dist b/w the centres = 40 cm find MOI about centre of the rod perpendicular to the line joining centres.
Answer: 0.17
Solution:



$$I = I_{cm} + ml^2$$

$$= \frac{2}{5}MR^2 + Ml^2$$

$$= \frac{2}{5} \times 2 \times (0.1)^2 + 2(0.2)^2$$

$$I = \frac{4}{500} + \frac{8}{100}$$

$$I = \frac{4+40}{500} = \frac{44}{500} \text{ kg m}^2$$

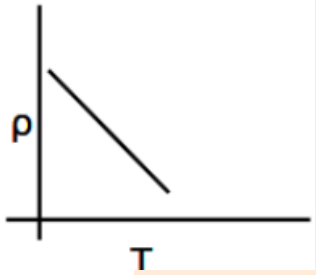
For 2 spheres

$$I_{final} = 2 \times I = 2 \times \frac{44}{500} = 0.176 \text{ kg m}^2$$

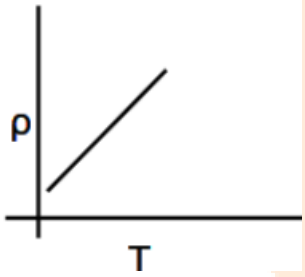
Question: Resistivity of semiconductor changes with temp according to which graph

Options:

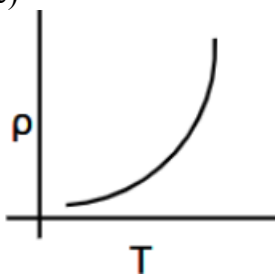
(a)



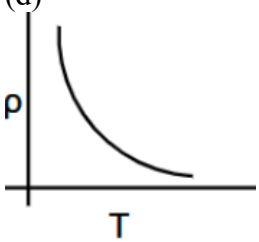
(b)



(c)



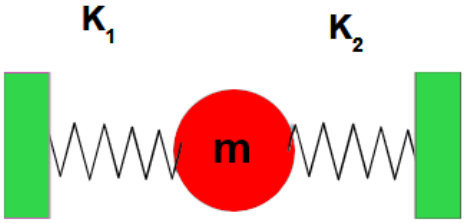
(d)



Answer: (d)

Question: Alpha, electron, proton has KE is such that $K_\alpha = 4K$, $K_e = 2K$, $K_p = K$ write order of de broglie wave
Solution: $\lambda_e > \lambda_P > \lambda_\alpha$

Question: For the oscillations exhibited by the spring block system on the smooth surface along the spring, the time period is equal to



Options:

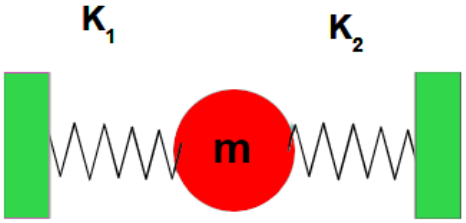
(a) $2\pi\sqrt{\frac{m(K_1+K_2)}{K_1K_2}}$

(b) $2\pi\sqrt{\frac{m(K_1+K_2)}{2K_1K_2}}$

(c) $2\pi\sqrt{\frac{m}{K_1+K_2}}$

(d) $\pi\sqrt{\frac{m}{K_1+K_2}}$

Answer: (c)
Solution:

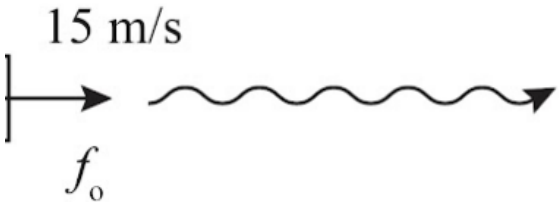


Since the springs are in parallel connection

$k_{eq} = k_1 + k_2$

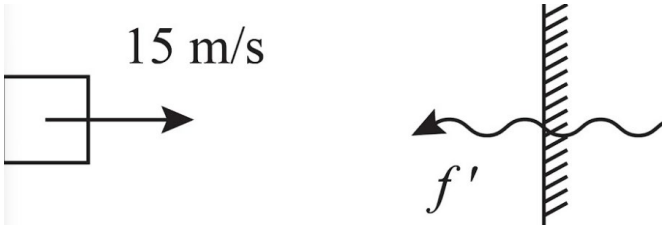
$T = 2\pi\sqrt{\frac{M}{K_1+K_2}}$

Question: A car is moving with speed of 15 m/s towards a stationary wall. A person in the car press the horn and experience the change in frequency of 40 Hz due to reflection from the stationary wall. Find the frequency of horn. (Use v_{sound} = 330 m/s)
Answer: 420.00
Solution:



$$f' = f_0\left[\frac{V}{V - V_C}\right]$$

$$f'' = f'\left[\frac{V + V_C}{V}\right]$$



$$f'' = f_0\left[\frac{V}{V - V_C}\right]\left[\frac{V + V_C}{V}\right]$$

$$f'' = f_0\left[\frac{V + V_C}{V - V_C}\right]$$

$$f'' - f_0 = 40$$

$$f_0\left(\frac{330 + 15}{330 - 15}\right) - f_0 = 40$$

$$f_0\left[\frac{23}{21} - 1\right] = 40$$

$$f_0 = 420$$

Question: Communication system
Height of the tower increased 21% percentage increase in range.
Options:
(a) 10
(b) 12
(c) 14
(d) 15
Answer: (a)
Solution:
Range = $\sqrt{2R_E h}$

$$R_1 = \sqrt{2R_E \cdot h} = \sqrt{2R_E \cdot h}$$

$$R_2 = \sqrt{2R_E\left[h + \frac{21}{100} \cdot h\right]} = \sqrt{2R_E(1.21h)}$$

$$\frac{R_1}{R_2} = \frac{\sqrt{2R_E h}}{\sqrt{2R_E(1.21h)}} = \frac{1}{\sqrt{1.21}} = \frac{1}{1.1}$$

$$\Rightarrow R_2 = 1.1R_1$$

$$\% \text{ change in R} = \frac{(R_2 - R_1)}{R_1} \times 100$$

$$= \frac{1.1R_1 - R_1}{R_1} \times 100$$

$$\frac{1.1-1}{1} \times 100 = 10\%$$

Question: If length of wire is increased 20% and area is increased 4% the % change in resistance is

Answer: 15.00

Solution:

$$R = \frac{\rho l}{A}$$

$$R' = \frac{\rho(1.2\ell)}{1.04A} \Rightarrow R' = \frac{12}{1.04} R = 1.15R$$

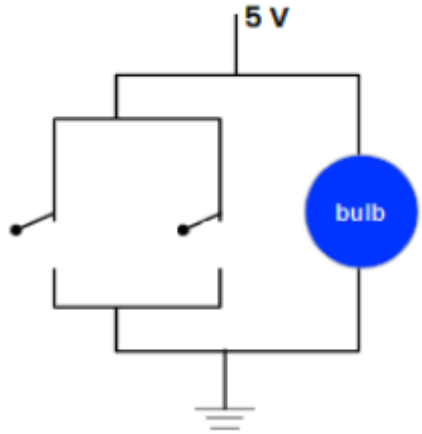
$$\Rightarrow \uparrow 15\%$$

Question: A Body has mass m and moving with const vel in viscous fluid having coiff. of viscosity η density is ρb liquid density ρL find vel v

Solution:

$$\frac{mg\left(1 - \frac{\rho}{S}\right)}{6\pi\eta r} = v$$

Question: Which gate is this



Options:

(a) NOR

(b) OR

(c) AND

(d) NOT

Answer: (a)