doubtnut
India's Number 1 Education App

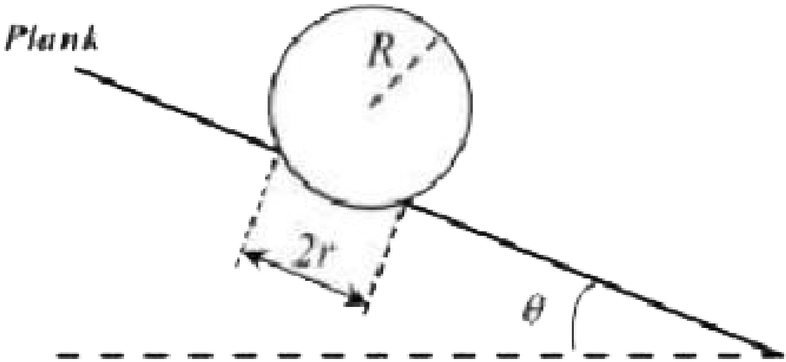
PHYSICS

BOOKS - JEE ADVANCED PREVIOUS YEAR

JEE ADVANCED 2020

Section 1

1. A football of radius R is kept on a hole radius r $(r < R)$ made on a plank kept horizontally. One end of the plank is now lifted so that it gets tilted making an angle θ from the horizontal as shown in the figure below. The maximum value of θ so that the football does not start rolling down the plank satisfies (figure is schematic and not drawn to scale)



A. $\sin\theta = \frac{r}{R}$

B. $\tan\theta = \frac{r}{R}$

C. $\sin\theta = \frac{r}{2R}$

D. $\cos\theta = \frac{r}{2R}$

Answer: A

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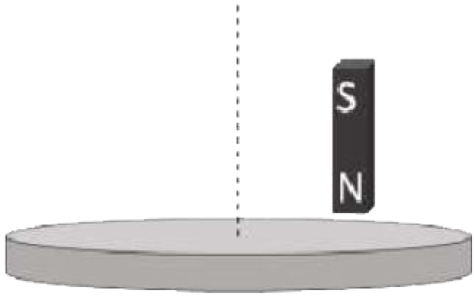
2. A light disc made of aluminum (a nonmagnetic material) is kept horizontally and is free to rotate about its axis as shown in the figure. A strong magnet is held vertically at point above the disc away from its at



A. rote in the direction opposite to the

B. rotate in the same direction as the sirection of magnet's otion

C. not rotate and its temperature will remain unchanged

D. not rotate but its temperature will slowly ries

Answer: B

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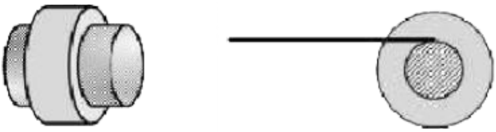
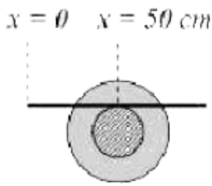
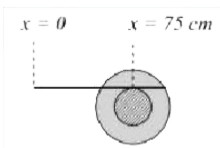
3. A small roller of diameter 20 cm has an axle of diameter 10 cm (see figure below on the left). It is on a horizontal floor and a meter scale is positioned horizontally on its axle with one edge of the scale on top of the axel (see figure on the right). The scale is now pushed slowly on the axle so that it moves without slipping on the axle, and the roller without slipping. After the roller has moved 50 cm, the position of the scale will look like (figures are schematic and not drawn to scale)



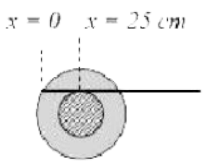
A.



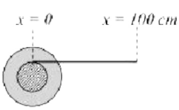
B.



C.



D.



Answer: B

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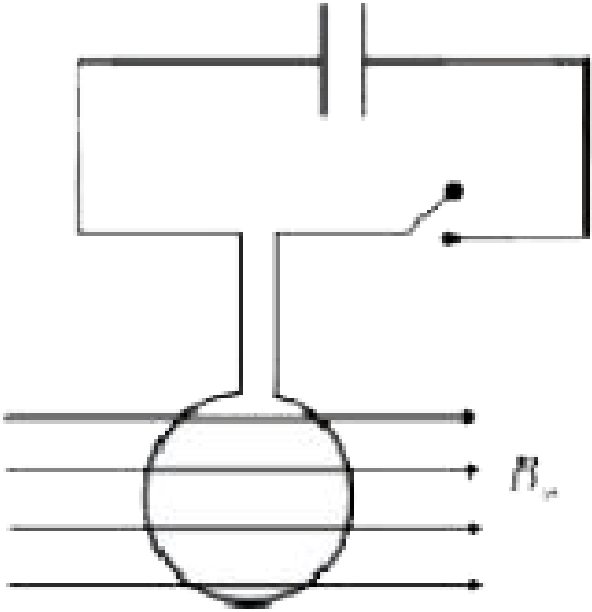
4. A circular coil of radius R and N turns has neglible resistance. As shown in the schematic figure. Its two wnds are connected to wires and it is hanging by those wires with its plane being vertical the wires are connected to a capacitor with charge Q through a switch. The coil is a horizontal uniform magnetic field B_o parallel to the plane of the coil. When the switch is closed, the capacitor gets discharged through the coil in a very short time. By the time capacitor is discharged fully, magnitude of the angular momentum gained by the coil will be (assume that the discharge time is so short that the coil has hardly rotated suring this time)



A. $\frac{\pi}{2}NQB_0R^2$

B. πNQB_0R^2

C. $2\pi NQR^2$

D. $4\pi NQB_0R^2$

Answer: B

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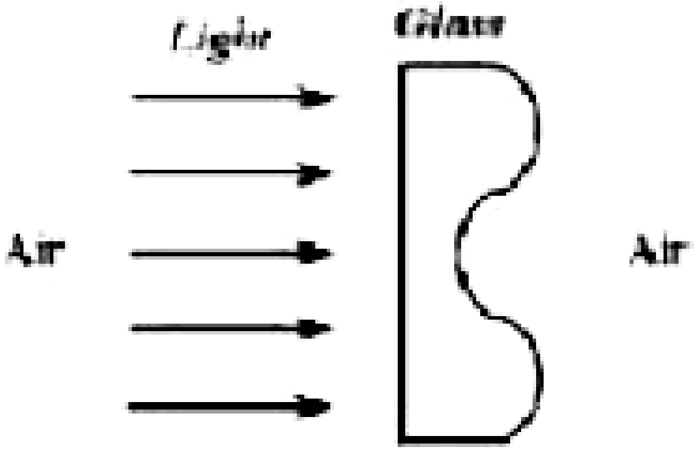
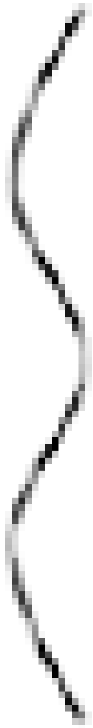
5. A parallel beam of light strikes a piece of transparent grass having cross section as shown in the figure below. Corrent shape of the emergent wave front will be (figures are schematic and not drawn to scale)





A.

B.

C.

D.

Answer: A

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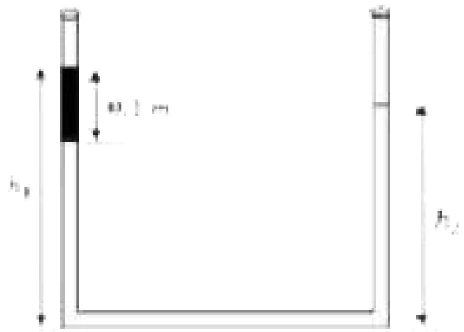
6. an open - ended U-tube cross - sectional area contains water (density 10^3Kg m^{-3}). Initially the water level stands at 0.29 m from the bottom in each arm. Kerosene oil (a wtare - immiscible liquid) of density 800 kg m^{-3} is added to the left arm until its length is 0.1 m, as shown in the schematic figure below. The ratio $\left(\frac{h_1}{h_2}\right)$ of the heights of the liquid in the two arms is



A. $\frac{15}{14}$

B. $\frac{35}{33}$

C. $\frac{7}{6}$

D. $\frac{5}{4}$

Answer: B

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Section 2

1. A particle of mass m moves in circular orbits with potential energy $N(r) = Fr$, wjere F is a positive constant and r its distance from the origin. Its energies are calculated using the Bohr model. If the radius of the the n^{th} orbit (here h is the Planck's constant)

A. $R\alpha n^{1/3}$ and $v\alpha n^{2/3}$

B. $R\alpha n^{2/3}$ and $v\alpha n^{1/3}$

C. $E = \frac{3}{2}\left(\frac{n^2h^2F^2}{4\pi^2m}\right)^{1/3}$

D. $E = 2\left(\frac{n^2h^2F^2}{4\pi^2m}\right)^{1/3}$

Answer: B::C

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2. The filament of a light bulb has surface has area $64mm^2$. The filament can considered as a black body at temperature 2500 K emitting radiation like a point source when viewed form far. At night the light bulb is observed from a distance of 100 m. Assume the pupil of the eyes of the observer to be circular with radius 3 mm. Then (Take Stefan-Boltzman constant $= 5.67 \times 10^{-8} \text{ Wm}^{-2} K^{-4}$, Wien's displacement constant $= 2.90 \times 10^{-3}$ m-k, Planck's constant $= 6.63 \times 10^{-8} Wm^{-2} K^{-4}$, Wien's displacement constant $= 2.90 \times 10^{-3}$m-K, Planck's constant $= 6.63 \times 10^{\cdot} - 34)$ js, speed of light in vacumm $= 3.00 \times 10^8 ms^{-1}$)

A. power radiated by the filament is in the range 642 W to 645 W

B. radiated power entering into one of range 642 W to $3.25 \times 10^{-8} W$

C. the wavelength corresponding to maximum intensity is 1160 nm

D. taking the average wavelength of emitted radiation to be 1740 nm, the number of photons entering per second into one eye of the observer is in the range 2.75×10^{11} to 2.85×10^{11}

Answer: B::C::D

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3. Some times it is convenient to construct a system of units so that quantities can be expressed in terms of a quantity X as follows : $[\text{position}] = [X^{\alpha}]$, $[\text{speed}] = \left[X^{\beta}\right]$, $[\text{acceleration}] = [X^{p}]$, linear moment

.Then

A. $\alpha + p = 2\beta$

B. $p + q - r = \beta$

C. $p - q + r = \alpha$

D. $p + q + r = \beta$

Answer: A::B

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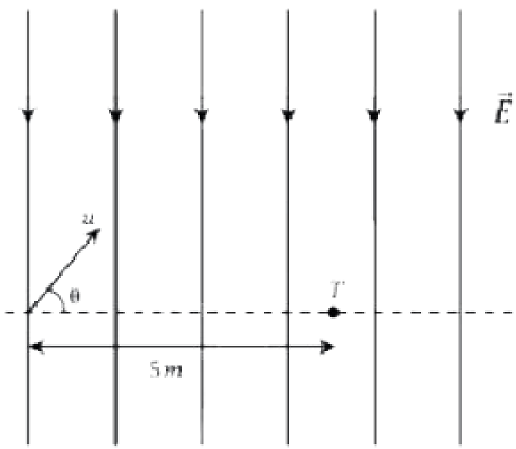
4. A uniform electric field $\overrightarrow{e} = -4000\sqrt{3}\hat{y}NC^{-1}$ is applied in a region. A charged particle of mass m carrying positive charge q is projected in this region with an initial speen of $2\sqrt{10} \times 10^6 ms^{-1}$. This particle is aimed to hit a target T, which is 5 m away from its entry point the field as shown schematically in the figure.

Take $\frac{q}{m} = 10^{10} Ckg^{-1}$, Then



A. the particle will hit T if projected at an angle 45° from the horizontal

B. the particle will hit T if projected at an angle 45° from horizontal

C. time taken by the particle to hit T could be $\sqrt{\frac{5}{6}}\mu s$ well as $\sqrt{\frac{5}{2}}\mu m$

D. time taken by the particle to hit T is $\sqrt{\frac{5}{3}}\mu s.$

Answer: C

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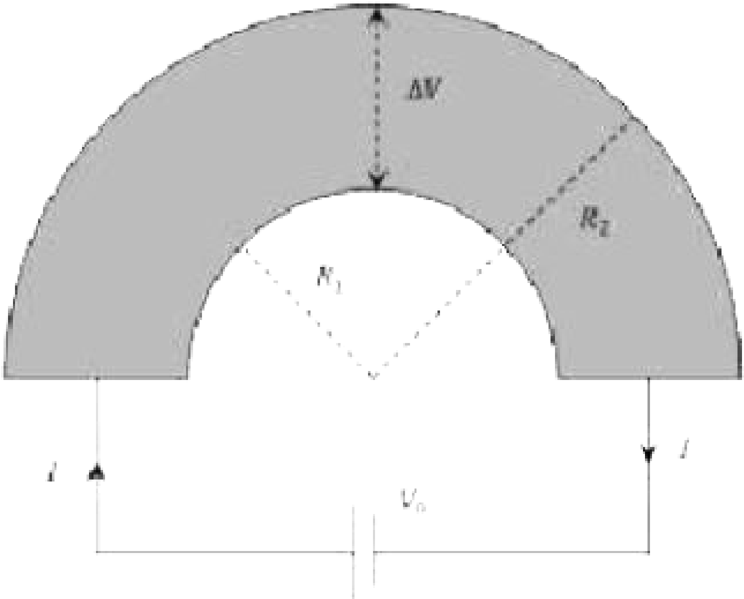
5. Shown in the figure is a semi - circular metallic strip that has thickness t and resistivity ρ its inner radius is R_1 and outer radius is R_2. It a voltage V_0 is applied between its two ends , a current I floes in it . In addition , it is observed that a transverse voltage ΔV develops between its inner and outer surfaces due to puerly kinetic effects of moving electrons (ignore any role of the magnetic field due to the current). Then (figure is schematic and not drawn to scale



A. $1 = \frac{V_0 t}{\pi \rho} In\left(\frac{R_2}{R_1}\right)$

B. the outer surface is at a higher voltage than inner surface

C. the outer surface is at a lower voltage than the inner surface

D. $\Delta V \propto 1^2$

Answer: A::C::D

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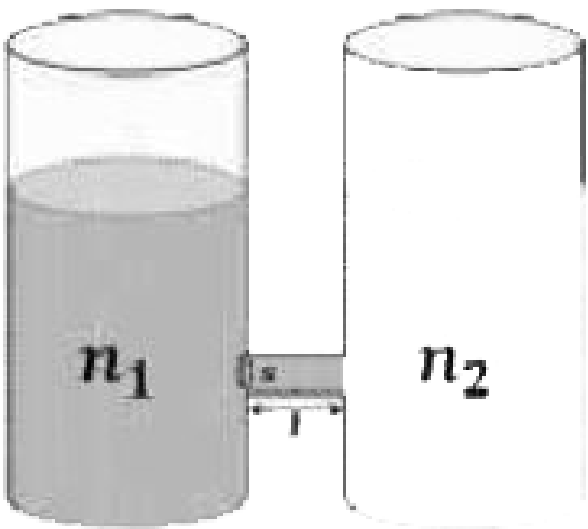
6. As shown schematically in the figure , two vessels contain water solutions (at temperature T) of potassium permanganate $(KMnO_4)$ of different concentrations n_1 and $n_2 (n_1 > n_2)$ molecules per unit volume with $\Delta n = (n_1 - n_2 < < n_1$. When they are connected by a tube of small length and cross - sectional area s, $KMnO_4$ starts to diffuse from the left to the right vassel through the tibe Consider the two collection of molecules to between as dilute ideal gases and the difference in their partial pressure in the two vassels causing the diffusion . The speed v of the molecules is limited by the viscous force $-\beta v$ on each molecule, where β is a constant . neglecting all terms of the order $(\Delta n)^2$ which of the following is / are correct ? (k_B is the Boltzmann constant)



A. the force causing the molecules to move across the tube is

$\Delta n k_a T S$

B. force balance implies $n_1 \beta v l = \Delta n k_B T$

C. total number of molecues going across the tube per sec is

$\left(\frac{\Delta n}{l}\right)\left(\frac{k_B T}{\beta}\right) S$

D. rate of molecules getting transferred through the tube does not change with time

Answer: A::B::C

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Section 3

1. Put a unifrom meter scale horizontally on your extended index fingers with the left one at 0.0 cm and the right one at 90.00 cm when you attempt to move both the fingers slowly towards the center , initially only the left finger slips with respect to to the scale and the right finger does not . after some distance, the left finger stops and the right one starts slipping . Then the right finger stops at a distance XR from the center (50.00 cm) of the scale and the left one starts slopping again . This happens because to the difference in the fiictional forces on the two fingers . it the coefficients of static and dynamic between the fingers and the scale are 0.4 and 0.32 respectively , the value of XR (in cm is ....

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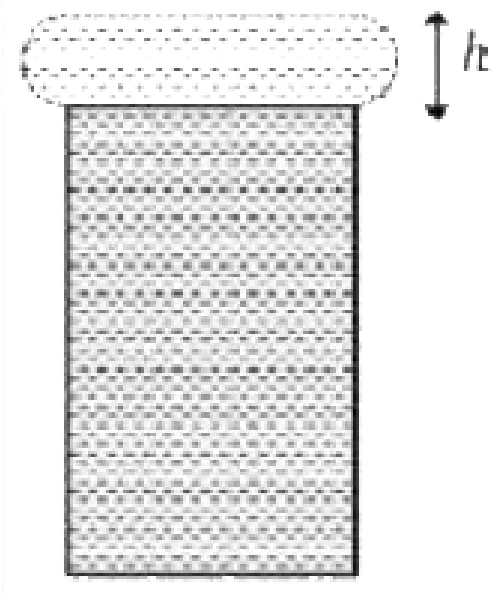
2. When water is filled caerfully in a glass . One can fill it to a height h above the rim of glass due to the surface tension of water . To calculate h just before water starts flowing model the shape of the water above the rim as a disc of thickness h having semicircular edges as shown achematically in the figure When the pressure of water at the bottom of this disc exceeds what can be withstood due to the surface lension , the water surface breaks near the rim and water starts flowing form there if the density of water, its surface tension and the acceleration due to gravity are $10^3 kgm^{-3}, 0.07 Nm^{-1}$ and $10ms^{-2}$, respectively, the value of h (in mm) is ________



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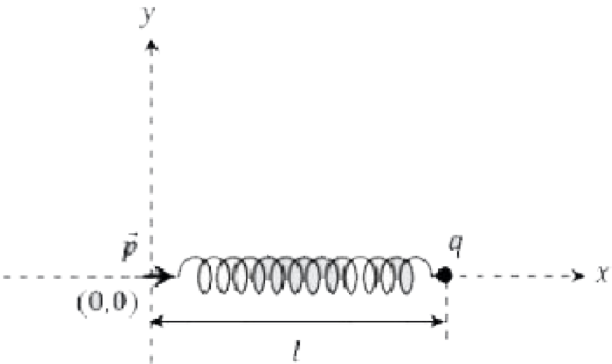
3. One end of a spring of negligible unstretched length and spring constant k is fixed at the origin (0,0) . A point particle of mass m carrying a positive charge q attached at its other end . The entire system is kept on a smooth horizontal surface . When a point dipole p pointing towards the charge q is fixed at the origin , the spring gets stretched to a length l and attains a new equilibrium positition (see figure below) . if the point mass is now displaced slightly by $\Delta l < < l$ from its equilibrium position and released it is found to oscillate at frequency $\frac{1}{\delta}\sqrt{\frac{k}{m}}$. The value of δ is

_______.



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4. Consider one mole of helium gas enclosed in a container at initial pressure $P_1$and volume V_1 . It expands isothermally to volume V_1 After this , the gas expands adiabatically and its volume becomes $32V_1$. The work done by the gas during isothermal and adiabatic expansion processes are W_{iso} and W_{adia} respectively . if the radio $\frac{W_{iso}}{W_{adia}} = fIn2$, then f is ________ .

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5. A stationary tuning fork is in resonance with an air column in a pipe . If the tuning fork is moved with a speed of $2ms^{-1}$ in front of the open end of the pipe and parallel to it , the length of the pipe should be changed for the resonance to occur with the moving tuning fork if the speed of sound in air is $320ms^{-1}$, the smallest value of the percentage change required in the length of the pipe is ________.

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6. A circular disc of radius carries surface charge density $= \sigma_0 \left(1 - \frac{r}{R}\right)$, where σ_0 is a constant and is the distance from the center of the disc Electric flux through a lange spherical surface that endcloses the charged disc completely is ϕ_0. electric flux through another spherical surface of radius $\frac{R}{4}$ and consentri with the disc is ϕ . Then the ratio $\frac{\phi_0}{\phi}$ is __________.

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