PHYSICS

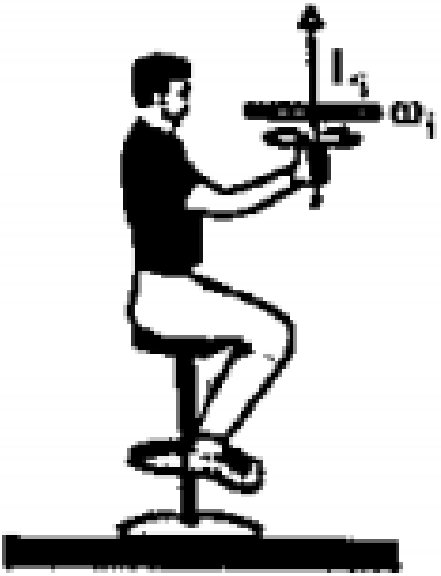
BOOKS - KVPY PREVIOUS YEAR

MOCK TEST 1

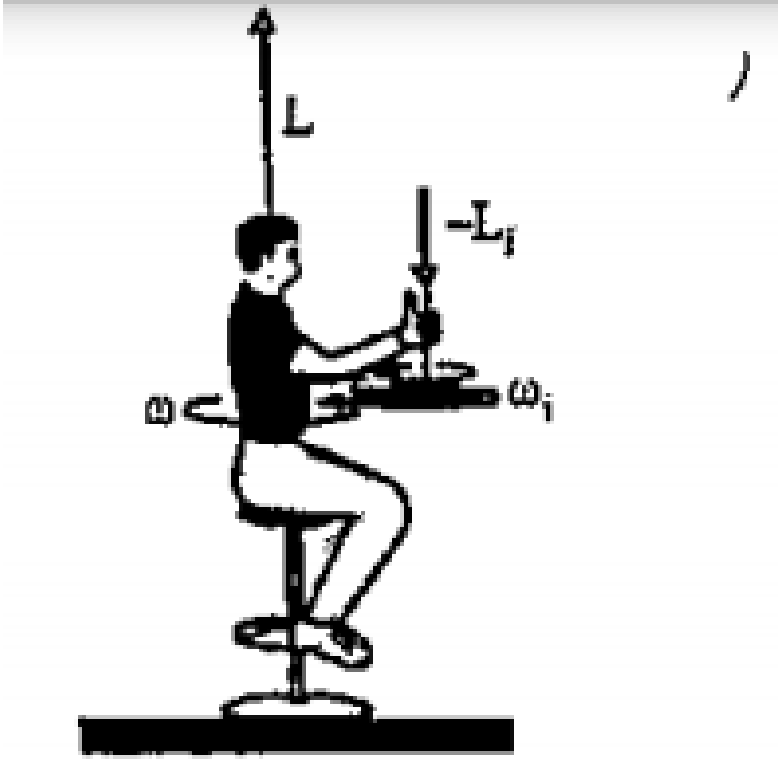
Exercise

1. Figure shows a student, sitting on a stool that can rotate freely about a vertical axis. The student, initially at rest, is holding a bicycle

wheel whose rim is loaded with lead and whose moment of inertia is I about its central axis. The wheel is rotating at an angular speed ω_i from an overead perspective, the rotation is counter clockwise. The axis of the wheel point vertical, and the angular momentum $\overrightarrow{L}_i$ of the wheel points vertically upward. The student now inverts the wheel, as a result, the student and stool rotate about the stool axis. With what angular speed and direction does the student then rotate? (The moment of inertia of the student+stool+wheel system about the stool axis is I_0)



(a) A student holds a bicycle wheel rotating around the vertical.



(b) The student inverts the wheel, setting himself into rotation

A. $\frac{2\vec{L}_i}{I_0}$ counter clockwise

B. $\frac{2\vec{L}_i}{I_0}$, clockwise

C. $\frac{\vec{L}_i}{I_0}$ counter clockwise

D. $\frac{\vec{L}_i}{I_0}$, clockwise

Answer:

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2. Two identical trains are moving on rails along the equator on earth in opposite directions with the same speed. The pressure exerted on rails will be:

A. same for both

B. zero for both

C. more for train moving along the earth's motion

D. more for train moving opposite the earth's motion

Answer:

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3. A light cylindrical vessel is kept on a horizontal surface it's base area is A. A hole of cross-sectional area a is made just at it's bottom side. The minimum coefficient of friction necessary for not sliding of vessel due to the impact force of the emerging liquid.

A. varying

B. $\frac{a}{A}$

C. $\frac{2a}{A}$

D. None of these

Answer:

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4. A solid sphere of radius R_1 and volume charge density $\rho = \frac{\rho_0}{r}$ is enclosed by a hollow sphere of radius R_2 with negative surface charge density σ, such that the total charge in the system is zero . ρ_0 is positive constant and r is the distance from the centre of the sphere . The ratio R_2 / R_1 is

A. $\frac{\sigma}{\rho_0}$

B. $\sqrt{\frac{2\sigma}{\rho_0}}$

C. $\sqrt{\frac{\rho_0}{2\sigma}}$

D. $\frac{\rho_0}{\sigma}$

Answer:

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5. A man of height 'h' is walking away from a street lamp with a constant speed 'v'. The

height of the street lamp is 3h. The rate at which the length of the man's shadow is increasing when he is at a distance 10 h from the base of the street lamp is

A. 2v

B. v

C. v/2

D. v/3

Answer:

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6. An a.c. source of angular frequency ω is fed across a resistor R and a capacitor C in series. The current registered is I. If now the frequency of the source is changed to $\omega/3$ (but maintaining the same voltage), the current in the circuit is found to be halved. calculate the ratio of reactance to resistance at the original frequency ω.

A. $\sqrt{\frac{3}{5}}$

B. $\sqrt{\frac{2}{5}}$

C. $\sqrt{\frac{1}{5}}$

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

Answer:

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7. A thin spherical shell of radius R lying on a rough horizontal surface is hit sharply and horizontally by a cue. Where should it be hit so that the shell does not slip on the surface?

A. $\frac{2R}{3}$

B. $\frac{3R}{2}$

C. $\frac{5R}{3}$

D. $\frac{3R}{5}$

Answer:

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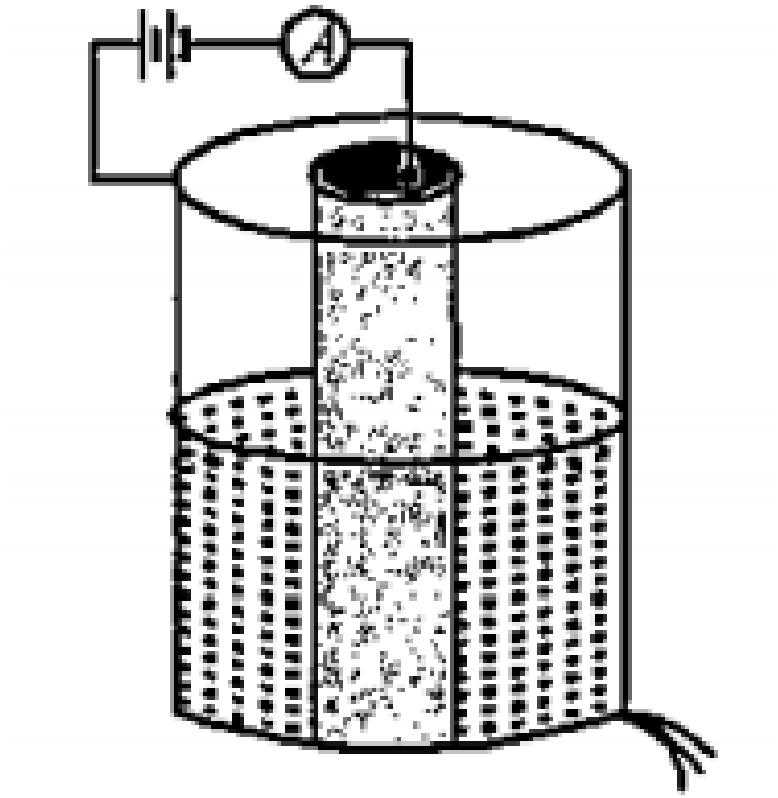
8. Two long cylindrical metal tubes stand on insulating floor. A dielectric oil is filled between plates. Two tubes are maintained

with potential difference v. A small hole is opened at bottom then



A. Reading of ammeter decreases

B. Capacitance of system increases

C. Current in circuit is dependent on area of hole

D. Current in circuit is inversely propotional to dielectruc constant

Answer:

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9. A single slit of width a is illuminated by violet light of wavelength 400 nm and the width of the diffraction pattern is measured as

y. When half of the slit width is covered and illuminated by yellow light of wavelength 600 nm, the width of the diffraction pattern is

A. the pattern vanished and the width is zero

B. y/3

C. 3y

D. 5y

Answer:

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10. A jumper of mass m and length l is placed on two prabolic rails in x-y plane. Shape of the rails can be described by Rail 1:y=x^2 (and z=0) Rail 2:y=x^2 (and z=l) If x is horizontal and y is vertical direction and magnetic field in the space is $B_0\hat{j}$, the jumper can remain in equilibrium when y coordinate of its ends (i=current in jumper)

A. $\frac{iB_0l}{2mg}$

B. $\frac{iB_0l}{mg}$

C. $\left(\frac{iB_0l}{mg}\right)^2$

D. $\left(\frac{iB_0l}{2mg}\right)^2$

Answer:

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11. A torsional pendulum consists of a solid disc connected to a thin wire $\left(\alpha = 2.4 \times 10^{-5}/^\circ C\right)$ at its centre. Find the percentage change in the time period

between peak winter $(5^{\circ}C)$ and peak summer $(45\,\%\ \circ C)$.

A. $9.6 \times 10^{-4}\,\%$

B. $9.6 \times 10^{-2}\,\%$

C. $6.9 \times 10^{-4}\,\%$

D. $6.9 \times 10^{-2}\,\%$

Answer:

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12. A bar magnet suspended at a place P where dip angle is 60° gives 10 oscillations per minute. The same bar magnet suspended at another place Q where dip angle is 30° gives 20 oscillations per minute. The ratio of magnetic fields at P and Q, $\frac{B_P}{B_O}$ is

A. $\frac{\sqrt{3}}{4}$

B. $\frac{\sqrt{3}}{2}$

C. $\frac{2}{\sqrt{3}}$

D. $\frac{4}{\sqrt{3}}$

Answer:

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13. A chain of length l is placed on a smooth spherical surface of radius R with one of its ends fixed at the top of the sphere. What will be the acceleration of the each element of the chain when its upper end is released? It is assumed that the length of the chain $l < \left(\frac{\pi R}{2}\right)$.

A. $\frac{gR}{l}$

B. $\frac{gR}{l}\left[1-\cos\left(\frac{l}{R}\right)\right]$

C. $\frac{gl}{R}\left[1-\cos\left(\frac{R}{l}\right)\right]$

D. $\frac{2l}{R}$

Answer:

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14. A star initially has 10^{40} deuterons. It produces energy via the processes

$_{}1H^2 +_1 H^2 \rightarrow_1 H^3 + p$

$_1H^2 +_1 H^3 \rightarrow_2 He^4 + n$ The masses of the nuclei are as follows: $M\left(H^2\right) = 2.014$ amu' $M(p) = 1.007$ amu, $M(n) = 1.008$ amu, $M\left(He^4\right) = 4.001$ amu if the average power radiated by the star is $10^{16}W$, the deuteron supply of the star is exhausted in a time of the order of

A. 10^6 sec

B. 10^8 sec

C. 10^{12} sec

D. 10^{16} sec

Answer:

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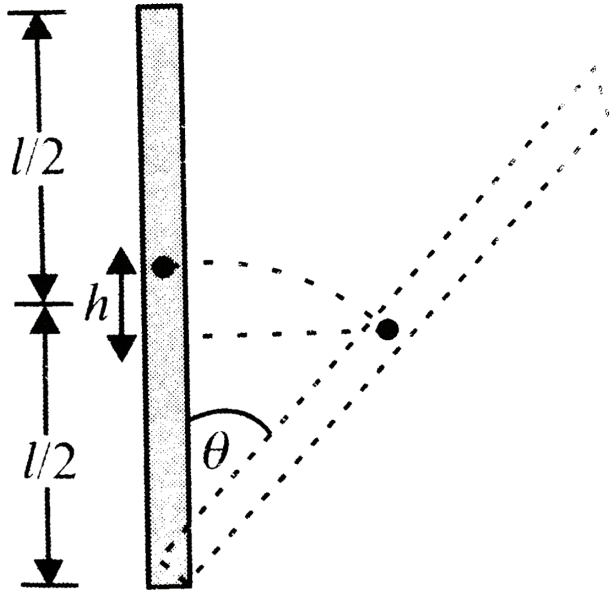
15. A rod of length l is pivoted about a horizontal , frictionless pin through one end. The rod is released from ret in a vertical position. Find the velocity of the CM of the rod when the rod is inclined at an angle θ

from the vertical.



A. $\sqrt{\dfrac{gl(1-\cos\theta)}{4}}$

B. $\sqrt{\dfrac{gl(1-\sin\theta)}{4}}$

C. $\sqrt{\dfrac{3gl(1-\sin\theta)}{4}}$

D. $\sqrt{\dfrac{3gl(1-\cos\theta)}{4}}$

Answer:

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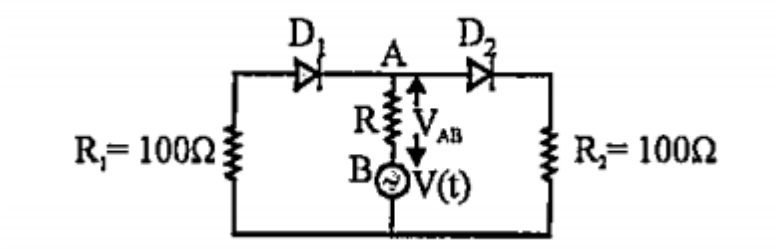
16. In the circuit given below, V(t) is the sinusoidal voltage source, voltage drop $V_{AB}(t)$ across the resistance R is



A. is half wave rectified

B. is full wave rectified

C. has the same peak value in the positive and negative half cycles

D. has different peak values during positive and negative half cycle

Answer:

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17. A thermocole cubical icebox of side 30 cm has a thickness of 5.0 cm if 4.0 kg of ice are put ini the box, estimate the amount of ice remaining after 6 h. The outside temperature is $45^{\circ}C$ and coefficient of thermal conductivity of thermocole $= 0.01J/kg$.

A. 4.234 kg

B. 1.734 kg

C. 3.687 kg

D. 0.456 kg

Answer:

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18. An artificial satelite of the moon revolves in a circular orbit whose radius exceeds the radius of the moon η times. The process of motion the satelite experiences a slight resistance due to cosmic dust. Assuming the resistance force to depend on the velocity of the satellite as $F = \alpha v^2$, where α is a

constant, find how long the satellite will stay in orbit until it falls onto the moon's surface.

A. $\frac{1}{\alpha}\frac{\left[\sqrt{\eta R}-\sqrt{R}\right]}{\sqrt{GM}}$

B. $\frac{1}{\alpha}\frac{\left[\sqrt{\eta R}-\sqrt{R}\right]}{M}$

C. $\frac{m}{\alpha}\frac{\left[\sqrt{\eta R}-\sqrt{R}\right]}{\sqrt{GM}}$

D. $\frac{m}{\alpha}\frac{\left[\sqrt{\eta R}-\sqrt{R}\right]}{\sqrt{GM}}$

Answer:

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19. A body falling freely from a given height H hits an inlclined plane in its path at a height h. As a result of this impact the direction of the velocity of the body becomes horizontal. For what value of h/H, the body will take the maximum time to reach the ground.

A. $\frac{1}{2}$

B. 2

C. $\frac{1}{4}$

D. 4

Answer:

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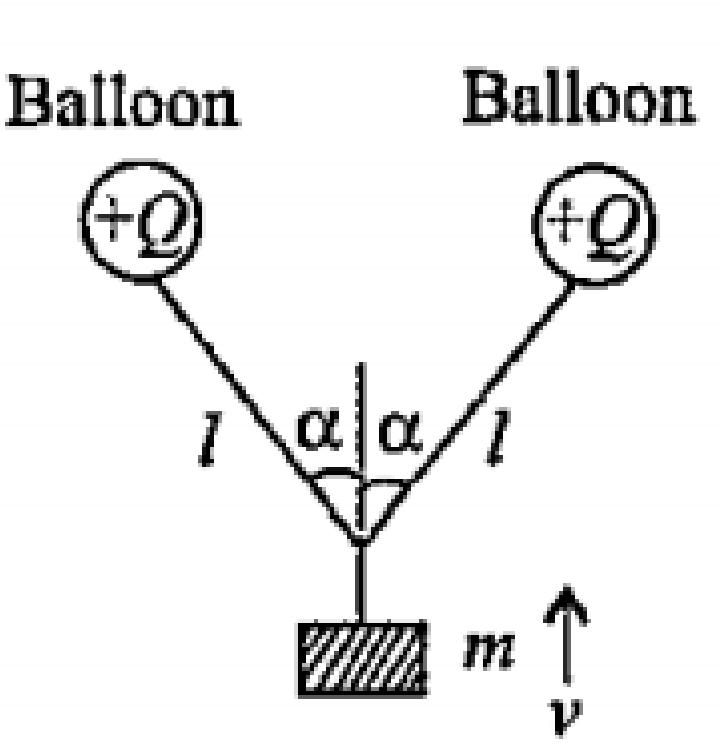
20. In the arrangement shown, a block (of mass m) is being moved up against gravity, by two identical balloons, with constant speed v. the balloons carry +Q charge each and the connecting strings are massless. T and B respectively represent tension in each of the connecting strings and buoyant force on each of the balloons. Choose the incorrect

alternative.



A. $b = \dfrac{mg}{2}$

B. $2T\cos\alpha = mg$

C. $T = \dfrac{Q^2}{16\pi\varepsilon_0 l^2 \sin\alpha} + \dfrac{mg}{2}\cos\alpha$

D. $2T \sin \alpha = \dfrac{Q^2}{16\pi\varepsilon_0 l^2 \sin^2 \alpha}$

Answer:

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21. For an ideal gas the molar heat capacity varies as $C = C_V + 3aT^2$. Find the equation of the process in the variables (T,V) where a is a constant.

A. $Ve^{\frac{3a}{2R}T^2}$ = Constant

B. $Ve^{\frac{-3a}{2R}T^2}$ = Constant

C. TV^2 = Constant

D. VT^2 =Constant

Answer:

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22. A $4\mu F$ capacitor, a resistance of $2.5M\Omega$ is in series with $12V$ battery. Find the time after which the potential difference across the

capacitor is 3 times the potential difference across the resistor :

A. 13.86 s

B. 6.93 s

C. 7 s

D. 14 s

Answer:

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23. Water is boiled in a rectangular steel tank of thickness 2 cm by a constant temperature furnace. Due to vaporisation, water level falls at a steady rate of 1 cm in 9 minutes. Calculate the temperature of the furnace. Given K for steel $0.2cals^{-1}m^{-1}.^{\circ}C^{-1}$

A. $150^{\circ}C$

B. $110^{\circ}C$

C. $130^{\circ}C$

D. $200^{\circ}C$

Answer:

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24. A uniform rod of density ρ is placed in a wide tank containing a liquid of density $\rho_0(\rho_0 > \rho)$. The depth of liquid in the tank is half the length of the rod. The rod is in equilibrium, with its lower end resting on the bottom of the tank. In this position the rod makes an angle θ with the horizontal.

A. $\frac{1}{2}\sqrt{\frac{\sigma}{\rho}}$

B. $\frac{1}{2}\frac{\sigma}{\rho}$

C. $\sqrt{\frac{\rho}{\sigma}}$

D. $\sqrt{\frac{\sigma}{\rho}}$

Answer:

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25. A plano convex lens of refractive index 1.5 and radius of curvature 30cm. Is silvered at the curved surface. Now this lens has been used to

form the image of an object. At what distance from this lens an object be placed in order to have a real image of size of the object.

A. 20cm

B. 30 cm

C. 60cm

D. 80cm

Answer:

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26. A micture of light, consisting of wavelength 590nm and an unknown wavelength, illuminates Young's double slit and gives rise to two overlapping interference patterns on the scree. The central maximum of both lights coincide. Further, it is obseved that the third bright fringe of known light coincides with the 4th bright fringe of the unknown light. From this data, the wavelength of the unknown light is:

A. 393.4nm

B. 885.0nm

C. 442.5nm

D. 776.8nm

Answer:

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27. A diatomic ideal gas is used in a Carnot engine as theworking substance. If during the adiabatic expansion part of the cycle the

volume of the gas increases from V to 32 V, the efficiency of the engine is

A. 0.5

B. 0.75

C. 0.99

D. 0.25

Answer:

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28. A very long (length L) cylindrical galaxy is made of uniformly distributed mass and has radius R $(R << L)$ A star outside the galaxy is orbiting the galaxy in a plane perpendicular to the galaxy and passing through its centre. If the time period of star is T and its distance from the galaxy's axis is r, then-

A. $T \propto r$

B. $T \propto \sqrt{r}$

C. $T \propto r^2$

D. $T^2 \propto r^3$

Answer:

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29. A point source of constant power P is emitting photon of wavelength λ. What is the intensity of photons at r distance from the source ?(speed of light = c)

A. $\frac{P\lambda}{2\pi r^2 hc}$

B. $\frac{P\lambda}{4\pi r^2 hc}$

C. $\frac{P\lambda}{hc}$

D. $\frac{P\lambda}{r^2 hc}$

Answer:

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30. A car,starting from rest, accelerates at the rate f through a distance s, then continuous at constant speed for time t and then

decelerates at the rate $\frac{f}{2}$ come to rest. If the total distance traversed is 5 s,then :

A. $s = \frac{1}{4}ft^2$

B. $s = \frac{1}{2}ft^2$

C. $s = \frac{1}{6}ft^2$

D. $s = ft$

Answer:

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31. A barometer kept in an elevator accelerating upward reads 76 cm. The air pressure in the elevator is

A. equal to 76 cm of Hg

B. less than 76 cm of Hg

C. greater than 76 cm of Hg

D. zero

Answer:

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32. The binding energy of deuteron $._1^2 H$ is $1.112 MeV$ per nucleon and an $\alpha -$ particle $._2^4 He$ has a binding energy of $7.047 MeV$ per nucleon. Then in the fusion reaction $._1^2 H + ._1^2 h \rightarrow ._2^4 He + Q$, the energy Q released is.

A. 1 MeV

B. 11.9MeV

C. 23.8MeV

D. 931MeV

Answer:

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33. The magnetic field in a region is given by $B = B_0\left(1 + \frac{x}{a}\right)\hat{k}$.A square loop of edge-length d is placed with its edges along the x and y-axes. The loop is moved with a constant velocity $v = v_0\hat{i}$.The emf induced in the loop is:

A. zero

B. $v_0 B_0 d$

C. $\frac{v_0 B_0 d^3}{a^2}$

D. $\frac{v_0 B_0 d^2}{a}$

Answer:

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34. An ideal Black-body at room temperature is thrown into a furnace. It is observed that

A. Initially it is the darkest body and at later timesthe brightest

B. It is the darkest body at all times

C. It cannot be distinguished at all times

D. Initially it is the darkest body and at later times it cannot be distinguished

Answer:

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35. A particle of charge q and mass m starts moving from the origin under the action of an electric field $\overrightarrow{E} = E_0\hat{i}$ and $\overrightarrow{B} = B_0\hat{i}$ with velocity $\overrightarrow{v} = v_0\hat{j}$. The speed of the particle will become $2v_0$ after a time

A. $t = \dfrac{2mv_0}{qE}$

B. $t = \dfrac{2Bq}{mv_0}$

C. $t = \dfrac{\sqrt{3}Bq}{mv_0}$

D. $t = \dfrac{\sqrt{3}mv_0}{qE}$

Answer:

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36. A train has just completed a U-curve in a trach which is a semi circle. The engine is at the forward end of the semi circular part of the trach while the last carriage is at the rear end of the semi circular track. The driver blows a whistle of frequency 200 Hz. Velocity of sound is $340\frac{m}{s}$. Then the apparent frequency as observed by a passenger in the middle of the train, when the speed of the train is 30 m/s, is

A. 209Hz

B. 288Hz

C. 200Hz

D. 181Hz

Answer:

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37. Four person K,L,M and N are initally at the corners of a square of side of length d. If every person starts moving, such that K always

heads towards L, L heads towards M, M heads directly towards N and N heads towards K, then the four perons will meet after

A. $\frac{d}{v}\sec$

B. $\frac{\sqrt{2}d}{v}\sec$

C. $\frac{d}{\sqrt{2}v}\sec$

D. $\frac{d}{2v}\sec$

Answer:

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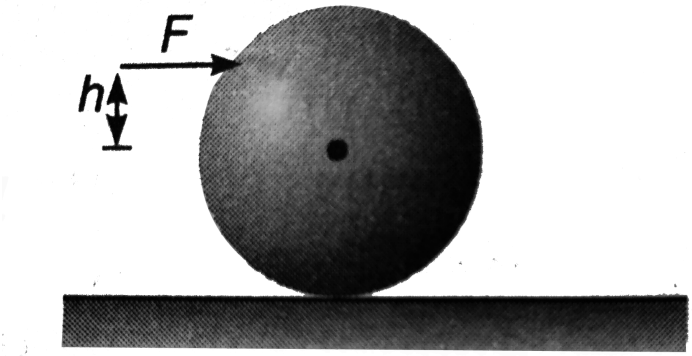

38.

A billiard ball, initially at rest, is given a sharp impulse by a cue. The cue is held horizontally a distance h above the centre line as shown in figure. The ball leaves the cue with a speed v_0 and because of its backward slipping eventually acquires a final

speed $\frac{9}{7}v_0$ show that $h = \frac{4}{5}R$

Where R is the radius of the ball.

A. R/5

B. 5R/4

C. 4R/5

D. R/4

Answer:

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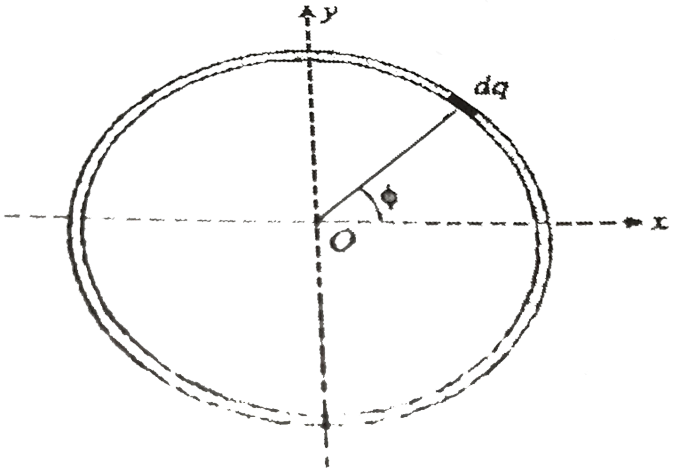
39. A thin non-conducting ring or radius a has a linear charge density $\lambda = \lambda_0 \sin\phi$. A uniform electric field $E_0\hat{i} + E_0\hat{j}$ exist in the region . .Net torque acting on ring is given as :



A. $E_0\sqrt{2}\pi a^2\lambda_0$

B. $E_0\pi a^2\lambda_0$

C. $2E_0\pi a^2\lambda_0$

D. zero

Answer:

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40. A particle of mass m undergoes oscillations about x = 0 in a potential given by $V(x) = \frac{1}{2}kx^2 - v_0\cos\left(\frac{x}{a}\right)$, where V_0,K,a are constants. If the amplitude of oscillation is

much smaller than a, the time period is given by-

A. $2\pi\sqrt{\frac{ma^2}{ka^2+V_0}}$

B. $2\pi\sqrt{\frac{m}{k}}$

C. $2\pi\sqrt{\frac{ma^2}{V_0}}$

D. $2\pi\sqrt{\frac{ma^2}{ka^2-V_0}}$

Answer:

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41. A carpet of mass M is rolled along its length so as to from a cylinder of radius R and is kept on a rough floor. When a negligibly small push is given to the cylindrical carpet, it stars unrolling itself without sliding on the floor. Calculate horizontal velocity of cylindrical part of the carpet when its radius reduces to $R/2$.

A. $\sqrt{\frac{14}{3}gR}$

B. $\sqrt{\frac{3}{14}gR}$

C. $\sqrt{\frac{4}{3}gR}$

D. $\sqrt{\frac{3}{4}gR}$

Answer:

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42. The angle substanded by the first diffraction minimum for a point source viewed in the hydrogen line at 1420 MHz with a radio telescope having an aperture of 25 m is:

A. 0.8°

B. 0.64°

C. 1.2°

D. 2.2°

Answer:

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43. A simple pendulum is hanging from a peginserted in a vertical wall. Its bob is strteched to horizontal position form wall and left freee to move, the bob hits the wall. If

coefficient of restitution is $\frac{2}{\sqrt{5}}$. After how many collisions the amplitude of vibration will becomes less then 60°.

A. 6

B. 3

C. 4

D. 5

Answer:

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