QCM 3 (physics)

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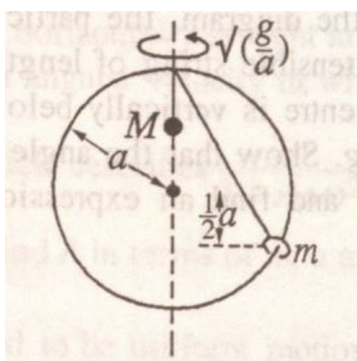
1. Two uniform infinite sheets of electric charge densities +σ and –σ intersect at right angles. The magnitude of the electric field everywhere in space is:

   A. $E = \dfrac{2\sigma}{\varepsilon_o}$ B. $E = \dfrac{\sigma}{2\varepsilon_o}$

   C. $E = \dfrac{\sqrt{2}\sigma}{\varepsilon_o}$ D. $E = \dfrac{\sqrt{2}\sigma}{2\varepsilon_o}$

2. Gauss' law would be invalid if :
   A. There were magnetic monopole
   B. The inverse-square law were not exactly true
   C. The velocity of light were not a universal constant.

3. A circular hoop of radius *a* is formed from a smooth thin wire on which is threaded a small bead of mass *m*. One end of a light inelastic string is attached to the bead. The string passes through a small smooth ring fixed to the hoop at its highest point and carries a particle of mass *M* attached to the other end, as shown in the figure below. The hoop is made to rotate with angular speed $\sqrt{g/a}$ about the vertical diameter. The bead remains at rest relative to the hoop at a depth *a*/2 below the center of the hoop. The ratio between the *M* and *m* is :



   A. $\dfrac{M}{m} = \dfrac{1}{2}$ B. $\dfrac{M}{m} = \dfrac{\sqrt{2}}{2}$

   C. $\dfrac{M}{m} = \dfrac{\sqrt{3}}{2}$ D. $\dfrac{M}{m} = \dfrac{\sqrt{5}}{2}$

4. A metal sphere of radius a is surrounded by concentric metal sphere of inner radius b, where $b > a$. The space between the spheres is filled with a material whose electrical conductivity σ varies with the electric field strength E according to the relation $\sigma = KE$, where K is a constant. A potential difference V is maintained between the two spheres. The current between the spheres is given by :

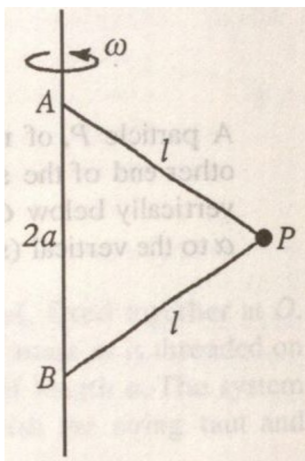
A. $I = \dfrac{4\pi K V^2}{\ln(b/a)}$

B. $I = \dfrac{4 K V^2}{\ln(b/a)}$

C. $I = \dfrac{2\pi K V^2}{\ln(b/a)}$

D. $I = \dfrac{2 K V^2}{\ln(b/a)}$

5. The figure below shows a particle P, of mass m which is attached by means of two light inextensible strings PA and PB to the fixed points A and B. The point B is at a distance $2a$ vertically below A, and the strings are each of length l, where $l > a$. The system rotates about AB with constant angular speed ω, and with both strings taut. The tension in string PB is given by:



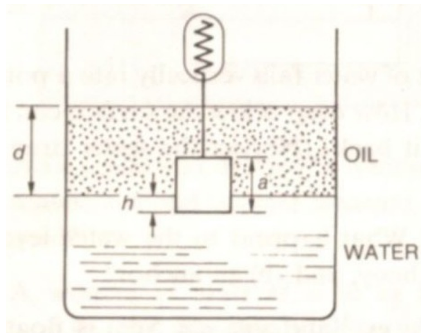
A. $T = \dfrac{ml}{a}(a\omega^2 - g)$

B. $T = \dfrac{ml}{2a}(a\omega^2 - g)$

C. $T = \dfrac{ml}{3a}(a\omega^2 - g)$

D. $T = \dfrac{ml}{4a}(a\omega^2 - g)$

6. A solid cube of side $a = 0.1m$ hangs from a dynamometer (a spring measuring force), and is submerged inside a container of liquid. The container holds water, with above it a layer $d = 0.2m$ of oil of density $\rho_o = 500 kg\ m^{-3}$. In equilibrium the base of the cube is a distance $h = 0.02m$ below the water level (see figure below), so that its upper face is below the surface of the oil. The dynamometer reading is $W_D = 0.49N$. The mass M of the cube is:



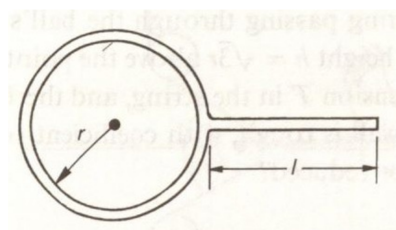
A. M=0.5 kg

B. M=0.7 kg

C. M=0.45 kg

D. M=0.65 kg

7. A tennis racket can be approximated by a circular hoop of radius *r* and mass m_1 attached to a uniform shaft of length *l* and mass m_2. Assuming that r=l/2 and $m_1=m_2=m$, then the position of racket's center of mass as measured from the center of the circular hoop, is given by :



A. $x_{cm} = \frac{l}{2}$

B. $x_{cm} = \frac{l}{3}$

C. $x_{cm} = \frac{2l}{3}$

D. $x_{cm} = \frac{l}{4}$

8. A solid object has a density ρ, mass *M,* and coefficient of linear expansion α. At pressure *p*, the heat capacities C_p and C_v are related by:

A. $C_p - C_v = \frac{2\alpha Mp}{\rho}$

B. $C_p - C_v = \frac{3\alpha Mp}{\rho}$

C. $C_p - C_v = \frac{4\alpha Mp}{\rho}$

D. $C_p - C_v = \frac{5\alpha Mp}{\rho}$

9. The initial state of a quantity of monoatomic ideal gas is P = *1 atm* and V = l liter and T = 373 K. The gas is so isothermally expanded to a volume of 2 liters and then is cooled at constant pressure to the volume V. This volume is such that a reversible adiabatic compression to a pressure of *1 atm* returns the system to its initial state. All of the changes of state are conducted reversibly. Given that *1 atm = 101300 Pa*, the volume V is given by:

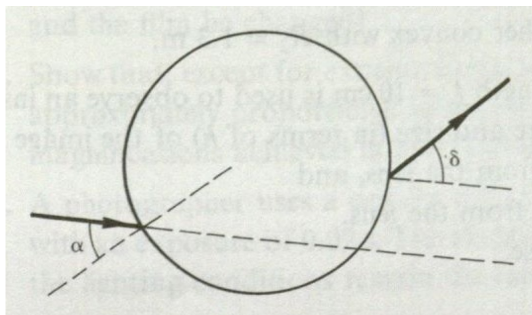
A. V = 2.15 liters

B. V = 1.52 liters

C. V = 3.21 liters

D. V = 3.65 liters

10. A beam of white light is incident at angle $\alpha = 30^o$ on a spherical water droplet with refractive index $n = n(\lambda)$ given as a function of wavelength λ. As the ray emerges from the far side of the droplet it has been deflected through an angle δ from its original path. The value of δ is given by:



A. $\delta(\lambda) = 60^o - 2\arcsin\left[\frac{1}{2n(\lambda)}\right]$

B. $\delta(\lambda) = 60^o - 2\arcsin\left[\frac{1}{n(\lambda)}\right]$

C. $\delta(\lambda) = 60^o - 2\arcsin\left[\frac{2}{n(\lambda)}\right]$

D. $\delta(\lambda) = 60^o - \arcsin\left[\frac{1}{2n(\lambda)}\right]$