Problem (60 points)

1. (15 points) A plywood disk of radius ***20.0 cm*** and mass ***2.20 kg*** has a small hole drilled through it, ***2.00 cm*** from its edge **(Fig. 1).** The disk is hung from the wall by means of a metal pin through the hole, and is used as a pendulum. What is the period of this pendulum for small oscillations?

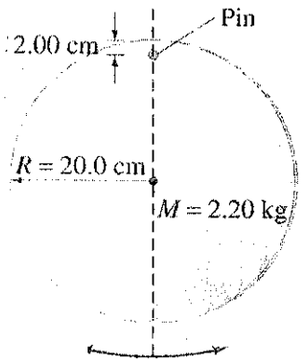


Fig. 1

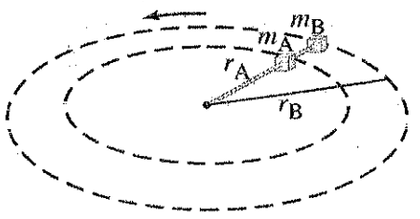


Fig. 2

2. (15 points) Two blocks, with masses m_A and m_B are connected to each other and to a central post by cords as shown in ***Fig.2***. They rotate about the post at frequency f (revolutions per second) on a frictionless horizontal surface at distances r_A and r_B from the post. Derive an algebraic expression for the tension in each segment of the cord (assumed massless).

3. (15 points) Three very large sheets are separated by equal distances of ***15.0 cm*** **(Fig.3)**. The first and third sheets are very thin and nonconducting and have charge per unit areas of ***+5.0 μC/m²*** and ***-5.0 μC/m²***, respectively. The middle sheet is conducting but has no net charge. (*a*) What is the electric field inside the middle sheet? What is the electric field (*b*) between the left and middle sheets, and (*c*) between the middle and right sheets? (*d*) What is the charge density on the surface of the middle sheet facing the left sheet, and (*e*) on the surface facing the right sheet? (ε_0***=8.85x10-12 C2/Nm²***)

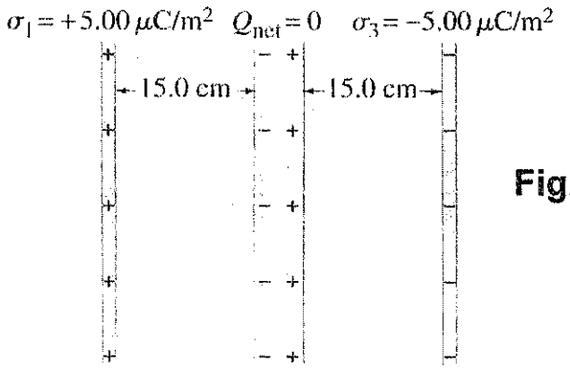


Fig. 3

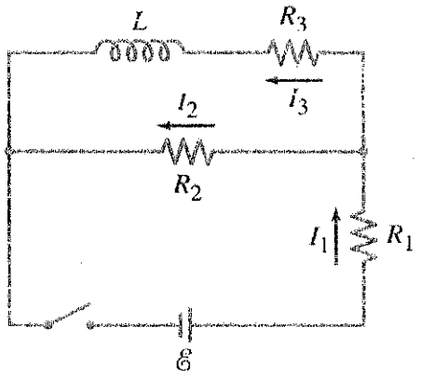


Fig. 4

4. (15 points) In the circuit of **Fig. 4**, determine the current in each resistor at the moment (*a*) the switch is closed, (*b*) a long time after the switch is closed. After the switch has been closed for a long time, and then reopened, what is each current (*c*) just after it is opened, (*d*) after a long time?

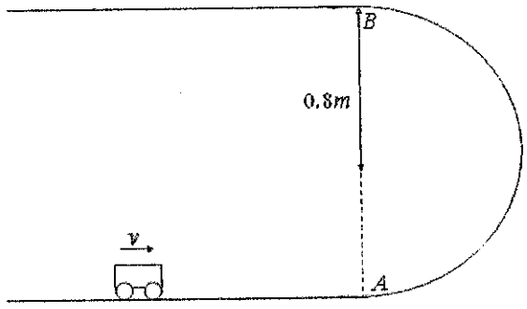
Multiple Choice (40 points)

1 You have a machine which can accelerate disks on frictionless ice. Starting from rest, the disk travels a distance ***x*** in time ***t*** when force ***F*** is applied. If force ***3F*** is applied, the distance the puck travels in time *t* is

a. *x*.
b. (3/2)x.
c. 3*x*.
d. (9/2)x.
e. 9*x*.

2. A ***1.2-kg*** mass is projected up a rough circular track (radius = ***0.80 m***) as shown. The speed of the mass at point A is ***8.4 m/s***, and at point B, it is ***5.6 m/s***. How much work is done on the mass between A and B by the force of friction?

a. –2.7 J
b. –8.8 J
c. –4.7 J
d. –6.7 J
e. –19 J

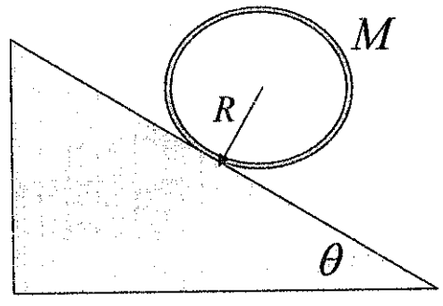


3. A ***3.00 kg*** stone is dropped from a ***39.2 m*** high building. When the stone has fallen ***19.6 m***, the magnitude of the impulse the Earth has received from the gravitational force exerted by the stone is

a. 9.8 Ns.
b. 19.6 Ns.
c. 29.4Ns.
d. 58.8Ns.
e. 117.6Ns.

4. A cylindrical shell rolls without slipping down an incline as shown in the figure. The linear acceleration of its center of mass is

a. (5/7)*g* sin θ
b. (1/2)*g* sin θ
c. (3/5)*g* sin θ
d. (2/3)*g* sin θ
e. (4/5)*g* sin θ

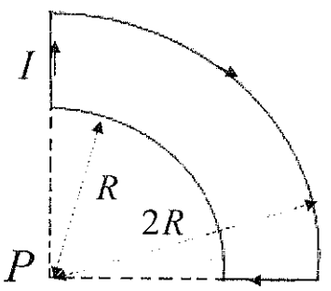


5. The change in entropy of ***1.00 kg*** of water that is heated from ***50℃*** to ***100℃*** is (in ***cal/K***)

a. 516
b. 312
c. 144
d. 946
e. 391

6. What is the magnitude of the magnetic field at point ***P*** if ***a = R*** and ***b = 2R*** ?

a. $\frac{\mu_0 I}{6R}$　**b.** $\frac{3\mu_0 I}{16R}$　**c.** $\frac{\mu_0 I}{12R}$　**d.** $\frac{\mu_0 I}{16R}$　**e.** $\frac{\mu_0 I}{32R}$



7. A coil is wrapped with ***300 turns*** of wire on the perimeter of a square frame (side length = ***20 cm***). Each turn has the same area as the frame, and the total resistance of the coil is ***1.5 W***. A uniform magnetic field perpendicular to the plane of the coil changes in magnitude at a constant rate from ***0.50 T*** to ***0.90 T*** in ***2.0 s***. What is the magnitude of the induced ***emf*** in the coil while the field is changing?

a. 2.4 V
b. 1.6 V
c. 3.2 V
d. 4.0 V
e. 8.4 V

8. A film of index of refraction n_1 coats a surface with index of refraction n_2. When $n_1 > n_2$, the condition for constructive interference for reflected monochromatic light of wavelength λ in air is

a. $t = m\frac{\lambda}{n_1}$　**b.** $t = \left(m+\frac{1}{2}\right)\frac{\lambda}{n_1}$　**c.** $2t = m\frac{\lambda}{n_1}$　**d.** $2t = \left(m+\frac{1}{2}\right)\frac{\lambda}{n_1}$　**e.** $4t = m\frac{\lambda}{n_1}$