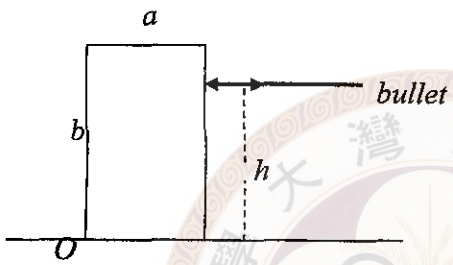
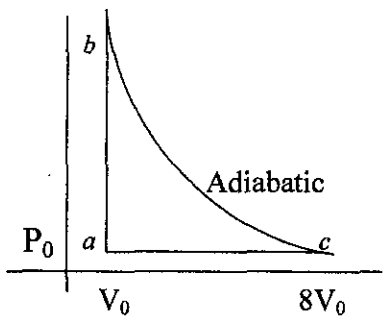
1. A metal block of mass M rests on a rough floor (see graph below). A bullet of mass m and speed v hits the block at height h and bounced back with velocity $v/3$ in the opposite direction.
   (a) With origin O calculate the angular momentum of the bullet before and after hit.
   (b) Calculate the total energy of the block after hit.
   (c) Find the relation between v and h such that the block is toppled.

Hint: The moment of inertia of the block around O is equal to $(a^2+b^2)M/3$.
The rough floor is such that the block rotates around point O without slipping.
(15 points)



2. The lower graph showed a cycle of a mole monatomic ideal gas with three quasi-static processes.
   (a) What is the pressure at b?
   (b) Calculate the work done in the cycle $abca$.
   (c) Calculate the entropy change in the processes ab and ac.
(15 points)



3. A simple pendulum of length b is hung from the roof of a car moving with horizontal acceleration a. The gravity g is in vertical direction. Calculate its period.
(10 points)

4. Give two examples that result from the principle of linear superposition of wave.
(10 points)

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5. A long, straight solid cylinder oriented with its axis in the z-axis direction, carries a current whose current density is **J**. The current density, although symmetrical about the cylinder axis, is not constant and varies according the relation

$$\mathbf{J} = J_0(1 - r^2/R^2)\mathbf{k}$$

Where J_0 is constant, R is the radius of the cylinder, and r is the radial distance from the cylinder axis.

(a) Find the magnetic field at the points outside of the cylinder, where $r > R$.

(b) Find the magnetic field at the points inside of the cylinder, where $r < R$.

(c) Prove the part a and part b yield the same result for the magnetic field at the surface of the cylinder, , where $r = R$.

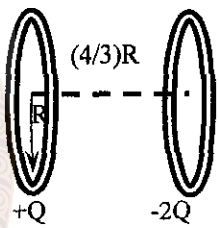
(15 points)

6. Two thin rings with equal radii of R have total electric charges +Q and -2Q distributed uniformly. They are placed parallel to each other along their common axis as shown in the figure. The distance between center of rings is (4/3)R.

(a) Find the potential at the center of the ring at left hand side, (in terms of ε_0, Q and R)

(b) Find the potential at the center of the ring at right hand side, (in terms of ε_0, Q and R)

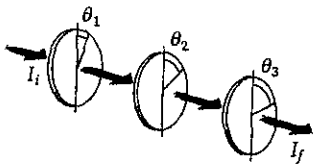
(c) Find the work required to move charge –q from the center of the ring at right to the center of the ring at left.



(15 points)

7. (a) Unpolarized light passes through two polaroid sheets. The axis of the first is vertical, and that of the second is at $\pi/6$ to the vertical. What fraction of the incident light is transmitted?

(b) Three polarizing disks, whose planes are parallel, are centered on a common axis. The direction of the transmission axis in each case is relative to the common vertical direction, as shown in right figure. A plane-polarized beam of light with $\mathbf{E}_0$ parallel to the vertical reference direction is incident from the left on the first disk. What fraction of the incident light is transmitted when $\theta_1 = 0$, $\theta_2 = \pi/6$, and $\theta_3 = \pi/3$.



(10 points)

8. (a) Draw the physic model of an neutral atoms consists of five electrons.

(b) Why the electron's energy in an atom is quantized?

(c) Explain the physic significance of the Stern-Gerlach Experiment.

(10 points)

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