1. (10 points) A thin rod of length $L$ varies in its composition in such a manner that its linear mass density is $\lambda(x) = a + bx$, where $x$ is the distance from one end. Locate the center of mass relative to $x = 0$.

2. (15 points) A particle of mass $M$ moves in the $xy$ plane. Its coordinates as a function of time are given by $x(t) = At^3; y(t) = Bt^4 + Ct^2$, where $A$, $B$, and $C$ are constants. (a) Find its angular momentum about the origin. (b) What force acts on it?

3. (10 points) A uniform disk of mass $M$ and radius $R$ oscillates about a horizontal axis at a distance of $d$ from the center. What is the period of oscillation? The moment of inertia of the disk about a central axis is $MR^2/2$.

4. (15 points) When a gas undergoes a process depicted as the straight line from $a$ to $c$ in Fig. 1 the heat flow into the system is 200 J. (a) Find the work done from $a$ to $c$. (b) If $U_a = 200 J$, find $U_c$. (c) What is the work done by the gas when it return to $a$ via $b$? (d) What is the heat transfer in the process $cba$?

5. (10 points) A thin insulating rod of length $L$ carries a uniformly distributed charge $Q$. Find the field strength at a point along its axis at a distance $a$ from one end.

6. (10 points) Consider the circuit shown in Fig. 2. Find: (a) the initial current through each resistor when the switch is closed; (b) the final steady-state current through each resistor.

7. (15 points) A ring of radius $R$ lies perpendicular to a uniform magnetic field that varies according to $B = B_0 \exp(-t)$. What is the induced electric field in the ring.

8. (15 points) The total energy of a particle is four times its rest energy. Find (a) its kinetic energy; (b) its speed.