Question 1:
The areal mass density of a disk of radius $R$ is nonuniform, such that \( \sigma = ar \), where $a$ is some constant. (a) Find the total mass of the disk as a function of $a$ and $R$. Find the moment of inertia with respect to an axis which is perpendicular to the disk, (b) that passes through the center of mass, (c) that passes through the point $A$.

Question 2:
A long uniform rod of length $L$ and mass $M$ is pivoted about a horizontal, frictionless pin through one end. Another small mass of $M$ is attached to the other end of the rod. The rod is released from rest in a vertical position, as shown in the figure. (a) Find the moment of inertia, $I$, of the system with respect to the pivot. At the instant the rod is horizontal (b) find the center of mass of the system, (c) the magnitude of its angular acceleration $\alpha$, (d) the $x$ and $y$ components of the acceleration of its center of mass $\vec{a}_{CM}$, and (e) the components of the reaction force at the pivot, $\vec{F}_{pivot}$. \[ I_{rod,cm} = \frac{1}{12}ML^2 \]

Question 3:
The collision between the masses is perfectly inelastic (they stick each other.) The massless spring of force constant $k$ is initially unstretched. There is no friction.

a) Find the speeds $v_1$ and $v_2$ just after the collision.

b) Find the impulse on $B$ at the instant of the collision.

c) Find the maximum compression of the spring.

Question 4:
A girl of mass $m$ is standing on a plank that has a mass of $3m$. The plank, originally at rest, is free to slide on a frozen lake, which is a flat, frictionless supporting surface. The girl begins to walk along the plank at a constant speed of $v$ relative to the plank. (a) What is the speed of the plank relative to the ice surface? (b) What is her speed relative to the ice surface?