Midterm 2

You must show your work to get full credit.

1. A massless string connects a block of mass $m$ to a spring with spring constant $k$ over a pulley, as shown below. The pulley is a solid cylinder with radius $R$ and mass $M$ (and moment of inertia $\frac{1}{2}MR^2$). The block is released from rest with the spring unstretched. Find the speed of the block after it has fallen a vertical distance $y$.

![Diagram of mass and spring](image)

2. A block of mass $m$ is placed on a section of track with mass $M$. The track has the shape of a quarter circle with radius $R$. The track is free to slide on a horizontal frictionless surface. The system is released from rest. When the block slides to the bottom, the track slides to the left, as shown. Find the speed of the block and the track when the block is at the bottom of the track.

![Diagram of block and track](image)
3. Two balls of mass $m$ and $3m$ are attached by a massless rod of length $2\ell$, and the system is suspended by a string attached halfway between the two balls. Treat the balls as points without size. The system is released from rest with the rod horizontal, as shown.

(a) Find the angular acceleration of the system about the point where the string is attached just after it is released.

(b) Find the tension in the string just after the system is released. *Hint:* the center of mass of the system is accelerating.