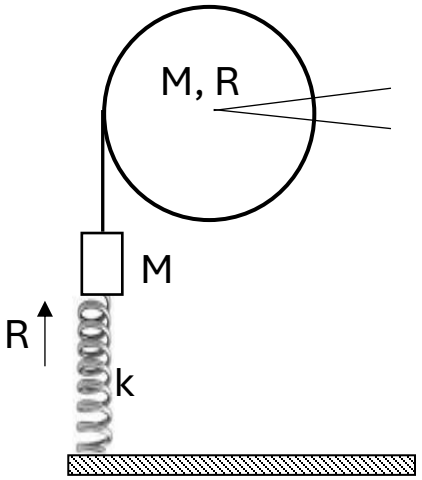
**Physics 1135 Test Preparation Homework #3**

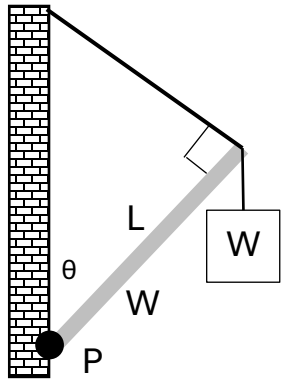
1. A string is wound tightly around a freely rotating disk of mass $M$ and radius $R$, with moment of inertia $\frac{1}{2} MR^2$. The free end of the string is then attached to a block of mass $M$, which itself is attached to a vertical spring of spring constant $k$. The disk is rotated clockwise by some external agent until the spring is stretched from its equilibrium length by a distance $R$ equal to the radius of the disk. It is held in this position until it is released.




a) Derive an expression for the linear acceleration magnitude of the block at the moment that the system is released, in terms of system parameters.

b) Find the block's speed when the spring is again at its natural length.

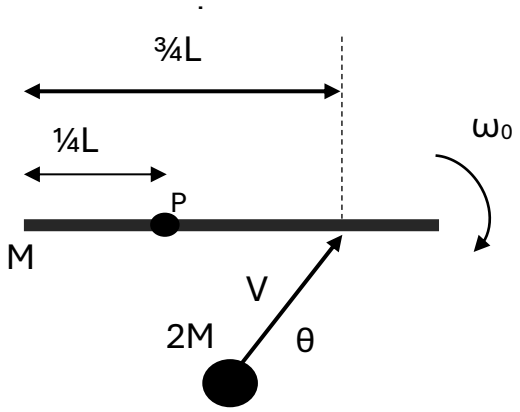
2. A beam of length $L$ and weight $W$ is attached to a wall at its base by a pivot P. A thin cable is attached to the beam and the wall in such a way that the cable and beam are perpendicular. The beam makes an angle of θ with respect to the vertical. A sign of weight $W$ is hung from the end of the beam.




a) Determine the tension the cable in terms of $W$ by taking the torques about the pivot P.

b) Determine the horizontal and vertical components of the force that the pivot exerts on the beam in terms of $W$.

3. An entrance gate into a petting zoo has mass $M$ and width $L$. It is pivoted at point **P** that is $\frac{1}{4}L$ from one end and is swinging counter-clockwise. A child of mass $2M$ enters the zoo by leaping onto the gate with speed $V$ and angle θ at a point that is $\frac{3}{4}L$ from its end. **Just before** the child hits and clings to it, the gate's angular speed is $\omega_o$ as shown in the diagram. The moment of inertia of the gate about its center of mass is $\frac{1}{12} ML^2$ and about an end it is $\frac{1}{3}ML^2$.




a) What is the moment of inertia of the gate about pivot **P**?

b) Derive an expression of the angular speed of the gate-child system just after the child has leaped onto it.