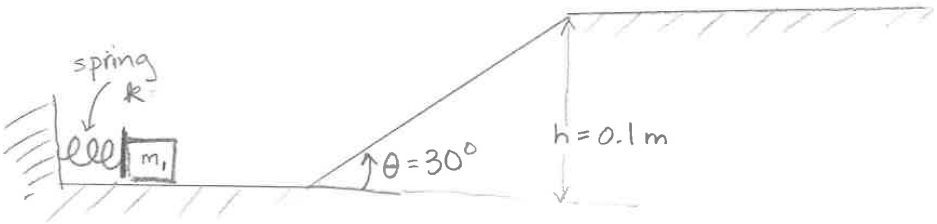
Physics 215 Fall 2019
Problem set for week 11:

OpenStax
Chapter 9: #111
Chapter 10: 47, 56, 68, 75, 81, 90

and the following problem:
Pin-"cube" machine

A crazy pinball machine contains "pin-cubes" instead of pinballs. At the start of the game, one of the cubes, with mass m_1=10 g sits on the track shown below. Both horizontal surfaces are frictionless, but the cube's coefficient of friction with the incline is μ_k=0.3. The incline has a height of h= 0.1 m, and the angle of the incline with respect to the horizontal is 30 degrees. The spring constant for the spring is k = 50 N/m.



a) A player compresses the spring by a distance x = 3 cm. Write an expression for the total mechanical energy of the block when the spring is fully compressed.
b) The player releases the spring. What is the velocity of the block just after it leaves the spring (i.e. the spring is at zero compression)?
c) Draw a free body diagram for the block as it travels up the incline, and use this free body diagram to calculate the magnitude of the frictional force exerted on the block by the incline.
d) Write an expression for the work done on the block by friction as a function of the distance it travels up the incline.
e) Does the block reach the top of the incline? If not, what is the distance it travels up the incline? If so, what is its velocity at the top of the incline?
f) In another part of the game, the cube falls into a cart. The cart has a mini engine that provides constant power to accelerate the cart and the cube from 0 m/s to 3 m/s in 2 s. The mass of the cart is 200 g. Assuming no mechanical energy losses, what is the power provided by the engine?
g) To the right is a diagram of the cube in the cart. COM = "center of mass". What is the x- and y-position of the center of mass of the cube and cart system? Neglect the wheels.