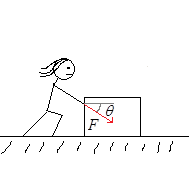
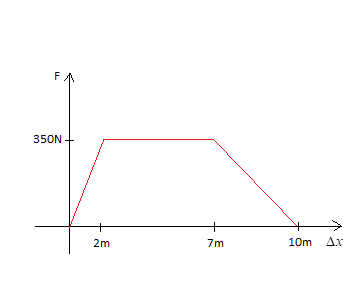
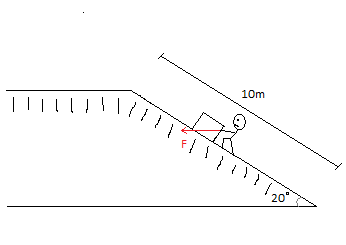
**Homework 9 due never**

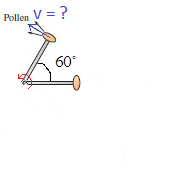
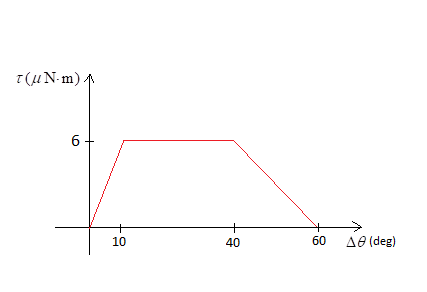
**Problem 1.** Suppose Cinderella pushes a 45 kg box of slippers along a floor as shown below, with a force F = 200N directed at an angle θ = 29◦ below the horizontal. If she pushes the box through a distance of 24m, what will be its speed at that point? Let there be a kinetic friction coefficient μk = 0.17.



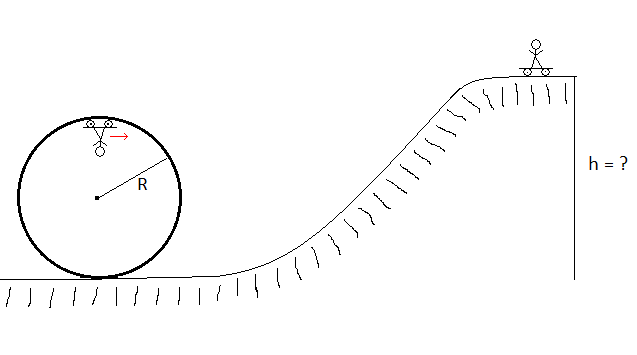
**Problem 2.** Now she shoves the box onto a descending frictionless ramp with an initial speed 7m/s. The prince slows it down by pushing with a horizontal force, whose magnitude changes with position along the ramp, according to the graph shown below. What is the box’s speed at the bottom of the ramp?



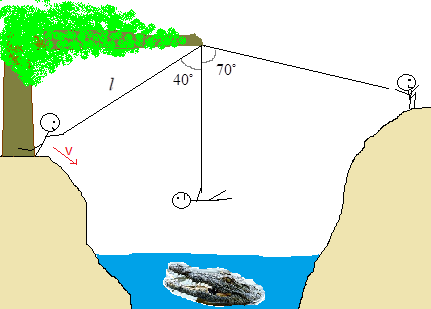
**Problem 3.** A bunchberry flower catapults its pollen to aid in reproduction. Suppose the flower exerts the torque graphed below on a stamen with anther sac/pollen attached (note μN∙m = 10-6N∙m). After the stamen has rotated through 60°, it releases the anther sac. You can model the anther sac as a point mass manther = 10μg = 10×10-9kg, and the stamen as a rod of mass mstamen = 15μg = 15×10-9kg, and length ℓ = 1.3mm. Don’t forget to include the effects of gravity, and calculate with what speed the anther sack is released.

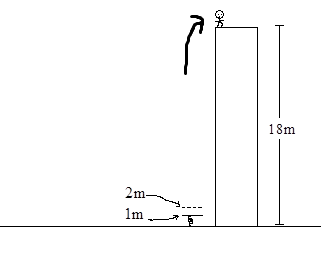
**Problem 4.** You want to ride your skateboard through a loop-the-loop of radius R = 5m, so you build a ramp h meters high to start from. Note that if you made h = 2R (i.e. the same height as the loop-the-loop), then you would get to the top of the loop-the-loop, but since your speed at the top would then be zero, you’d immediately fall of the track. So h needs to be higher, high enough so that you will continue to go around the loop when you get to the top. So what is h? You can ignore friction.



**Problem 5.** You’re got to swing across a crocodile infested river with an ℓ = 10m long vine. Say that you have a mass of 70kg. What minimum speed do you need to leap off the cliff with, so that you just barely make it to the top on the other side? If you can only grip onto the vine with a maximum force of twice your body weight, would you slip off the vine or not?



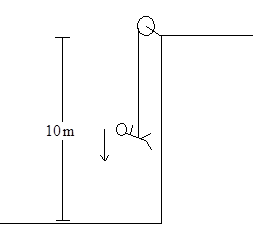
**Problem 6.** Suppose you construct a spring-loaded contraption to propel you to the top of a building 18m high. Your mass is m = 65kg, and you plan on compressing the spring 1m from its rest length of 2m so that you will start 1m off the ground. What must the spring constant of the spring be? What would be your maximum speed? And what would be your maximum acceleration?



**Problem 7.** Suppose you have a mass of 65kg, your bike frame has a mass of 10kg, and the tires on your bike each have a mass of 5kg, and a diameter of 80cm. If you coast down a hill 15m high, how fast will you be going at the bottom? You can treat the tires as hoops.



**Problem 8.** Suppose you drop off a rock wall, your rope attached to a pulley, shaped like a disk. As you fall, the rope will spin the disk (like a fish pulling on the reel of a fishing pole) which will in turn slow your rate of decent. Say the mass of the disk is M = 200kg, and your mass is m = 70kg. If you drop from rest at the top of the wall, what will be your speed when you hit the floor?



**Problem 9.** Your 3000kg car is driving up a 15° incline at a constsant speed of 25m/s. What power must the engine deliver to the wheels to accomplish this?

**Problem 10.** You’re on a stair climber making one step of 30cm every second. Your mass is 60kg. What power must you deliver to your muscles to accomplish the exercise? Your metabolic efficiency is about 20%, so what is your metabolic power output? How many kcal would you ‘burn’ in 30 minutes of such exercise?

**Problem 11.** Water flows over Niagara falls at a rate of 1800 m3/s down a distance of approximately 45m. The water obviously picks up kinetic energy as it falls. But when it hits the rocks below, all the kinetic energy gets dispersed and wasted. Electrical power plants are often built near waterfalls to instead utilize this kinetic energy to turn turbines which will generate electrical power via electromagnetic induction (PHY 123). What would be the power output of a plant utilizing all the water in Niagra falls? Compare this to the power requirements of a medium size city (P ~ 1GW). Note the density of water is ρ = 1000kg/m3. And you can assume the water is nearly stationary at the top of the falls, for simplicity.