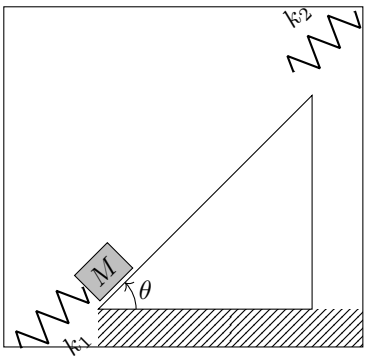
Energy Practice

Instructions: For short answer questions, work must be shown to receive credit. You should not need a calculator for most problems.

1 This is a title

1. You put a spring with spring constant k_1 just before the bottom of a frictionless ramp with angle θ and a spring with spring constant k_2 at the top. You push a cart with mass M into the spring so that it compresses by a distance Δr_1. When the cart reaches the top of the ramp at height h_f above it's initial height, what is the furthest that the second spring is compressed (Δx_2)? You may assume the cart actually reaches the top of the ramp and that $\Delta x_2 << h_f$.



2. You have three ramps all with the same height and angle. On each ramp is placed an identical object. ramp A has no friction, ramp B has friction that makes the object slip but also spin as it goes down, and ramp C has enough friction for the object to roll without slipping. Justify each answer with words and/or equations.

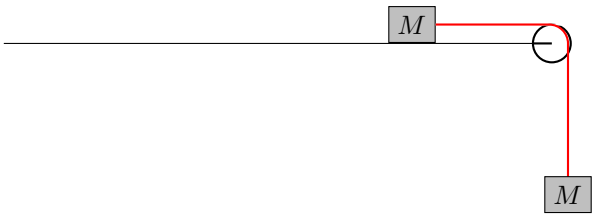
   (a) Rank the total energy of the objects from each ramp when that object reaches the bottom.

   (b) Rank the translational kinetic energy of the objects from each ramp when that object reaches the bottom.

   (c) When the object on ramp A reaches the bottom, will the object on ramp C have more kinetic energy, less kinetic energy, or the same amount?

3. You want to throw a ball from a cliff of height h so that it impacts the ground below with the highest speed possible. Assuming that you can throw equally hard at any angle, what angle should you choose? Justify your answer using some combination of equations and words.

4. You have the machine shown. You release the objects from rest. The pulley is a thin ring with mass M.



(a) When the hanging mass impacts the ground a distance of h below, what speed will each of the blocks have? Ignore friction and assume that the string is long enough so that the hanging mass hits the ground before the sliding mass hits the pulley.

(b) What speed will each object be moving at some time t after it is released, but before it hits the ground?

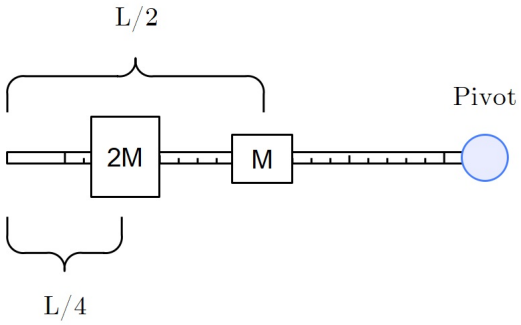
(c) If, instead of a single sliding mass M on top, you had N masses, each tied to the one before, what is the new speed?

5. Which has more energy, a bullet with a mass of 100 g traveling at 500 $\frac{\text{m}}{\text{s}}$ or a truck, with mass 1000 kg traveling at 5 $\frac{\text{m}}{\text{s}}$?

6. An object with mass M is falling through the air with a constant speed v. Take a system that consists of the object and the Earth

   (a) Is the system closed? How do you know?

   (b) How much energy has been extracted from the system when it hits the ground if the object started at a height of h?



7. Consider a massless rod with 2 extra masses attached as shown above. The rod is released from rest while horizontal. When the bar is vertical, what is its angular speed?

8. The drag power on an object is given by $\frac{1}{2}C\rho v^3 A$ where v is speed, ρ is density of the fluid, and A is cross sectional area, and C is some constant that depends on shape. If the engine in some car had to put out 1 HP to overcome drag at 20 $\frac{\text{mi}}{\text{hr}}$, what is the maximum speed of the 500 HP car?