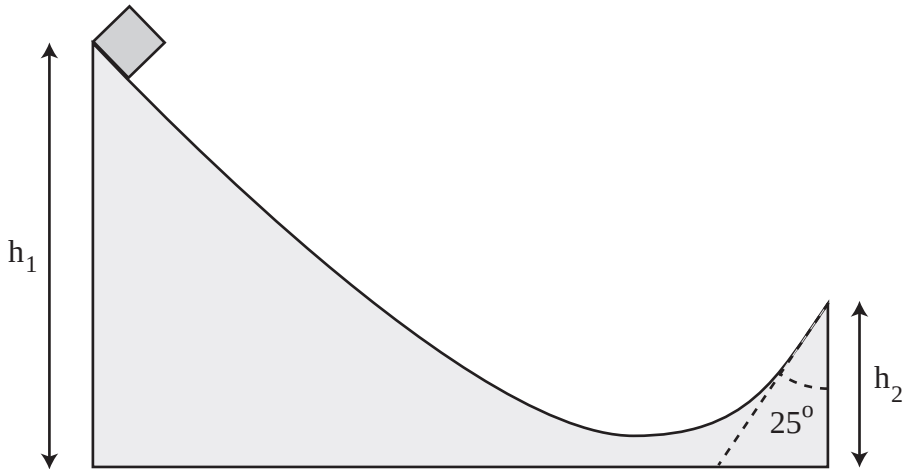
Homework #9

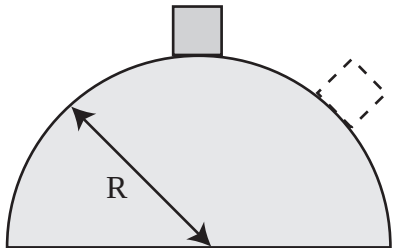
Due Friday, Apr. 15 (Tax day!)

1. A block starts from rest and slides down a frictionless ramp shaped as shown below.

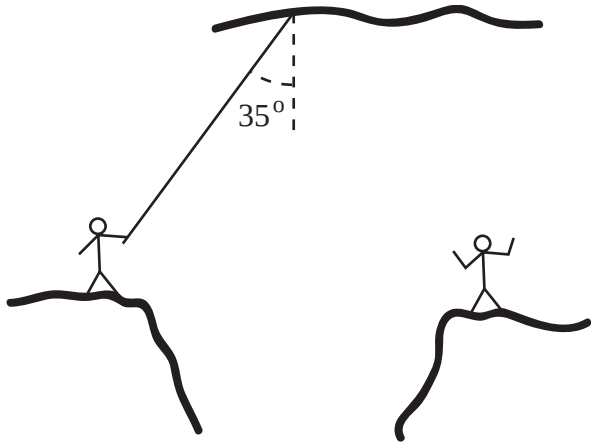


Here, $h_1 = 1.2$ m and $h_2 = 0.34$ m. The block slides down the ramp and is launched into the air. What is the maximum height that it reaches?

2. A block starts from rest and slides down a mound of ice shaped like a circle of radius R. Where does it fall off the mound? Neglect friction.



3. Tarzan swing to Jane on vine. Tarzan weigh 65 kg. Before Tarzan move, vine have angle 35°. If tension more than 700 N, vine break.



(a) Vine break?

(b) If vine break, where happen? If vine no break, what biggest tension?

4. A certain spring does not obey Hooke's law. Instead, the force exerted by the spring as a function of the distance x it is stretched from its equilibrium position is found to be well-approximated by

$$F = -kx - cx^3, \tag{1}$$

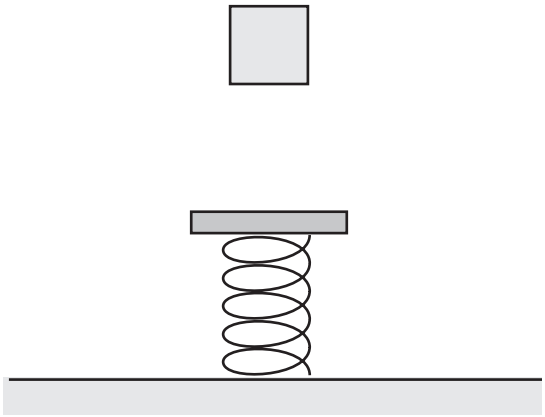
where k and c are positive constants.

(a) Find an expression for the work done by the spring when it is stretched from its unstretched length by x. Is the force exerted by this spring conservative?

(b) Suppose that this spring is used to launch a ball into the air. Does the ball go higher or lower compared to a Hooke's law spring with the same k (with $c = 0$) compressed by the same amount? Try to answer this question without putting in numbers or doing a detailed calculation.

(c) Suppose that this spring is used to launch a ball of mass 0.34 kg directly upward by compressing the spring by 0.089 m. How high does the ball go? Take $k = 120$ N/m and $c = 230$ N/m^3.

5, 6. (Counts as 2 problems) A block of mass 0.23 kg is dropped from rest 1.2 m above a platform of mass 0.11 kg attached to an ideal spring with spring constant 420 N/m.



(a) Find the speed of the block just before it hits the platform.

(b) The block and the platform collide and move together, compressing the spring. Find the speed of the block and platform just after this collision.

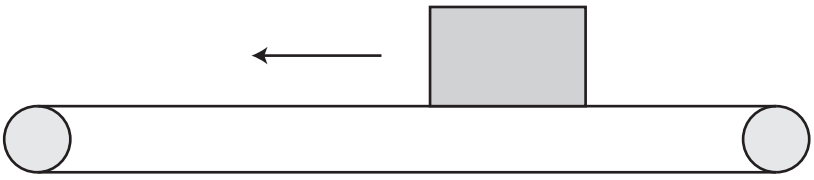
(c) Find the maximum compression of the spring.

(d) After the point of maximum compression, the platform pushes the block up again. What is the condition for the platform to lose contact with the block? What is the kinetic energy of the block at this instant?

(e) What is the maximum height of the block when it is relaunched?

(f) How much thermal energy is in the platform? Where did the rest of the initial potential energy go?

7. A package of mass 3.5 kg is dropped onto a conveyer belt that is moving at a steady speed of 0.75 m/s. The package initially slips relative to the conveyer belt, but it gradually picks up speed and moves with the conveyer belt due to friction. Assume that the coefficients of friction between the package and the belt are $\mu_k = 0.38$ and $\mu_s = 0.55$.



(a) Find the work done on the package by friction, analyzed from the point of view of a coordinate system at rest relative to a factory worker standing next to the belt. Is the work done by friction positive or negative?

(b) Find the work done on the package by friction, analyzed from the point of view of a coordinate system at rest relative to a box moving with the conveyer belt. Is the work done by friction positive or negative?

(c) Which work calculated in parts (a) and (b) above corresponds to the energy that the motor must supply to the conveyer belt to keep it moving at a constant speed? Assume no energy losses other than friction between the box and the belt.