1) You and your friend are moving a bookcase up some stairs with an angle θ. The bookcase has a mass M, uniform, and the height and width are h and w, respectively. The height of the bookcase is parallel to the stairs and you are holding the bookcase from the corners on the edge closer to the stairs. See fig. 1. If the bookcase is moving with a constant velocity, find your forces F_1 and F_2.

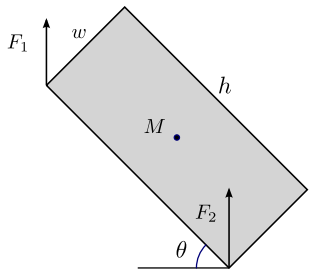

Figure 1: The bookcase.

2) You want to raise a heavy bucket with mass m at a constant velocity. You install a uniform beam of mass M and length l hinged to a wall, and is supported by a rope which is connected to the end of the beam and to the wall, with an angle θ. Then you install a system of pulleys as shown in the fig. 2. The pulleys are massless and frictionless.
a) Find the appropriate amount of force you need so that the bucket moves with a constant velocity.
b) Find the two forces that the system of pulley puts on the beam.
c) Write down the equilibrium equations for the beam and find the tension force, and also the force on the hinge.

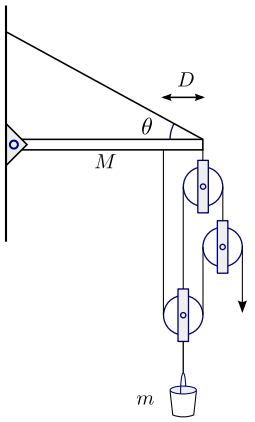

Figure 2: The hinge, pulleys, and the bucket.

3) Consider a uniform rigid rod which can revolve around a pivot. There are two rubber stoppers for protecting the rod, made from different materials with Young's modulus Y_1 and Y_2, but the same length and area. The rod touches both the stoppers at the same time, at the lengths l_1 and l_2 from the pivot. See fig. 3.

a) If we apply a force F at a distance l from the pivot, find the magnitude of the forces compressing the stopper 1 and the stopper 2.
b) You want to protect the pivot when the rod is suddenly gets stopped by the stoppers. Is it possible to avoid impulse force on the pivot by choosing specific values for Y_1 and Y_2? Find the condition.

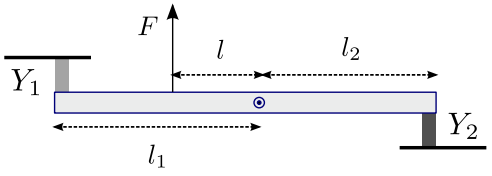

Figure 3: The rubber stoppers.

4) Consider a uniform rod with mass m, length l, cross sectional area A, and Young's modulus Y.
a) We hang this rod from one end. How much will the length change because of the rod's weight?
b) We rotate this rod, around one end, with a constant angular velocity ω. How much will its length change?