equilibrium and elasticity, problem set #2

1) A uniform rod with length $L = 4$ m and mass $M = 6$ kg is sitting on a fulcrum, and it is in equilibrium with two other masses, $m_1 = 12$kg and m_2.

a) When m_1 sitting at one end of the rod, and m_2 is siting $l = 1$ m from the other end, the system is in equilibrium if fulcrum is $l_f = 1$ m from m_1, as shown in fig. 1. Find m_2.
b) Now if both masses m_1 and m_2 sit on two ends of the rod, where must we put fulcrum so that the system is in equilibrium?

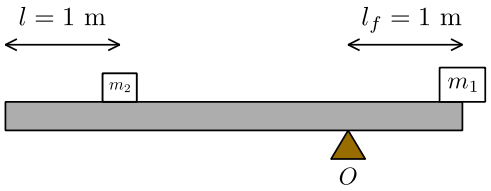

Figure 1: The rod with two masses, for part 'a'.

2) Consider a uniform beam with length L and math M, is hinged to a wall and supported by a horizontal rope, as shown in fig. 2. The angle between the beam and horizontal line is $\theta = 30°$.

a) Draw the free body diagram for the beam.
b) Find the tension force T of the rope.
c) Rod is pushing the hinge. Find this force's direction and magnitude.

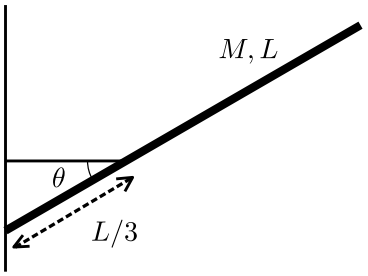

Figure 2: A beam connected to wall.

3) Two uniform, $m = 50$ gr marbles, with radius $r = 1.0$ cm are stacked as shown in fig. 3 in a container that is $w = 3.0$ cm wide.

a) Find the angle θ between the horizontal line and the line connecting the centers.
b) Draw the free body diagram for each marble. Call the forces at the points A, B, and C as N_A, N_B, and N_C, respectively.
c) Consider two marbles as a system and explain why $N_A = N_C$ and find N_B.
d) Now considering equilibrium of any one of the marbles and find N_A or N_C.
e) The length of the container is L and we apply a force F horizontally to the top edge of the container. The container's mass is negligible and it does not slide on the ground. Find minimum of F to knock over the system.

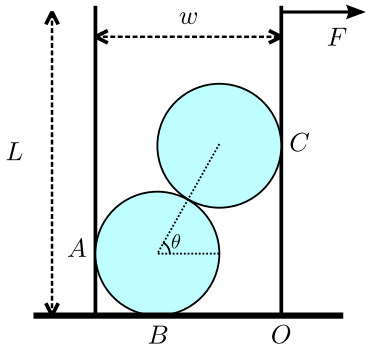

Figure 3: The marbles inside a container.