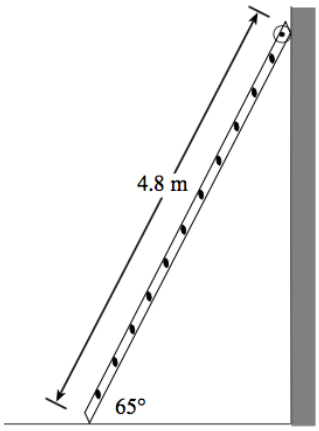
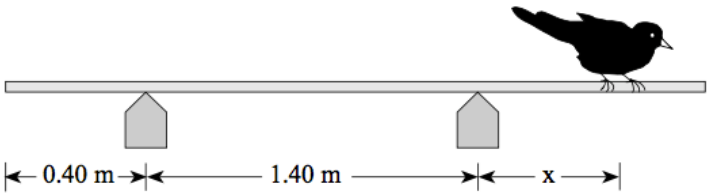
Equilibrium and Torque Worksheet 3.4 - Challenging Questions

1. A uniform 4.8 m long ladder of mass 16 kg leans against a frictionless vertical wall as shown in the diagram below.



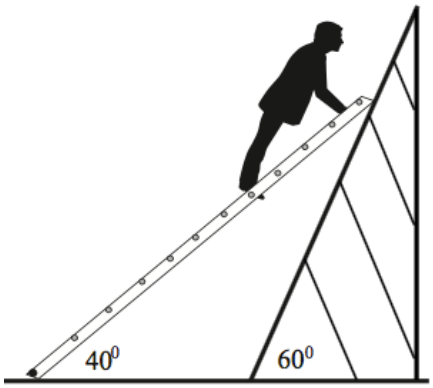
What minimum force of friction is needed at the base of the ladder to keep it from sliding?

2. A 0.75 kg board of length 2.60 m initially rests on two supports as shown.



What maximum distance, x, from the right-hand support can a 1.2 kg bird walk before the board begins to leave the left-hand support?

3. A 20 kg ladder leans against a frictionless vertical wall at 50° to the ground. If the ladder is 5 m long and μ=0.5 on the ground How far up the ladder can a 80 kg person climb before the ladder starts sliding?

4	A 65 kg person is ¾ of the way up a 25 kg uniform ladder as shown in the diagram below. The ladder is leaning against a frictionless surface inclined at 60° to the horizontal. What is the minimum coefficient of friction between the ladder and the floor necessary to maintain equilibrium? 

Super challenging (for fun only)

A ladder is leant against the wall. The coefficient of the static friction μ_1 between the ladder and the wall is 0.3 and the coefficient of the static friction μ_2 between the ladder and the floor is 0.4. The center of mass of the ladder is in the middle of it. Find the **minimum angle** θ that the ladder can form with the floor not to slip down.

Hint 1: mass is not given on purpose because you don't need it
Hint 2: this trig identity is necessary **Sin(90-θ)= Cos(θ)**
Hint 3: with the magic of Physics you will end up with three main equations and a few side ones; only the magic of Maths/algebra can get you out of the mess that comes after.
Hint 4: Other than θ, μ_1 and μ_2, all other unknown can be cancelled out somehow.
Hint 5: the 2nd last step should be an equation that contains only three variables θ, μ_1 and μ_2 and some trig function.