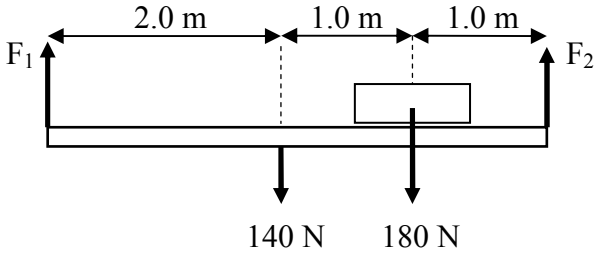
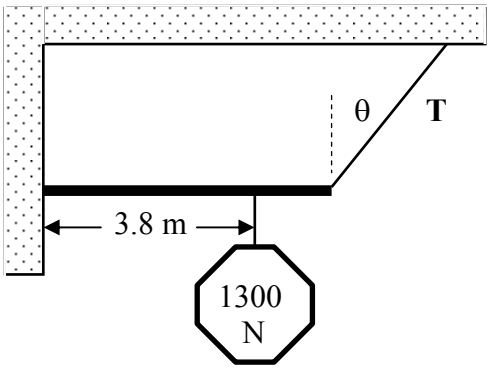
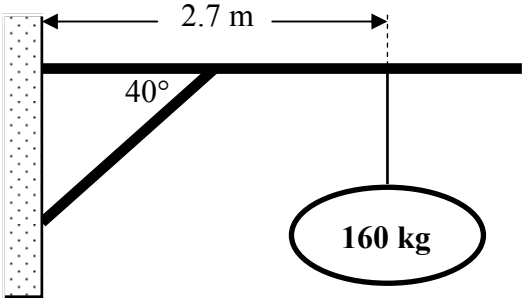
PHYSICS 12 ROTATIONAL EQUILIBRIUM WORKSHEET 2

1. 

For the left diagram, what upward force F_2 is required to keep the beam in both static and rotational equilibrium?

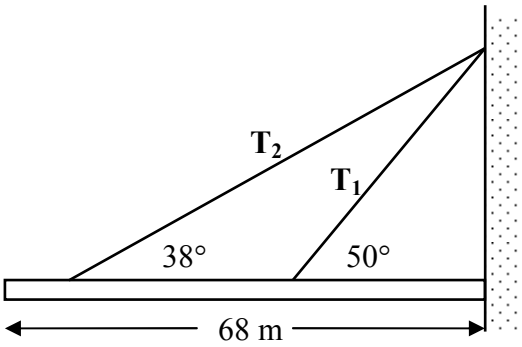
2. Examine the diagram to the left. Given that the 800. N uniform beam has a length of 4.2 m and the tension **T** in the support wire is 1700 N, determine the unknown angle θ.



3. 

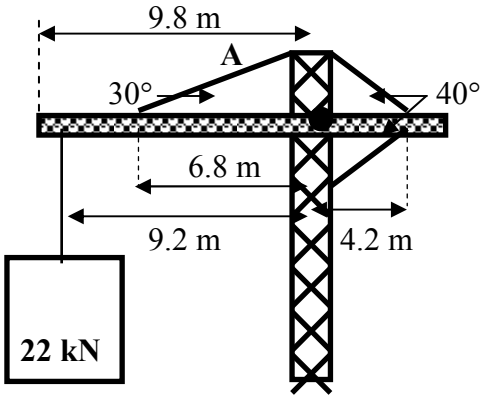
Examine the diagram to the left. If the horizontal uniform 3.6 m-long beam has a mass of 82 kg, and the location of the support beam is 1.4 m from the wall, what force is the support beam supplying to keep the system in equilibrium?

4. Examine the diagram to the right. The uniform 1.2 x 10^5 N beam has one cable attached 22 m from the wall, and another at 50 m from the wall. If cable T_1 has a tension of 6.5 x 10^4 N, what is the tension in the other cable T_2?



5. Indiana Jones (mass 75 kg) attempts to cross a fallen 36 m-long uniform log of mass 420 kg that *just* extends across a deep gorge. What he doesn't realise is that although the log is held up firmly on his side of the chasm, the other side is unstable, and can only withstand a force of 2.65 x 10^3 N before collapsing.
Should Indiana attempt to cross this log? Explain using calculations.

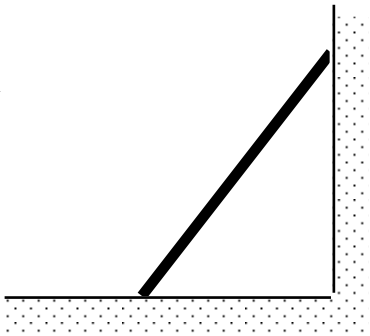
6. A uniform rectangular crate of mass 146 kg is 8.00 m tall and 3.00 m wide. Its coefficient of friction to the floor is 0.70.
   a) What minimum horizontal force is needed to slide this crate along the floor?
   b) How high up the crate can this force be applied without tipping over the crate?

7. 

In the left diagram, the uniform 15 m-long beam weighs 1.3×10^4 N, and is lifting a 2.2×10^4 N load. All lengths are measured from the pivot.

Calculate the tension in cable **A**. Note that the two cables on the right effectively cancel their torques.

8. A uniform 5.00 m-long ladder of mass 25.0 kg leans against a *frictionless* wall. Draw and label all horizontal and vertical vector components directly on the diagram to the right.
   If the ladder makes an angle of 60° with the floor, calculate the following:
   a) the force of contact the wall exerts against the ladder.
   b) the normal force that the floor exerts on the ladder.
   c) the friction force exerted by the floor to keep the ladder from sliding.
   d) the *minimum* coefficient of friction needed for the ladder not to slide.



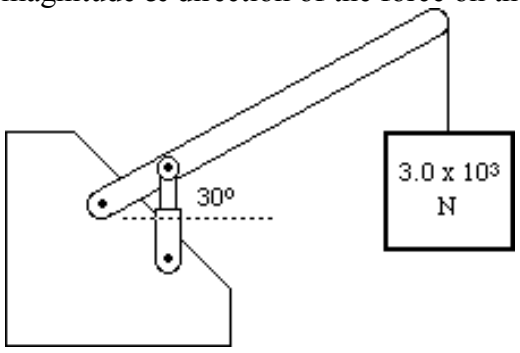
9. A 50.0 kg physics student now attempts to climb the ladder from question 8. Using $\mu = 0.29$, calculate the following:
   a) the new normal force of the floor pushing up on the ladder.
   b) the maximum force of contact that the wall can exert on the ladder without slippage along the floor.
   c) how far up the ladder the student can climb before the ladder slides out.

1. 205 N 2. 22° 3. 6.3×10^3 N 4. 9.7×10^4 N 5. no; at 29 m across, force needed to support log = 2650 N
$\therefore$ any distance further will exceed this force and bank will collapse 6. a) 1.00×10^3 N b) 2.14 m 7. 6.8×10^4 N
8. a) 71 N b) 245 N c) 71 N d) 0.29 9. a) 735 N b) 213 N c) 2.51 m

8. The floor is now resurfaced, making the coefficient of friction between ladder and floor to be 0.40. What is the new minimum angle (at floor) at which the ladder will not slide out?

9. A carpet is now placed on the floor, making $\mu = 0.50$ between ladder and floor. The ladder is then placed against the wall at a floor angle of 50°.
a) Calculate the force with which the ladder pushes against the wall.
b) Calculate the normal force exerted by the floor on the ladder.
c) Calculate the *maximum* friction force that will keep the ladder from sliding.
d) Calculate the actual friction force exerted by the floor. Will the ladder slide? Explain.
e) Will a 50.0 kg person be able to climb to the top of the ladder without it sliding out?
(two hints: - use the person's torque at the <u>top</u> of the ladder to find F_{wall}
- calculate a new F_N and use to find maximum F_f)
f) How far up the ladder will a 60.0 kg person get before it slides?

*10. A crane supports a 3.0 kN weight as shown. The crane's boom (essentially weightless) is
8.0 m long, and the hydraulic support is attached to the boom 2.0 m from the pin.
a) What is the compressional force in the hydraulic?
b) What is the magnitude & direction of the force on the pin at the bottom of the boom?



8. 51° 9. a) 103 N b) 245 N c) 123 N d) 103 N; no sliding, since maximum F_f has not been exceeded
e) F_w = 514 N while max. F_f = 368 N ∴ ladder <u>will</u> slide f) 3.2 m 10 a) 1.2 x 10^4 N b) 9000 N down