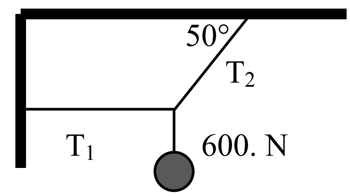
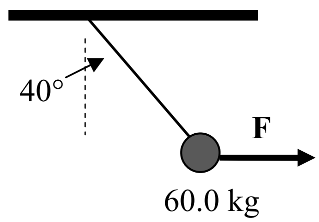
PHYSICS 12 STATIC EQUILIBRIUM WORKSHEET

1. For the situation shown to the right, find the values of T_1 and T_2 if the weight is 600. N.

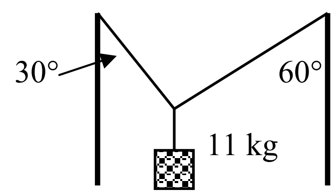


2. Examine the diagram to the left. What force **F** is required to keep the 60.0 kg mass in static equilibrium?



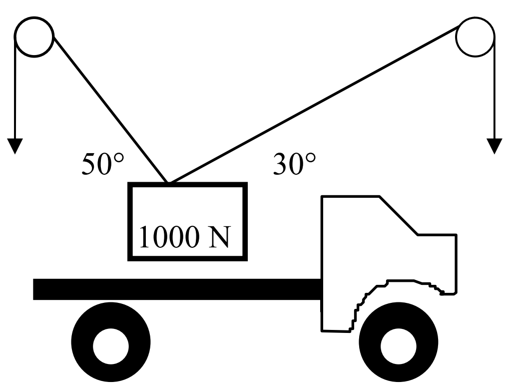
3. An 11 kg lamp is supported between two vertical poles by two wires attached as shown to the right.

   What is the tension in the *right* wire?

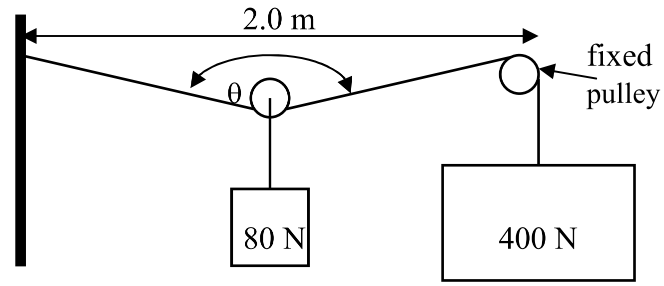


4. Two wires are used to suspend a sign that weighs 500. N. The two wires make an angle of 100° between each other. If each wire is exerting an equal amount of force, how much force does each wire exert?

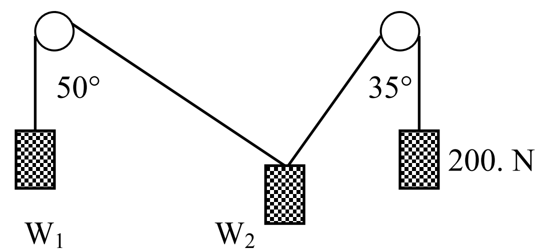
5. What must the tension in each cable be in the diagram in order to support the cargo in static equilibrium? Note that pulleys only change the *direction* of the force, not the magnitude.



6. What will the unknown angle θ be in order for the pulley system to the right to be in static equilibrium? Note that the 80 N weight is attached to a free-moving pulley, and the cable is fastened to the wall on the left.



7. In the system to the right, the pulleys are frictionless and the system hangs in equilibrium. Determine the values of each of the unknown weights.



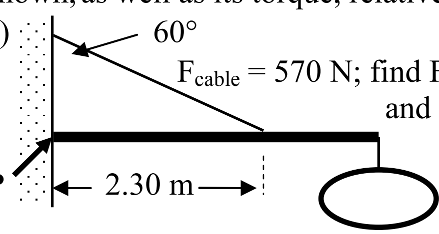
8. The following forces pull on a ring along the same plane (i.e. *coplanar*): 200 N at 30° E of N, 500 N at 10° N of E, 300 N at 60° W of S, and an unknown force that keeps the ring in equilibrium. Find the magnitude and direction of this unknown force.

1. 503 N, 783 N 2. 493 N 3. 54 N 4. 390 N 5. 653 N, 879 N 6. 169° 7. 260 N, 150 N 8. 350 N at 18° S of W

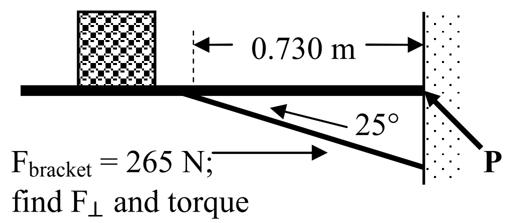
PHYSICS 12 ROTATIONAL EQUILIBRIUM WORKSHEET 1

1. For the following diagrams, determine the perpendicular component $\mathbf{F}_\perp$ for each force shown, as well as its torque, relative to pivot **P**:

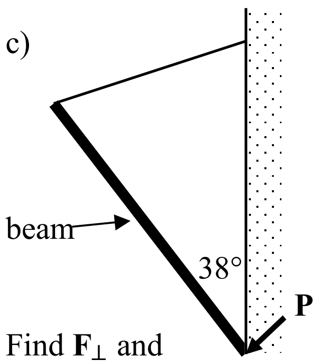
a)



b)

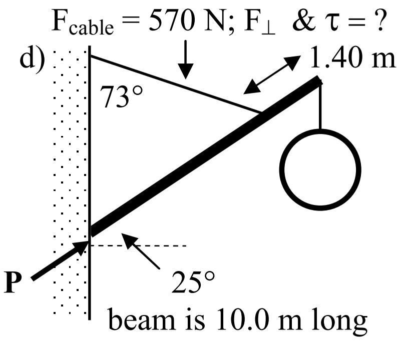


c)

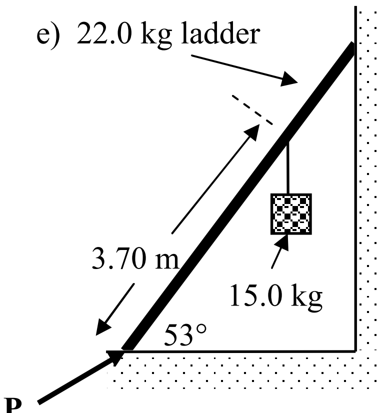


Find $\mathbf{F}_\perp$ and torque of the 5.00 m-long, 45.0 kg uniform beam.

d)



e) 22.0 kg ladder



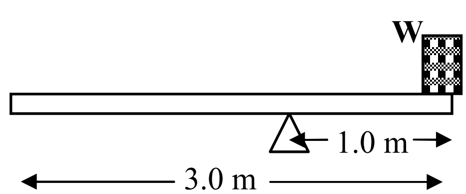
length of uniform ladder = 4.80 m

Find $F_\perp$ and τ for ladder and mass

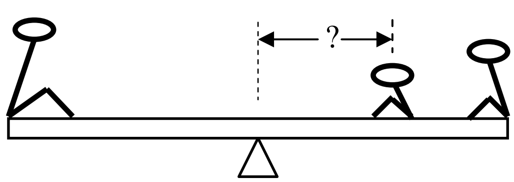
2. A young woman is sitting on the edge of a seesaw that is balanced on the other end. The seesaw is 10.0 m long and the fulcrum (which acts as the **pivot point**) is at the midpoint of its length. If her mass is 40.0 kg, how much torque is she applying?

3. A camper is trying to move a rock by creating a lever out of a steel pipe and another rock. Using the second rock as a fulcrum, he places it 1.50 m from the point at which he will exert a force. How much torque will he exert if he applies a force of 200. N:
a) perpendicular to the pipe? b) at 45° to the pipe?

4. A fulcrum is placed 1.0 m from the edge of a 3.0 m-long wooden uniform plank of mass 20 kg. A weight **W** is placed at the edge of the short end to balance it. What is the proper amount of weight needed to balance the plank? (Hint: first find the plank's weight and draw its vector in the correct location)



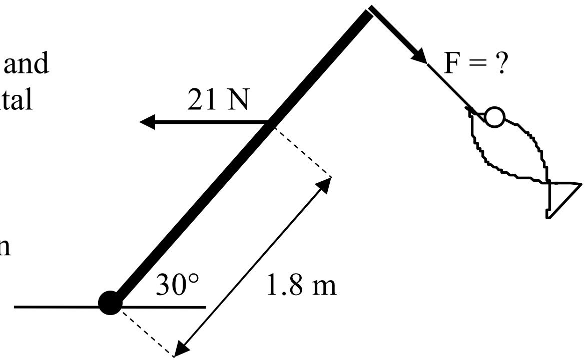
5.



Two children are on opposite ends of an 8.00 m-long seesaw that is pivoted in the middle. One child weighs 300. N while the other weighs 200. N. A third child weighing 150. N attempts to hop on and balance the seesaw. How far from the fulcrum should she sit?

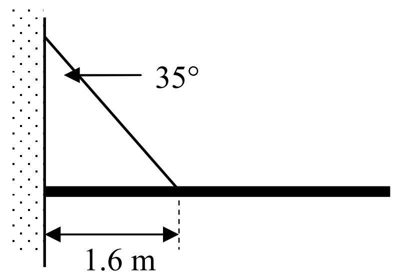
6. A 3.0 m-long bamboo fishing rod of negligible mass is pivoted at one end, and held in equilibrium by a 21 N-horizontal force while a fish pulls on a fishline attached to the rod as shown below.

How much force does the fish exert on the rod? Assume this force is perpendicular to the rod.



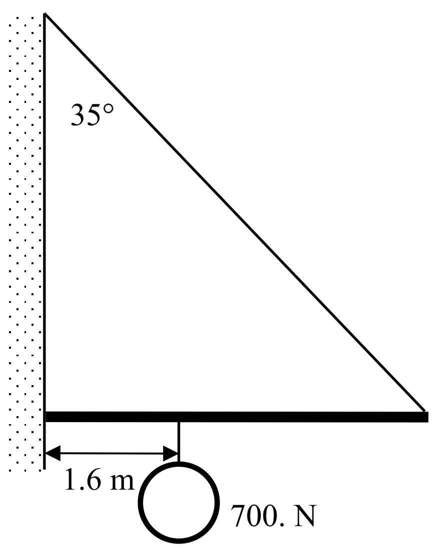
7. a) A 4.0 m-long uniform beam to the right weighs 500. N and is supported by a cable as shown. What is the tension in that cable?

b) The beam now has a 700. N weight that hangs at its end. What is the tension in the cable now?

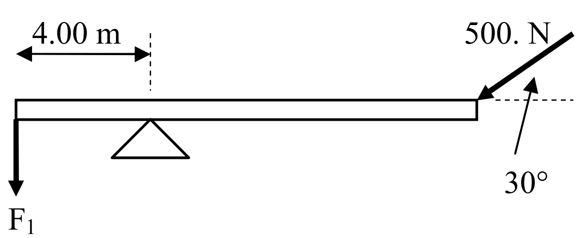


c) The same beam, mass and cable is now used in a different configuration as shown to the right. Calculate the new tension in the cable now.

d) Using physics principles, explain the advantages of using the arrangement in (c) over that in (b).



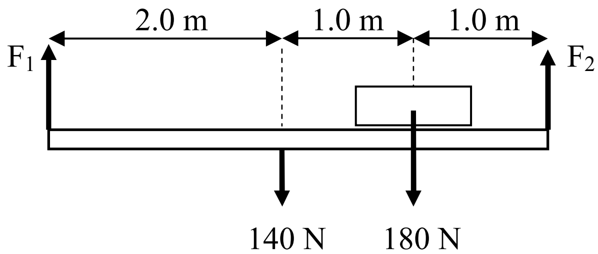
8. In the diagram to the right, the mass of the 12.0 m-long uniform board is 25.0 kg.
a) Calculate the unknown force F_1 needed to balance the system.
b) How much force does the fulcrum apply:
- vertically upward on the board?
- horizontally?
- overall? (magnitude and direction)



1. a) 285 N, 656 N-m b) 112 N, 82 N-m c) 272 N, 679 N-m d) 381 N, 3.28×10^3 N-m e) ladder: 130 N, 311 N-m; mass: 88.5 N, 327 N-m 2. 1960 N-m 3. a) 300 N-m b) 212 N-m 4. 98 N 5. 2.67 m 6. 6.3 N
7. a) 763 N b) 2900 N c) 647 N d) answers should be based on different cable tensions caused by torque due to relative positions of cable and weight 8. a) 623 N b) 1.12×10^3 N, 433 N to right, 1.20×10^3 N @ 69° up to the right

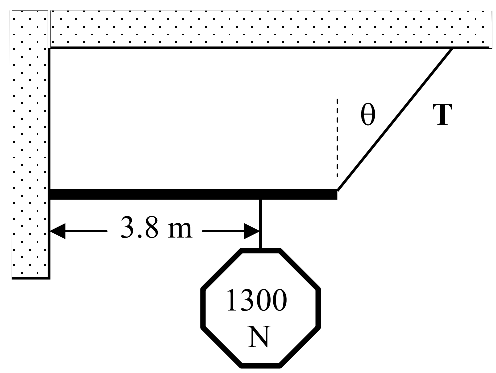
PHYSICS 12 ROTATIONAL EQUILIBRIUM WORKSHEET 2

1.

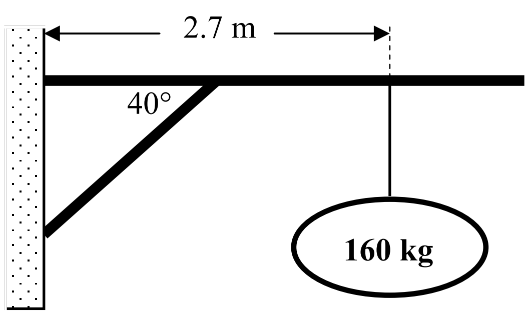


For the left diagram, what upward force F_2 is required to keep the beam in both static and rotational equilibrium?

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.

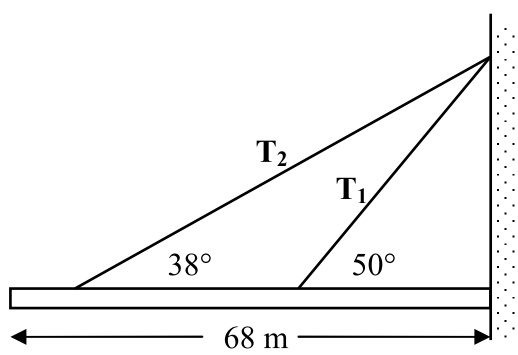


3.



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?

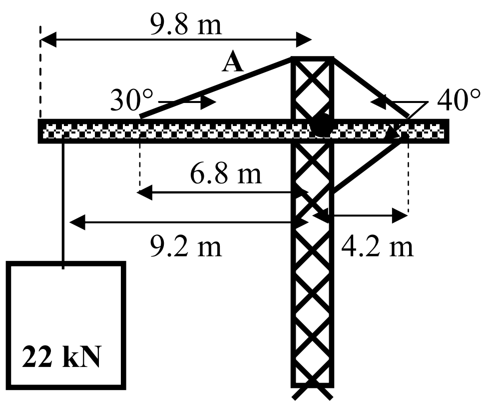
4. Examine the diagram to the right. The uniform 1.2×10^5 N beam has one cable attached 22 m from the wall, and another at 50 m from the wall. If cable T_1 has a tension of 6.5×10^4 N, what is the tension in the other cable T_2?



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 2.65×10^3 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?

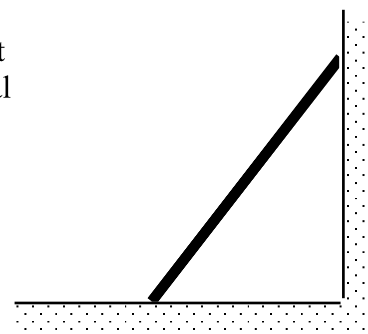
7.



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 <u>*frictionless*</u> 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.



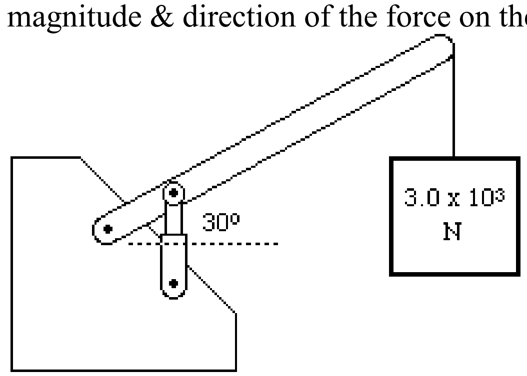
9. A 50.0 kg physics student now attempts to climb the ladder from question 8. Using $\mu = 0.29$, calculate the following:
a) the new normal force of the floor pushing up on the ladder.
b) the maximum force of contact that the wall can exert on the ladder without slippage along the floor.
c) how far 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 ∴ 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 top 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 will slide f) 3.2 m 10 a) 1.2×10^4 N b) 9000 N down