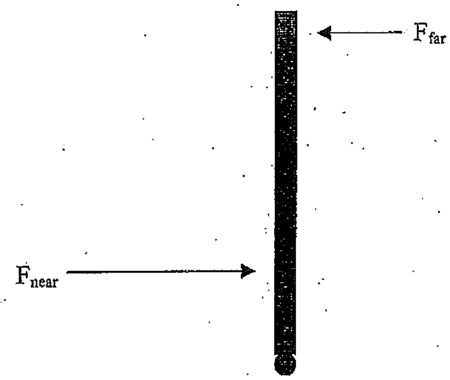
Static Equilibrium Conditions: $\Sigma \tau = 0$ $\Sigma F_y = 0$ $\Sigma F_x = 0$

G1

PHY 111 **Torques and forces on a door**

One person will push on a door close to the hinge. Another person will push in the opposite direction far from the hinge. They will push against each other so that the door doesn't turn one way or the other. (Forces will be measured with a bathroom scale.)

1. Balancing the torques.



Force at hinge?

a) The person at the far position is exerting a torque on the door. Why does the person at the near position need to push so much harder?

b) There is a force exerted by the hinge. Why don't we need to consider the force at the hinge when we think about balancing torques?

Data:

F_{far} = r_{far} = $torque_{far}$ =

F_{near} = r_{near} = $torque_{near}$ =

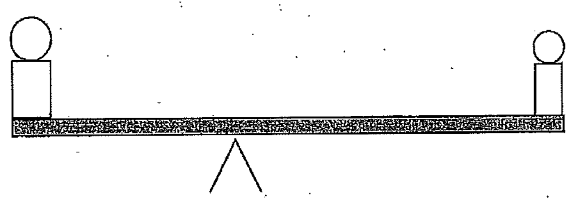
c) Do the two torques nearly balance?

2. Balancing the forces.

a) What is the force on the hinge? b) In what direction?

PHY 111 **Children on a See-Saw**

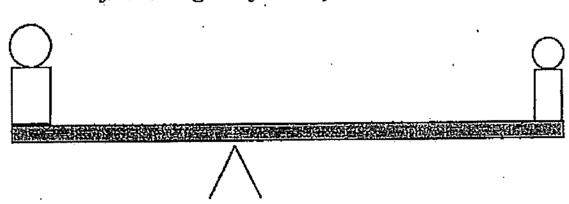
1. Two children are on a see-saw. The child on the left has a mass of 80 lbs and is located 4 feet from the fulcrum point. The child on the right is located 6 feet from the fulcrum point and has unknown mass.



a) Assuming the board itself has no mass, find the weight of the child on the right.
(First draw force diagram for the forces on the board.)

b) What is the force that the fulcrum exerts on the board?

2. We will now take the weight of the board to be 30 lbs. with the center of mass of the board to be at its center of the board.
a) Find the weight of the child on the right. (Not the same as the answer above.)
(First draw force diagram for the forces on the board.)

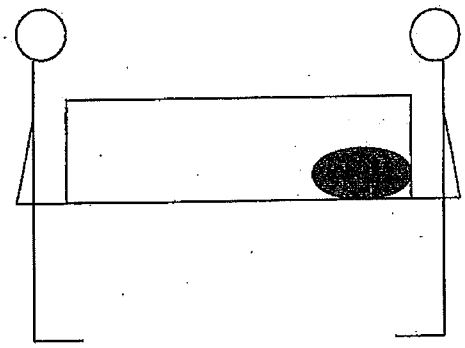


b) What is the force that the fulcrum exerts on the board?

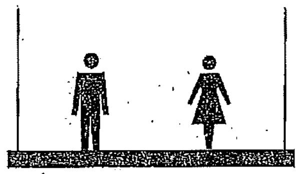
PHY 111 **Carrying a trunk**

Two friends are carrying a closed wooden trunk whose length is 6 feet and whose weight is 50 pounds. Its center of mass is at the center of the trunk. Concealed inside the trunk, unknown to the two friends, is a 60-lb. bag of lead shot located 1 foot from the right end of the trunk. As the two friends carry the trunk, one comments how light the trunk is and the other how heavy it is. How much of the weight is each supporting? (To begin, take either of the friends to be the pivotal point.)

Note: You may use lbs. as a unit of force and feet as a unit of distance.



4



Two painters stand on a 10-kg, 4.0-m-long uniform beam that is supported by ropes on each end. The gravitational constant is 10 N/kg. Determine the tension in each rope. (Complete the information below to answer Question 1.)

Description of Situation:

- The mass of the painter on the left is _______kg, and he stands _______m from the left rope.
- The mass of the painter on the right is _______kg, and she stands _______m from the right rope.

Free-Body Diagram for Beam (draw axes):

First Condition of Equilibrium (y-components):

Second Condition of Equilibrium:

Complete Solution:

Medical Science

Biceps and Triceps

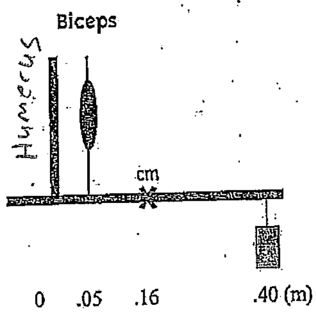
The diagrams are models for how the biceps and triceps work. The horizontal beam represents the lower arm and the vertical beam represents the humerus or upper arm. The lower arm has a mass of 5 kg.

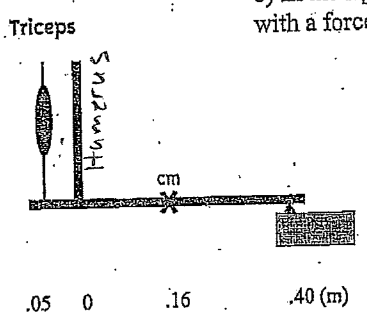
a) The block in the left diagram has a mass of 10 kg. Find the tension in the biceps.

b) In the right diagram, the hand is pushing on the table with a force of 150 N. Find the tension in the triceps.

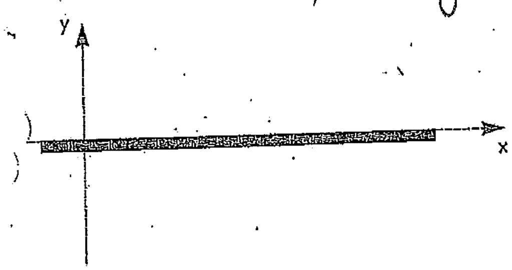
c.) Find the compression on the humerus bone for the diagram on the left.

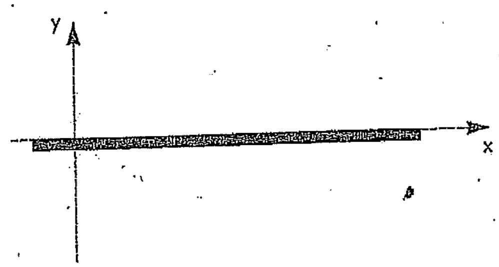
d.) Find the compression of the humerus bone for the diagram on the righ





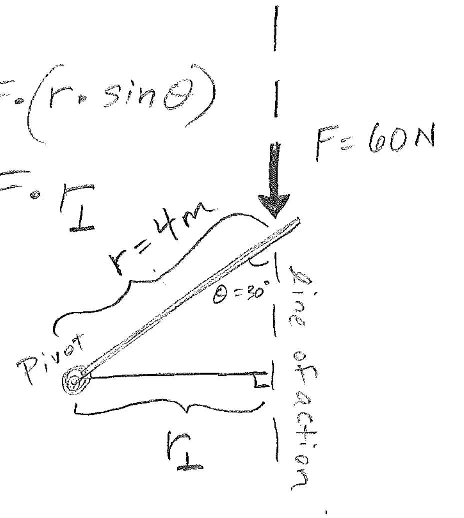
Draw free body diagrams here:





$\tau = F \cdot (r \cdot \sin\theta)$

$\tau = F \cdot r_{\perp}$

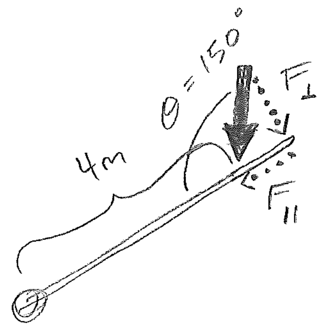


A dashed line can represent the 'line of action' which is in the same dimension as the force applied. The 'moment arm' or 'lever arm' is the perpendicular distance from the 'line of action to the pivot point or fulcrum.

1.) Find the lever arm length.

2.) Find the torque at the pivot point.

3.) In your own words, explain the difference between between 'r' and '$r_{\perp}$'.



$F = 60\,N$

$$\tau = r(F \sin\theta)$$

$$\tau = r\,F_\perp$$

4.) Instead of finding $r_\perp$ use $(\sin\theta)F$ to find the component of F that acts perpendicularly to 'r'.

5.) Use $\tau = r \cdot F_\perp$ to determine torque.

6.) Why can we ignore the parallel component of F when calculating torque?

7.) $\sin 30° =$ _____ $\sin 150° =$ _____ | Degree mode |

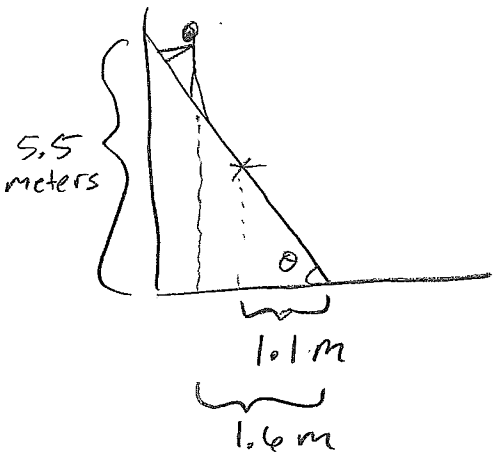
What is the force friction between the ladder and ground?

$g = 10\,m/s/s$

$\Sigma F_x = 0$ Ladder mass = 17kg

$\Sigma F_y = 0$ Person mass = 75 Kg

$\Sigma \tau = 0$



* Draw a force diagram for the ladder and choose an appropriate pivot pt.

* Write the conditions for static equilibrium

Steps:

a.) Draw all forces acting on the ladder.

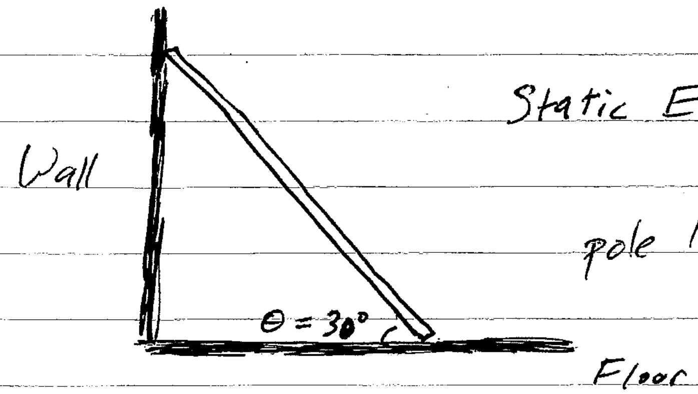
b.) Sum the forces in the x-direction. Create an equation.

c.) Sum the forces in the y-direction. Create an equation.

d.) Sum the torques on the ladder. Use the base of the ladder as the pivot point.

e.) Set the sum of the torques equal to zero and solve for the force of the wall on the ladder.

f.) What is the force friction between the ground and the ladder?



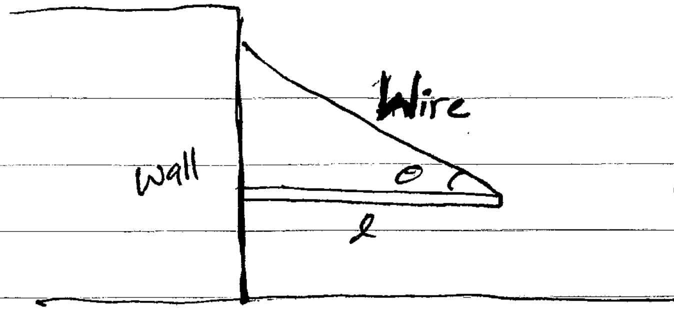
Static Equilibrium

$g = 10 \, m/s/s$

pole length = 6 m

A a 5 kg pole lays against a wall.

1. Draw a free body diagram.
2. Determine the F_N on the pole from the wall. Assume the wall is frictionless.
3. Determine the μ_s with the Floor and the pole.



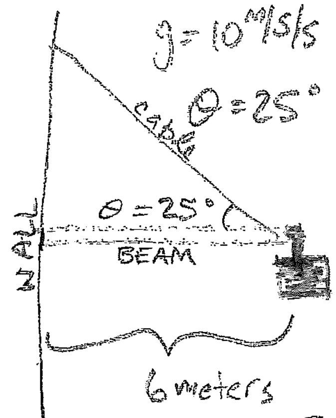
$g = 10\ m/s/s$

A 4m pole is held horizontally by a wire and the friction of a wall.

$\theta = 30°$ $l = 4m$ $M_{pole} = 6\,kg$ $F_{tension} = 100N$

1. Draw a free body diagram for the pole.
2. Determine the force normal from the wall.
3. Determine μ_s between the wall and pole. Assume static friction is at maximum.

$\Sigma \tau = 0 \quad \Sigma F_y = 0 \quad \Sigma F_x = 0$



* There is both F_N and $F_{friction}$ between the wall and beam.

Static Equilibrum Conditions Apply

A wire supports a horizontal wooden beam of mass 20 kg. that has a sign of mass 5 kg attached to the end.

1. Draw a force diagram for the beam.
2. What is the tension in the cable?
3. What is the horizontal force of the wall on the beam? F_N
4. What is the vertical force of the wall on the beam? $F_{friction}$
5. What is the total force of the wall on the beam?