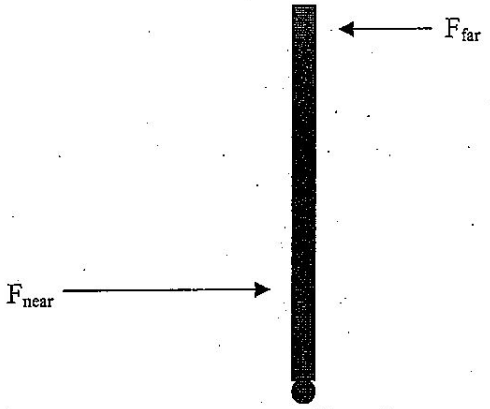
G1

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?

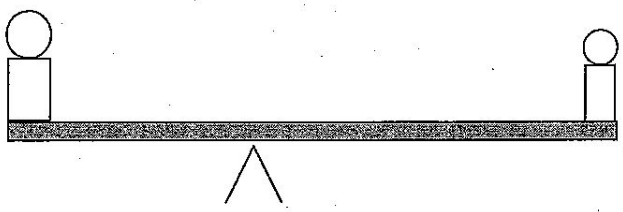
2. Balancing the forces.

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

2

PHY 111 Children on a See-Saw

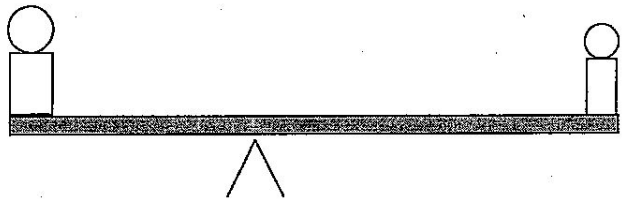
1. Two children are on a see-saw. The child on the left has a mass of 80 lbs and is located 4 feet from the fulcrum point. The child on the right is located 6 feet from the fulcrum point and has unknown mass.



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.)

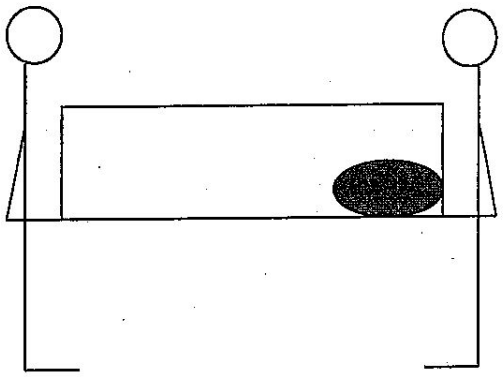


b) What is the force that the fulcrum exerts on the board?

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.



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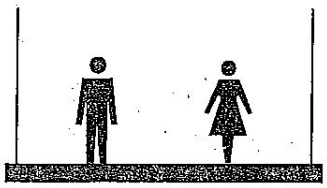
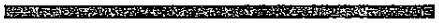


Two painters stand on a 10-kg, 4.0-m-long uniform beam that is supported by ropes on each end. The gravitational constant is 10 N/kg. Determine the tension in each rope. (Complete the information below to answer Question 1.)

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:

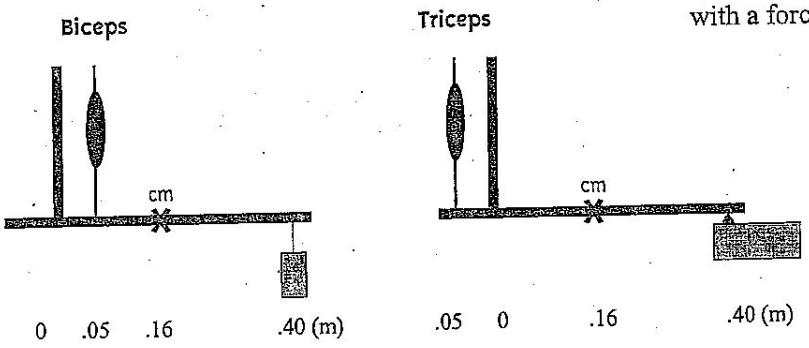
Complete Solution:

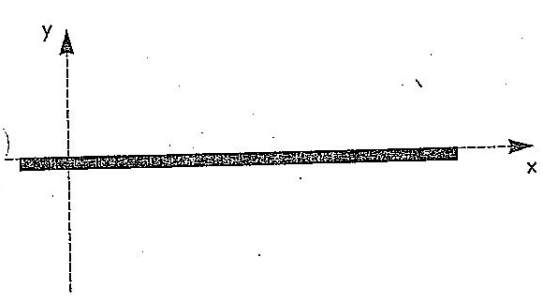
Biceps and Triceps

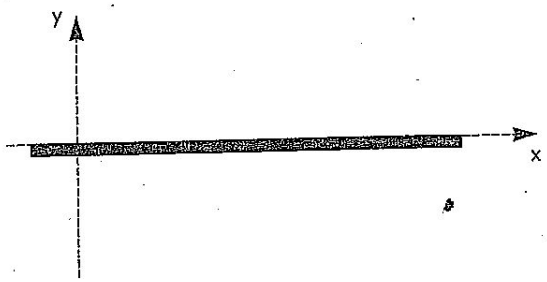
The diagrams are models for how the biceps and triceps work. The horizontal beam represents the lower arm and the vertical beam represents the upper arm. The lower arm has a mass of 5 kg.

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.







EXAMPLE 6.7 The foot and the Achilles tendon muscle provide a nice example of a body lever (Fig. 6.10a). The ball of the foot touching the ground is the fulcrum, the bones in the foot are the arm of the lever, and the Achilles tendon and its associated muscles provide the tension force needed to lift the load (the calf bone in this case). The ground pushes up on the ball of the foot with a force of half the person's weight. The heel of the foot is just off the ground. Find the tension T in the Achilles tendon and the compression force C at the joint between the leg and foot for a person weighing 800 N (180 lb).

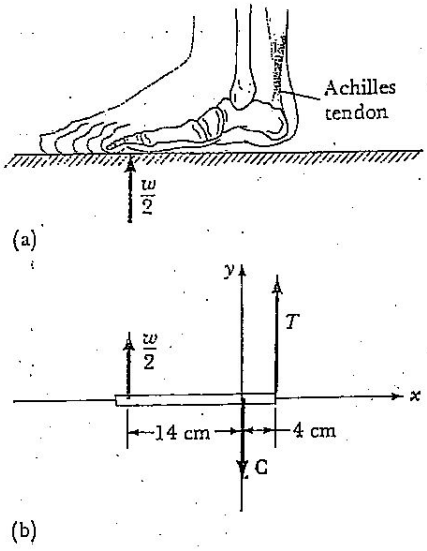


FIG. 6.10. (a) The foot as a lever. (b) A force diagram of the foot as a lever while supporting the leg by tension in the Achilles tendon.