
Problem Set 10

▪ Yoga

The yoga exercise “Downward-Facing Dog” requires stretching your hands straight out above your head and bending down to lean against the floor. This exercise is performed by a 750-N person as shown in Fig 10.1. When he bends his body at the hip to a 90° angle between his legs and trunk, his legs, trunk, head, and arms have the dimensions indicated. Furthermore, his legs and feet weigh a total of 277 N, and their center of mass is 41 cm from his hip, measured along his legs. The person’s trunk, head, and arms weigh 473 N, and their center of gravity is 65 cm from his hip, measured along the upper body.

- Find the normal force that the floor exerts on each foot and on each hand, assuming that the person does not favor either hand or either foot.
- Find the friction force on each foot and on each hand, assuming that it is the same on both feet and on both hands (but not necessarily the same on the feet as on the hands). *[Hint: First treat his entire body as a system; then isolate his legs (or his upper body).]*

▪ Amusement Park Ride

- An amusement park ride consists of airplane-shaped cars attached to steel rods. Each rod has a length of 15.0 m and a cross-sectional area of 8.00 cm^2 .
 - How much is each rod stretched when it is vertical, and the ride is at rest? (Assume that each car plus two people seated in it has a total weight of 1900 N.)
 - When operating, the ride has a maximum angular speed of 12.0 rev/min. How much is the rod stretched then?
- [Similar concept]* An aluminum wire is 0.850 m long and has a circular cross section of diameter 0.780 mm. Fixed at the top end, the wire supports a 1.20 kg object that swings in a horizontal circle. Determine the angular speed of the object required to produce a strain of 1.00×10^{-3} .

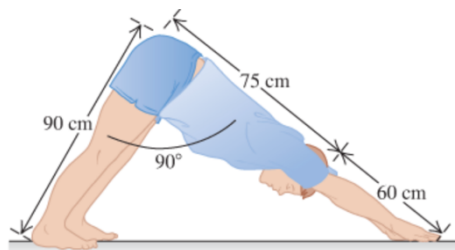


Figure 10.1

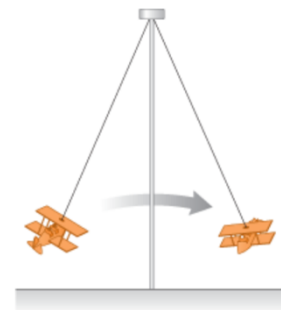


Figure 10.2

- Moving

Two friends are carrying a 200-kg crate up a flight of stairs. The crate is 1.25 m long and 0.500 m high, and its center of gravity is at its center. The stairs make a 45.0° angle with respect to the floor. The crate also is carried at a 45.0° angle, so that its bottom side is parallel to the slope of the stairs showing in Fig 10.3. If the force each person applies is vertical, what is the magnitude of each of these forces? Is it better to be the person above or below on the stairs?

- Pyramid

Ancient pyramid builders are balancing a uniform rectangular slab of stone tipped at an angle θ above the horizontal using a rope (Fig 10.4). The rope is held by five workers who share the force equally.

- If $\theta = 20.0^\circ$, what force does each worker exert on the rope?
- As θ increases, does each worker have to exert more or less force than in part (a), assuming they do not change the angle of the rope? Why?
- At what angle do the workers need to exert no force to balance the slab? What happens if θ exceeds this value?



Figure 10.3

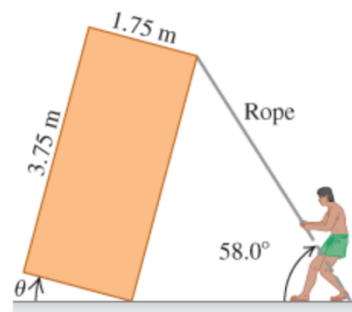


Figure 10.4