For example, imagine that you are pulling on a wishbone with a perpendicular force F_1 and that a friend is pulling in the opposite direction with a force F_2. If you pull the wishbone so that it would rotate counterclockwise, then you exert a positive torque of magnitude $F_1 d_1$. Your friend, on the other hand, exerts a negative torque, $-F_2 d_2$. To find the net torque acting on the wishbone, simply add up the individual torques.

$$\tau_{net} = \Sigma\tau = \tau_1 + \tau_2 = F_1 d_1 + (-F_2 d_2)$$

When you properly apply the sign convention, the sign of the net torque will tell you which way the object will rotate, if at all.

SAMPLE PROBLEM E

Torque

PROBLEM

A basketball is being pushed by two players during tip-off. One player exerts an upward force of 15 N at a perpendicular distance of 14 cm from the axis of rotation. The second player applies a downward force of 11 N at a perpendicular distance of 7.0 cm from the axis of rotation. Find the net torque acting on the ball about its center of mass.

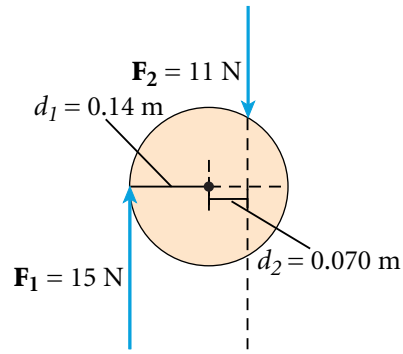
SOLUTION

1. DEFINE

Given: $F_1 = 15$ N $\quad F_2 = 11$ N
$d_1 = 0.14$ m $\quad d_2 = 0.070$ m

Unknown: $\tau_{net} = ?$

Diagram:



2. PLAN

Choose an equation or situation: Apply the definition of torque to each force, and add up the individual torques.

$$\tau = Fd$$
$$\tau_{net} = \tau_1 + \tau_2 = F_1 d_1 + F_2 d_2$$

TIP *The factor sin θ is not included because each given distance is the perpendicular distance from the axis of rotation to a line drawn along the direction of the force.*

3. CALCULATE

Substitute the values into the equations and solve: First, determine the torque produced by each force. Use the standard convention for signs.

$$\tau_1 = F_1 d_1 = (15\text{ N})(-0.14\text{ m}) = -2.1\text{ N}\cdot\text{m}$$
$$\tau_2 = F_2 d_2 = (-11\text{ N})(0.070\text{ m}) = -0.77\text{ N}\cdot\text{m}$$
$$\tau_{net} = -2.1\text{ N}\cdot\text{m} - 0.77\text{ N}\cdot\text{m}$$

$$\boxed{\tau_{net} = -2.9\text{ N}\cdot\text{m}}$$

4. EVALUATE

The net torque is negative, so the ball rotates in a clockwise direction.