

Answer on Question #69222, Physics / Other

A 60 kg man tries to step out of a 30 kg boat initially at rest onto a platform beside a lake. What happens if he tries to step 1 m sideways from the boat without holding onto the platform?

Solution:

The man and the boat are two separate objects, and mutually interact when the man walks across the boat. Initially the boat is at rest, so the center of mass is a stationary point. When the man walks across the boat, no external force acts on the system, as the boat is allowed to glide across the water. Thus while the man walks across the boat, the center of mass must stay in the same place. In order to do so, the boat must move out from the platform a certain distance. We can calculate this distance, which we shall denote by d , using center of mass calculations.

For x-coordinate of the center of gravity is formula:

$$x_{cm} = \frac{m_A x_A + m_B x_B}{m_A + m_B}$$

Remember that we can choose our origin, so we shall choose $x = 0$ to be at the platform.

$$x_{cm} = \frac{m_A(-L/2) + m_B \cdot 0}{m_A + m_B}$$

where

$$m_A = 30 \text{ kg}$$

$$m_B = 60 \text{ kg}$$

Next we calculate the center of mass when the man is at point B, introducing our variable, d . The man is a distance 1 m from the shoreline, while the boat is a distance $-(\frac{L}{2} + d)$ from the shoreline.

$$m_A \left(-\frac{L}{2}\right) + m_B \cdot 0 = m_A \left(-\frac{L}{2} + d\right) + m_B \cdot 1$$

$$m_A d = m_B$$

$$d = \frac{m_B}{m_A} = \frac{60}{30} = 2 \text{ m}$$

Answer: Thus as the man moves 1 m, the raft gets displaced **2 meters** from the platform.

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