NAME _____ DATE _____ CLASS _____

Holt Physics

Problem 8B

ROTATIONAL EQUILIBRIUM

PROBLEM

In 1960, a polar bear with a mass of 9.00×10^2 kg was discovered in Alaska. Suppose this bear crosses a 12.0 m long horizontal bridge that spans a gulley. The bridge consists of a wide board that has a uniform mass of 2.50×10^2 kg and whose ends are loosely set on either side of the gulley. When the bear is two-thirds of the way across the bridge, what is the normal force acting on the board at the end farthest from the bear?

SOLUTION

1. DEFINE

Given:

m_b = mass of bridge = 2.50×10^2 kg

m_p = mass of polar bear = 9.00×10^2 kg

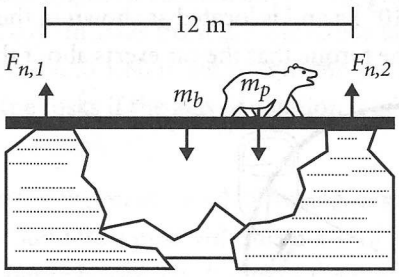
L = length of bridge = 12.0 m

$g = 9.81$ m/s^2

Unknown:

$F_{n,1} = ?$

Diagram:



2. PLAN

Choose an equation(s) or situation:

Apply the first condition of equilibrium: The unknowns in this problem are the normal forces exerted upward by the ground on either end of the board. The known quantities are the weights of the bridge and the polar bear. All of the forces are in the vertical (y) direction.

$$F_y = F_{n,1} + F_{n,2} - m_b g - m_p g = 0$$

Because there are two unknowns and only one equation, the solution cannot be obtained from the first condition of equilibrium alone.

Choose a point for calculating net torque: Choose the end of the bridge that is farthest from the bear. The torque contributed by $F_{n,1}$ is zero at that point.

Apply the second condition of equilibrium: The torques produced by the bridge's and polar bear's weights are clockwise and therefore negative. The normal force on the end of the bridge opposite the axis of rotation exerts a counterclockwise (positive) torque.

$$\tau_{net} = -(m_b g) d_b - (m_p g) d_p + F_{n,2} d_2 = 0$$