PhyzJob: Rollin' on a River

HUCK'S NEW RIVER RIDE

A wood raft floats in the river. The raft has a volume of 0.58 m^3 and is made of wood having a density of 580 kg/m^3. The deck has an area of 7.6 m^2. (The raft is a rectangular solid with a base whose area is 7.6 m^2 as well.)

1. What is the weight of the raft?

$W_R = m_R g = \rho_R V_R g = 580\ kg/m^3 \cdot 0.58\ m^3 \cdot 9.8\ m/s^2 = 3300\ N$

2. What will be the buoyant force on the *floating* raft?

$B = 3300\ N$

3. What weight of water must be displaced by the raft if it is to float in the water?

$W_W = 3300\ N$

4. What volume of water would that be?

$V_W = m_W/\rho_W = W_W/\rho_W g = 3300\ N\ /\ 1000\ kg \cdot 9.8\ m/s^2 = 0.34\ m^3$

5. How deep must the raft sink into the water so that the raft will displace that volume of water?

$V_W = A_W D_W$

$D_W = V_W/A_W = 0.34\ m^3\ /\ 7.6\ m^2 = 0.044\ m = 4.4\ cm$

When Huck and Jim step on board, the raft sinks an additional 0.02 m.

6. What is the combined mass of the passengers?

$m_P = m_W = \rho_W\ V_W = \rho_W A_W\ D_W = 1000\ kg/m^3 \cdot 7.6\ m^2 \cdot 0.02\ m = 152\ kg$

7. How much *more* of a mass can the raft carry before water washes over the deck?

TOTAL DEPTH OF RAFT:

$V_R = A_R D_R \Rightarrow D_R = V_R/A_R = 0.58\ m^3\ /\ 7.6\ m^2 = 0.076\ m = 7.6\ cm$

SUBMERGED ALREADY: 4.4 cm + 2.0 cm = 6.4 cm

REMAINING TO SUBMERGE: 7.6 cm – 6.4 cm = 1.2 cm = 0.012 m

MASS OF WATER TO BE DISPLACED:

$m_{ADD} = m_W = \rho_W\ V_W = \rho_W A_W\ D_W = 1000\ kg/m^3 \cdot 7.6\ m^2 \cdot 0.012\ m = 91\ kg$

1.3300 N 2.3300 N 3.3300 N 4.0.34 m^3 5.4.4 cm 6.152 kg 7.91 kg