Answer on Question #49850-Physics-Mechanics | Kinematics | Dynamics

A person who weighs $W_1 = 550\ N$ empties her lungs as much as possible and is then completely immersed in water while suspended from a harness. Her apparent weight is now $W_2 = 21.2\ N$.. What is her density?

Solution

The key to this question is buoyancy. If you know that water has a density of $\rho_w = 1000 \frac{kg}{m^3}$, and the ratio weight/mass of water $\frac{W_w}{m_w} = 9.81 \frac{N}{kg}$, then we can determine how much water is displaced, and therefore know the volume of the person. If we know her weight and volume, then we can determine her density.

So, to figure out the amount of water displaced we take

$$W_1 - W_2 = 550N - 21.2N = 528.8\ N = W_w.$$

$$m_w = \frac{W_w}{\left(\frac{W_w}{m_w}\right)} = \frac{528.8\ N}{9.81 \frac{N}{kg}} = 53.9\ kg.$$

The volume of water is amount of water divided by density of water

$$V_w = \frac{53.9kg}{1000 \frac{kg}{m^3}} = 0.0539\ m^3.$$

The volume of water displaced is equal to the volume of the person. We then take the weight of the person $W_1 = 550N$, and divide it by their volume and acceleration of gravity:

$$\rho = \frac{W_1}{gV_w} = \left(\frac{550N}{9.81 \frac{N}{kg} \cdot 0.0539\ m^3} \right) = 1040 \frac{kg}{m^3}.$$

Answer: $\mathbf{1040 \frac{kg}{m^3}}$.