



Flipping Physics Lecture Notes:
Floating Buoyant Force Demonstration
<http://www.flippingphysics.com/buoyant-force-float.html>

We've talked [a lot](#) about the [buoyant force](#) acting on objects [submerged](#) in fluids. Today we are going to look at the buoyant force acting on an object floating in a fluid.

Example: A wooden sphere floats on water. Determine the percentage of the volume of the wood sphere which is below the surface of the water. The density of water is $1.00 \times 10^3 \text{ kg/m}^3$. The density of this wood is 660 kg/m^3 .

Knowns: $\rho_{\text{water}} = \rho_f = 1.00 \times 10^3 \frac{\text{kg}}{\text{m}^3}$; $\rho_{\text{wood}} = \rho_o = 660 \frac{\text{kg}}{\text{m}^3}$; $\frac{V_f}{V_o} = ? (\%)$

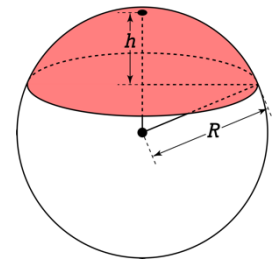
In the free body diagram, the force of gravity is down and the buoyant force is up.

$$\sum F_y = F_B - F_g = m_o a_y = m_o (0) = 0 \Rightarrow F_B = F_g$$

$$\Rightarrow m_f g = m_o g \Rightarrow m_f = m_o \text{ \& } \rho = \frac{m}{V} \Rightarrow m = \rho V \Rightarrow \rho_f V_f = \rho_o V_o$$

$$\text{\& not submerged} \rightarrow V_f \neq V_o \Rightarrow \frac{V_f}{V_o} = \frac{\rho_o}{\rho_f} = \frac{660}{1000} = 0.66$$

So, we have determined that 66% of the wooden sphere is below the surface of the water. Incidentally, that means 34% of the wooden sphere is above the surface of the water.



In order to test this, let's use an equation from Wolfram MathWorld.^{1*}

$$V_{\text{cap}} = \frac{1}{3} \pi h^2 (3R - h)$$

The equation is for a spherical cap:

Knowns:

$$D = 50.7 \text{ mm} \left(\frac{1 \text{ m}}{1000 \text{ mm}} \right) = 0.0507 \text{ m} \Rightarrow R = \frac{D}{2} = \frac{0.0507}{2} = 0.02535 \text{ m}$$

$$h = 2.0 \text{ cm} \left(\frac{1 \text{ m}}{100 \text{ cm}} \right) = 0.02 \text{ m}$$

$$V_o = \frac{4}{3} \pi R^3 = \frac{4}{3} \pi (0.02535)^3 = 6.82374 \times 10^{-5} \text{ m}^3$$

$$\Rightarrow V_{\text{cap}} = \frac{1}{3} \pi (0.02)^2 ((3)(0.02535) - 0.02) = 2.34782 \times 10^{-5} \text{ m}^3$$

^{1*} Wolfram MathWorld – [Spherical Cap](#)

$$\frac{V_{\text{cap}}}{V_o} = \frac{2.34782 \times 10^{-5}}{6.82374 \times 10^{-5}} = 0.3441 \approx 0.34 \Rightarrow 34\%$$

We just showed that 34% of the wood sphere is above the surface of the water. That matches our prediction. The physics works!