Hollow Hulls and Average Density

Explain why a steel hull can float

Name _____ Period _____ Date _____

Compare solid steel with a sealed hollow hull, then test how wall thickness affects floating.

About 25 to 30 minutes | buildphysics.com/?experiment=fluid-hollow-hull

Compare solid and hollow steel

1. Keep Hull material density at 7800 kg/m³, Liquid density at 1000 kg/m³, and Hull wall thickness at 0.010 m.

2. Click Play. Once the solid steel reaches the bottom, Pause.

What happened to the solid steel and the sealed hollow hull?

Change the hull walls

3. Select Sealed steel hull and open Fluid properties. For each thickness below, set Hull wall thickness in Explore this setup, then click Set floating position.

4. Read Mass in the hull's object properties and Submerged fraction in Fluid properties. Round mass to the nearest 0.1 kg.

Wall thickness (m)	Hull mass (kg)	Average density (kg/m³)	Submerged fraction (%)
0.006			
0.010			

5. The hull's outside volume stays at 0.250 m³. Calculate average density for both rows using $\rho = m/V$.

Show one average-density calculation. Why does average density change even though the steel material density stays the same?

Predict when the hull will sink

6. Set Hull wall thickness to 0.020 m while paused. Read the new mass. The outside volume is still 0.250 m³.

Calculate the hull's average density. Predict whether it will float or sink in water of density 1000 kg/m³. Explain.

7. Click Play and observe the hull, then Pause.

What happened? How does the result compare with your prediction?

Use displaced water to explain floating

8. Return Hull wall thickness to 0.010 m and click Set floating position. For water, use ρ = 1000 kg/m³. At rest, buoyant force balances the hull's weight.

$$F_B = \rho g V_{sub} \qquad W = mg$$

Here Vsub is the volume of the hull below the water surface.

Use the hull's mass to calculate the volume of water it must displace. Divide by 0.250 m³ and multiply by 100 to predict the percentage submerged. Compare with the displayed value.

9. Why can the hollow hull float while the solid steel sinks? Use mass and outside volume in your explanation.