

Ch 13 Fluids

Season 1 Episode 1 - **HYDROSTATICS**

In this episode of LARC Physics 3B, we're going to . . .

- Create a foundation to evaluate/predict fluid motion by first considering fluids at rest.
- Applying relevant concepts/equations, we can answer questions like:
 - Will this object sink or float? How deep can a submarine go? How many helium balloons does one need to fly? Is water wet?

Guided Practice

Within an open container, a 50 cm thick layer of oil floats on a 120 cm layer of water. What is the pressure at the bottom of the water layer?

Useful info: $\rho_{oil} = 900 \text{ kg/m}^3$

Answer: $P = 1.2 \times 10^5 \text{ Pa} \approx 1.2 \text{ atm}$

A geologist finds that a Moon rock whose mass is 9.28 kg has an apparent mass of 6.18 kg when submerged in water. Find the

- (a) Density of the rock (kg/m^3)
- (b) Specific gravity of the rock

Answer: $\rho_{rock} = 2990 \text{ kg/m}^3$

Breakout-Room Activity

A research submarine has a 20 cm diameter window. The manufacturer says the window can withstand forces up to 1.0×10^6 N. What is the submarine's maximum safe depth? Assume the pressure maintained inside the submarine is 1 atm.

Answer: depth ≈ 3 km

A crane lifts the 16 000 kg steel hull of a sunken ship out of the water. Accounting for the buoyant force in both cases, find the tension in the crane's cable when

- (a) the hull is completely out of the water
- (b) the hull is fully submerged in the water.

Useful info: $\rho_{steel} = 7.8 \times 10^3 \text{ kg/m}^3$, $\rho_{air} = 1.29 \text{ kg/m}^3$

Answer: (a) $T \approx 1.57 \times 10^5 \text{ N}$ (b) $T \approx 1.37 \times 10^5 \text{ N}$

Challenge Activity

Your LARC tutor weighs approximately 75 kg (on a good day :P). Suppose one helium balloon occupies volume $V = 15 \text{ L}$. How many helium balloons would you buy so that your LARC tutor can fly?

Useful info: $1 \text{ m}^3 = 1000 \text{ L}$, $\rho_{air} = 1.29 \text{ kg/m}^3$, $\rho_{He} = 0.179 \text{ kg/m}^3$

Answer: At least 4500 helium balloons to achieve human flight.