Lecture 28, Nov 17, 2022

Buoyancy and Archimedes' Principle

- Buoyant force is caused by the increase of pressure with depth
- Parts of an object that are submerged deeper experience higher pressure, which gives a net upward force

> **Theorem**
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> Archimedes' Principle: The buoyant force acting on a submerged body is equal to the weight of the fluid displaced by the solid body, acting in the direction opposite to gravity:
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> $$\vec{F}_B = \rho_{\text{fluid}} g V \vec{k}$$

- Note that the buoyant force is independent of the density of the object or how deep it is
- For any solid submerged object, consider a region of fluid in the same shape; the region of fluid is in static equilibrium, so its buoyant force should be equal to its weight
    - The buoyant force of the fluid is the same as that of the solid body since they have the same volume
    - Therefore the buoyant force on the object is the same as the weight of the fluid displaced
- For a floating body, the buoyant force caused by the submerged region is in balance with the weight of the body
- If $\rho_b < \rho_f$, the body floats because a partially submerged body displaces more weight of the fluid than the weight of the body
- If $\rho_b = \rho_f$, the body is neutrally buoyant and will be suspended in the fluid
- If $\rho_b > \rho_f$, the body sinks because the buoyant force never matches the weight of the body, even when the entire body is submerged
- Note the buoyant force is proportional to the fluid density, so buoyant forces in gases are usually negligible