Pascal's Principle

Pressure applied to an enclosed fluid is transmitted to every point of the fluid, and to the walls of the containing vessel.

\[
P_1 = P_2 \\
\frac{F_1}{A_1} = \frac{F_2}{A_2} \\
\frac{F_1}{A_1} = \frac{F_e}{A_2}
\]

Bouyant Force and Archimedes Principle

Bouyant Force - Upward force on object by a fluid
- Just like normal force, bouyant force has nothing to do with the weight of the object!!!
- However, if an object is floating and has no vertical acceleration, \( F_B = mg \) (see FBD)
Archimedes's Principle - Any body completely or partially submerged in a fluid is buoyed up by a force equal to the weight of the fluid displaced by the body.

Displacement - Equivalent volume of fluid a submerged object occupies.

\[ F_B = (m_{\text{fluid}})g \]
\[ F_B = (\rho_f V_A)g \]

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**Floating Object**

\[ F_B = F_g \]
\[ \rho_f v_f g = m_{\text{object}} g \]
\[ \rho_f v_f = \rho_{\text{ob}} V_{\text{ob}} \]
\[ \rho_{\text{ob}} = \frac{\rho_f}{V_{\text{ob}}/V_f} \]

**Submerged Object**

\[ V_f = V_{\text{ob}} \]
\[ F_{\text{net}} = F_B - F_{g\text{object}} \]
\[ = \rho_f v_f g - \rho_{\text{ob}} V_{\text{ob}} g \]
\[ = (\rho_f - \rho_{\text{ob}}) V_f g \]

.: If \( \rho_f > \rho_{\text{ob}} \) then object will rise.

.: If \( \rho_f < \rho_{\text{ob}} \) then object will sink.
Pressure Measurement Devices

Barometer

Pressure = 0 (perfect vacuum)

At point "A" inside tube, the weight of the mercury above the point balances the air pressure from below, so that \( F_{\text{net}} = 0 \).

\[
F_{\text{net}} = P_o A - \rho g A h = 0
\]

\[
P_o A - \rho g A h = 0
\]

\[
P_o = \rho g h
\]

\[\vdash\] We can correlate the height of the mercury to the atmospheric pressure.

\[\vdash\] A barometer measures atmospheric pressure, \( P_o \). This is an absolute pressure.

Absolute Pressure - Pressure measured with a complete vacuum as a reference point.

\[
P_o = 1.01 \times 10^5 \text{ Pa}
\]

\[= 1 \text{ atm}
\]

\[= 760 \text{ mm of Mercury}
\]

\[= 32 \text{ feet of water}! \text{ (this is why you never see a water barometer)}
\]
Open-tube manometer

\[ P = P_0 + \rho gh \]

\[ \text{Height is proportional to the difference between } P \text{ and } P_0. \]

Open-tube manometer's can therefore measure gauge pressure.

Gauge Pressure - Pressure measured with atmospheric as a reference point.

Example - If we constructed a simple manometer with a U-shaped glass tube, and filled it with both water and oil, what would happen?

\[ P_A = P_B \]
\[ P_0 + \rho_{\text{oil}} gh_{\text{oil}} = P_0 + \rho_{\text{water}} gh_{\text{water}} \]
\[ \frac{h_{\text{oil}}}{h_{\text{water}}} = \frac{\rho_{\text{water}}}{\rho_{\text{oil}}} \]