Two Intrinsic Quantities:

1) Density: \( \frac{\text{mass}}{\text{volume}} = \rho \)

which weighs more, a pound of feathers or a pound of lead?

neither, but lead is more dense

\( \frac{g}{cm^3} \rightarrow \text{"cgs"} \rightarrow \frac{kg}{m^3} \text{ mks} \)

we use this

\[ 1 \ \frac{g}{cm^3} = \frac{10^{-3}}{(10^{-2} \frac{m}{cm})^3} \times 1 \ \frac{g}{cm^3} \]

\[ 1 \ \frac{g}{cm^3} = 1000 \ \frac{kg}{m^3} \]

Air \( \rho \approx 1.2 \ \frac{kg}{m^3} \) (1)
(roomful \( \approx 72 \ kg \) !)

Liquids \( \rho \approx 10^3 \ \frac{kg}{m^3} \)

Solids: Lead \( \approx 11 \ \frac{kg}{m^3} \) Gold \( \approx 19 \ \frac{kg}{m^3} \)
2) Pressure: \[ PV = nRT \]

\[
\frac{\text{Force}}{\text{Area}} \rightarrow \text{direction of force is \textbf{\perp} to area}
\]

\[
P = \frac{|\vec{F}|}{A}
\]

\[
P' = \frac{|\vec{F}'|}{A'}
\]

units: \( \frac{N}{m^2} = \text{Pascal, "very small"} \)

\(1\text{ atm} \approx 10^5 \text{ Pa} \approx 1 "\text{bar}"
\approx 15 \frac{\text{lb}}{\text{in}^2}\)

Pressure versus depth in a fluid

Swimming: go deep, your ears hurt!
Qualitative:

atmosphere

~ Mt Everest
~ 30,000 ft
~ 10 km ~ 10^4 m

earth

\{ \text{column of air above you} \}
\text{pressure hear related to height}

Estimate

\[ W = \frac{p(Ah) \cdot g}{\text{mass}} \]

\[ p = \frac{W}{A} \approx 1.2 \cdot 10^4 \cdot 10 \text{ kg/m}^3 \text{ m m/s}^2 \]

\[ p \approx 1.2 \cdot 10^5 \frac{N}{\text{m}^2} \]

Pressure "Turns Around" in Ideal Fluids in fact a little higher!
Atmosphere: compressible gases.

Water: incompressible (nearly)

Pascal's Principle: Additional pressure applied to an incompressible fluid is transmitted undiminished to every portion of the fluid.

Basis of Hydraulics:

\[ F_2 = A_2 P_2 = (\frac{A_2}{A_1}) F_1 \]

What about work?