Solid	Liquid	Gas
• fixed volume • fixed shape	fixed volume not fixed shape	not fixed volume not fixed shape

fluid

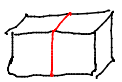
Density (or mass density)

$$\rho = \frac{M}{V}$$ (rho)

mass / volume

$\frac{kg}{m^3}$

e.g.



$M = 2kg$

$V = 0.02 m^3$

$\rho = \frac{2}{0.02} = 100 \frac{kg}{m^3}$

$\frac{1 kg}{0.01 m^3}$

$= 100 \frac{kg}{m^3}$

What is density of half?

A) $50 \frac{kg}{m^3}$

B) $100 \frac{kg}{m^3}$

C) $200 \frac{kg}{m^3}$

Density is a property of material -

e.g. Pure water at 4°C

$\rho = 1 g/cm^3 = 1000 \frac{kg}{m^3}$

oil $\rho = 900 \frac{kg}{m^3}$

rock $\rho \approx 2500 \frac{kg}{m^3}$

steel $\rho = 8000 \frac{kg}{m^3}$

styrofoam $\rho = 40 \frac{kg}{m^3}$

gases can change density to expand to fill containers

air $\rho = 1.2 \frac{kg}{m^3}$

Pressure $P = \frac{F}{A}$ (applied perpendicular to surface)

Units $1 \frac{N}{m^2} = 1$ Pascal (Pa)

(1 PSI ≈ 7000 Pa)

Fluids exert a pressure in all directions

e.g. air is pushing on every surface

$P_0 = 1.01 \times 10^5$ Pa $= 1$ atm

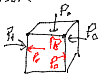
atmospheric pressure

e.g. my head has $A = 0.03 m^2$

$F = PA = (1.01 \times 10^5 Pa)(0.03 m^2)$

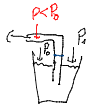
$= 3000 N$ (3x my weight)

Fortunately, my body has an internal pressure which balances this

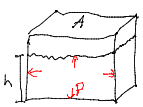


When I go in airplane, air pressure drops, my internal pressure is too large, ears pop to rebalance

Suction: remove air from one side allowing external pressure to work without obstruction

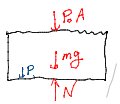


straw: get the air in the straw out of the way so atmosphere can push drink into your mouth



What is pressure on the bottom of tank?

Force diagram for water



$N = P_0 A + mg$

$PA = P_0 A + \rho A h g$

$P = P_0 + \rho g h$

force of tank on water: N

force of water on tank: PA

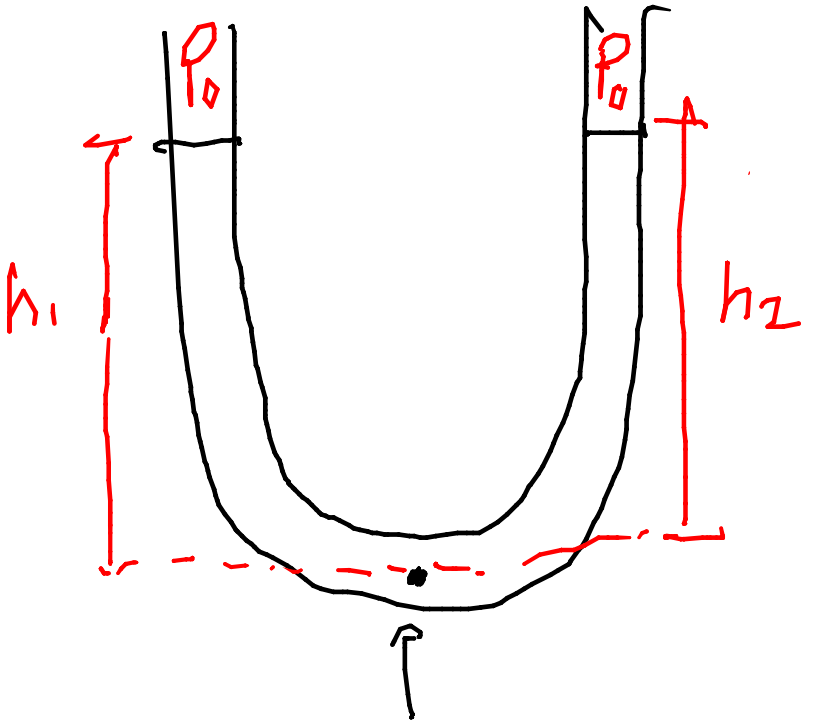
= due to N3L

Pressure in any fluid

$P = P_0 + \rho_{fluid} g h$

absolute pressure

$P - P_{atm}$ = gauge pressure (e.g. fill up tires)



$$p = p_0 + \rho g h_1 = p_0 + \rho g h_2$$

$$h_1 = h_2$$