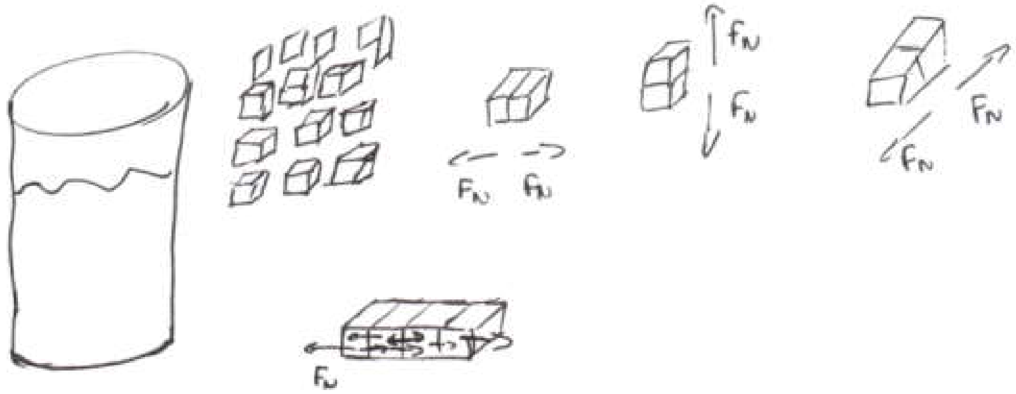
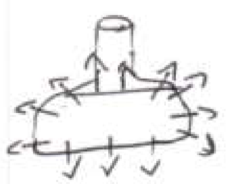
Ch. 13 Fluids

pressure $= \dfrac{\text{force}}{\text{area}}$

incompressible fluid at rest, like still water → You have a bunch of normal forces, and they all cancel out, except on the surface



P is not a vector because it "points in many directions"

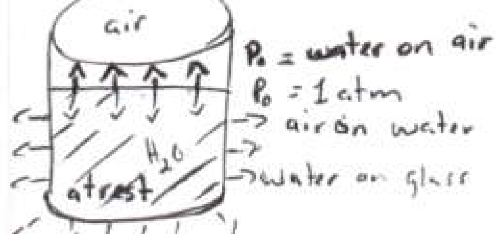


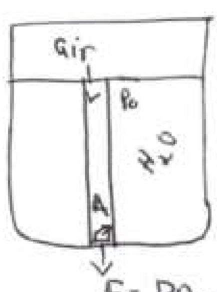
air

$P = 1\,\text{atm} = 1.013 \times 10^5\ N/m^2$

$= 14.7\ \text{pounds}/\text{in}^2$

open top





V = Volume

$mg = \rho_{H_2O} V g$

$F = PA = P_0 A + \boxed{\text{weight of } H_2O \text{ above you}}$

$\rightarrow \rho_{H_2O} A h g$

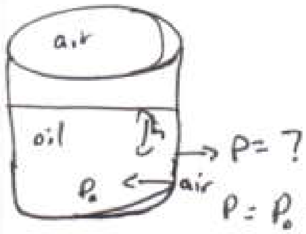
$P_0 A + \rho_{H_2O} A h g = \underbrace{(P_0 + \rho_{H_2O} h g)}_{\text{absolute pressure}} A$

pressure $P = \dfrac{F}{A}$ $\dfrac{\text{force}}{\text{area}}$

density $\rho = \dfrac{m}{V}$ $\dfrac{\text{mass}}{\text{volume}}$

"rho"

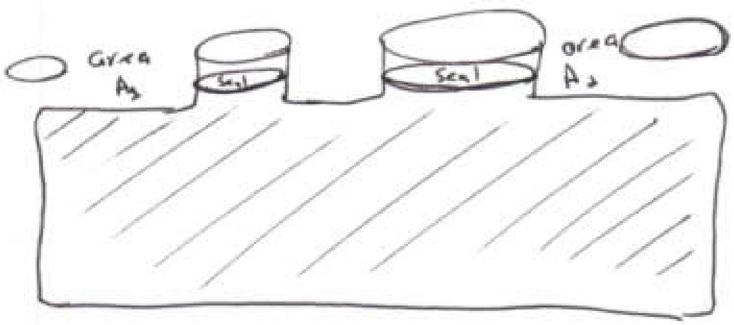
$\rho_{H_2O} = 1.00 \times 10^3\ kg/m^3 = 1.00\ \text{grams}/cm^3$



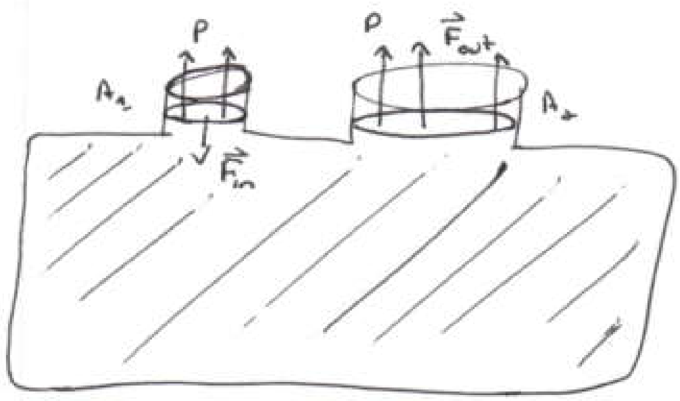
$P = P_0 + \underbrace{\rho_{oil} h g}_{\text{gauge pressure}}$

net pressure $= \rho_{oil} h g$

PASCAL'S PRINCIPLE:



- If external pressure is applied to a confined fluid, the pressure increases equally everywhere.



P's approx the same if heights approx the same

$$\left.\begin{aligned} F_{in} &= P A_1 \\ F_{out} &= P A_2 \end{aligned}\right\} \frac{F_{in}}{A_1} = P = \frac{F_{out}}{A_2} \Rightarrow \frac{F_{out}}{F_{in}} = \frac{A_2}{A_1}$$

mechanical advantage

$A_2 > A_1 \Rightarrow F_{out} > F_{in}$

Archimede's Principle:

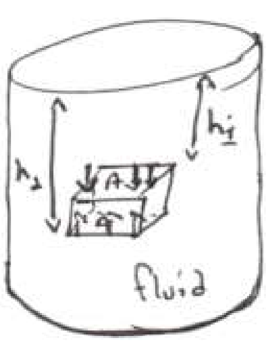
Buoyant force = weight of fluid displaced

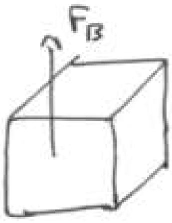
$F_1 = AP_1$

$P_1 = \rho_{fl} h_1 g + P_0$

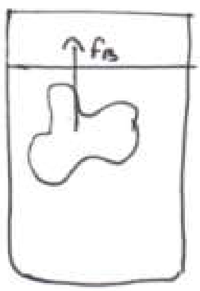
$P_2 = \rho_{fl} h_2 g + P_0$

$F_2 = AP_2$



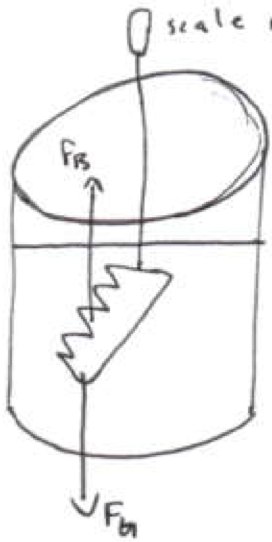


$$F_B = F_2 - F_1 = A(P_2 - P_1)$$
$$= A(\rho_{fl} h_2 g + P_0 - (\rho_{fl} h_1 g + P_0))$$
$$= \rho_{fl}\, g A (h_2 - h_1)$$



$$m_{fl}^{disp} g = \underbrace{\rho_{fl}\, g V}_{\text{weight of displaced fluid}}$$

$F_B = \rho_{fl}\, g V$
here too.



scale reads $F_T = F_G - F_B = (\rho_{crown} - \rho_{fl}) g V$

$F_B = \rho_{fl}\, g V$

$F_G = m_{crown}\, g = \rho_{crown}\, g V$

$$\frac{F_T}{F_T^*} = \frac{(\rho_{crown} - \rho_{fl}) g V}{\rho_{crown}\, g V} = \frac{\rho_{crown}}{\rho_{crown}} - \frac{\rho_{fl}}{\rho_{crown}} = 1 - \frac{\rho_{fl}}{\rho_{crown}}$$

scale reads $F_T^* = \rho_{crown}\, g V$

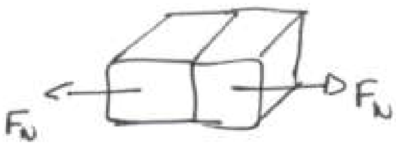
$$\frac{F_T}{F_T^*} = 1 - \frac{\rho_{fl}}{\rho_{crown}} \Rightarrow \frac{\rho_{fl}}{\rho_{crown}} = \frac{F_T^* - F_T}{F_T^*} \Rightarrow \boxed{\frac{\rho_{crown}}{\rho_{H_2O}} = \frac{F_T^*}{F_T^* - F_T}}$$

using water

- $\frac{\rho}{\rho_{H_2O}}$ called specific gravity (SG)

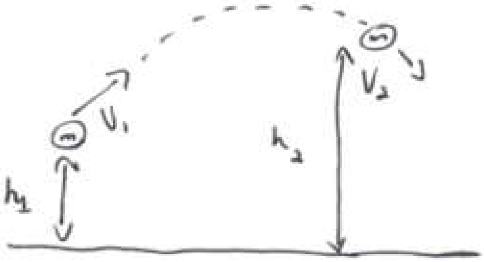
Archimedes's Principle

Newton's 3rd Law applied to fluids: Pascal's Principle



Conservation of energy applied to fluids:

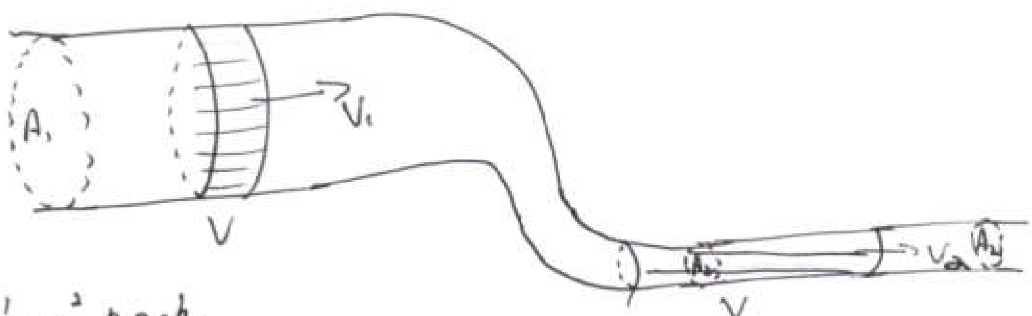
throwing a ball



$$E_1 = E_2 = \frac{1}{2}mv_1^2 + mgh_1 = \frac{1}{2}mv_2^2 + mgh_2$$

Bernoulli's Principle:

$$\frac{E_1}{V} = \frac{E_2}{V}$$



$$\parallel$$

$$P_1 + \frac{1}{2}\rho v_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2$$

Continuity Principle: (conservation of mass)

$$\rho_1 A_1 v_1 = \frac{m_1}{\Delta t} = \frac{m_2}{\Delta t} = \rho_2 A_2 v_2$$

(In case density change. Usually they don't)