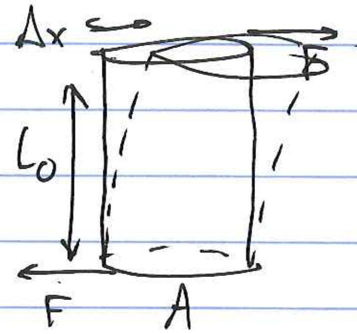
* Fluids (statics)
  - no resistance to deformation (ideal fluid)
  - yields to shear forces : shear modulus is zero



$$\frac{F}{A} = S\,\frac{\Delta x}{L_0}$$

$F = 0 \rightarrow S = 0$

no force F required for any Δx

Examples : liquids, gasses, glasses

* Two quantities that describe the static fluid

  1) Pressure P

  2) Density ρ

* Density : $\rho = \dfrac{M}{V} = \dfrac{\text{mass}}{\text{volume}}$ in units $\dfrac{kg}{m^3}$

H_2O : $1000\ kg/m^3 = 1\ kg/dm^3 = 1\ g/cm^3$

dm^3 = definition liter

float / sink

air : $1.29\ kg/m^3$

blood : $1060\ kg/m^3$

ice : $920\ kg/m^3$

$\rho_{object} < \rho_{liquid}$: float

$\rho_{object} > \rho_{liquid}$: sink

ρ neutron star: $5 \times 10^{17}\ kg/m^3$ ~ inside nucleus of an atom

$$s.g. = \text{specific gravity} = \frac{\rho}{\rho_{H_2O}}$$

$$\text{ice: } s.g. = \frac{920\ kg/m^3}{1000\ kg/m^3} = 0.920$$

$$\text{blood: } s.g. = 1.060$$

$s.g. < 1$: object float on water

* Pressure: $\underline{P = \frac{F}{A}} = \frac{\text{force}}{\text{area}}$ in units $\underline{\frac{N}{m^2}} = Pa$

Blaise Pascal: - first mechanical calculator
(1623-1662) - hydraulic presses

Other units of pressure: $\underline{1\ atm} = 101.3\ kPa$ // bar
$= 1.013 \times 10^5\ Pa$
$\underbrace{\pm 0.07 \times 10^5\ Pa}_{\text{weather}}$

$1\ atm = \underline{14.7}\ lbs/in^2$ (psi) → psia =

$= 760\ Torr = 760\ mm\ Hg$

Alternate definitions of density:

$$s.g. = \text{specific gravity} = \frac{\rho}{\rho_{H_2O}} \rightarrow \text{ice has } s.g. = 0.920$$

An object will float if $\rho_{object} < \rho_{liquid}$ → ice floats in water

* Pressure:

$$P = \frac{F}{A} = \frac{\text{force}}{\text{area}} \text{ in units } \frac{N}{m^2} = Pa, \text{ Pascal}$$

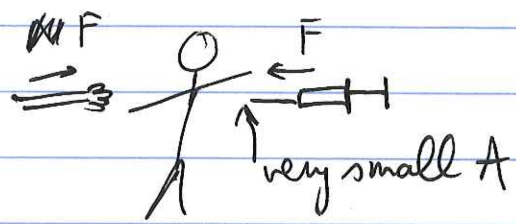
Blaise Pascal, 1623-1662, French math/phys/phil/inventor
- first mechanical calculator
- hydraulic press

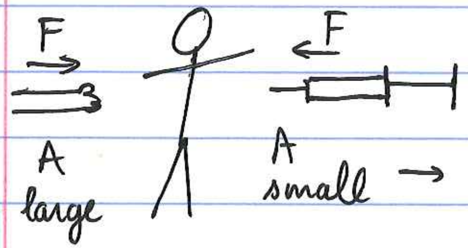
Other units of pressure: 1 atm = 101.3 kPa

$$= 1.013 \times 10^5 \, Pa \; \underbrace{\pm 0.07 \times 10^5 \, Pa}_{\text{weather}}$$

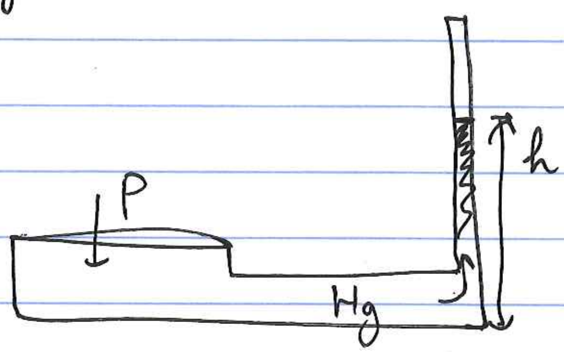
$$1 \text{ atm} = 14.7 \, lbs/in^2 \text{ (psi)}$$
$$= 760 \text{ Torr} = 760 \text{ mm Hg}$$
$$= 1.013 \text{ bar}$$

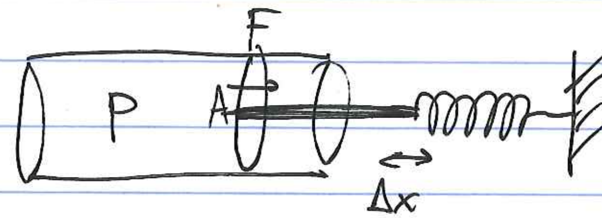
A smaller area with the same force → larger pressure





small $\rightarrow$ P large

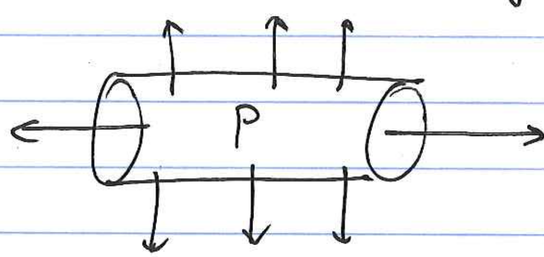


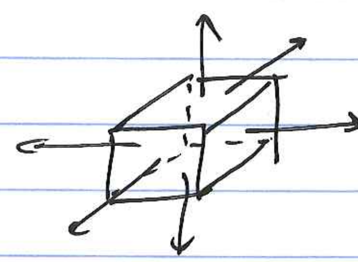


$$F = P.A = k\Delta x$$

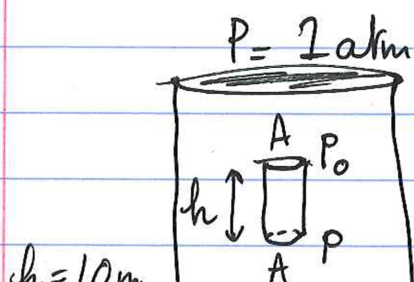
$$P = \frac{k\Delta x}{A}$$

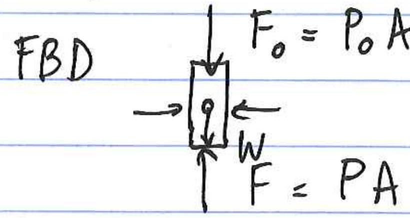
* Force due to pressure is always in the perpendicular direction to the surface





* Fluids under gravity: pressure will increase with depth



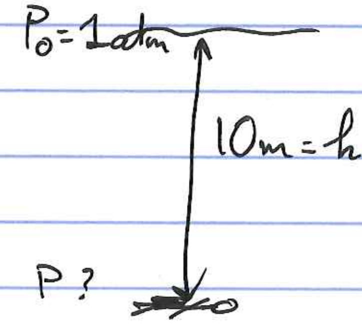


$$W = mg = \rho V g = \rho A h g$$

$$F_{net} = 0 = PA - P_0 A - \rho A h g = 0$$

$$\hookrightarrow \underline{P = P_0 + \rho g h}$$

What's the pressure when you are 10 m under water?



$$\underset{\uparrow\atop 10m}{P} = \underset{\uparrow}{P_0} + \rho g h$$

$$= 10^5\,Pa + (1000\,kg/m^3)(10\,m/s^2) \times (10\,m) \qquad P\,?$$

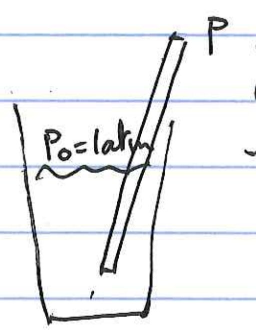
$$= 10^5\,Pa + 10^5\,Pa = \underline{2 \times 10^5\,Pa}$$

$$760\,mm\,Hg = 0.76\,m\,Hg$$

$$\rho_{Hg} = 13.6 \times \rho_{H_2O}$$

What is the <u>additional force</u> on the eardrum, $A = 1\,cm^2$?

$$F = P \cdot A = (10^5\,Pa)(\underset{10^{-4}\,m^2}{0.0001\,m^2}) = \underset{10\,N}{10\,Pa \cdot m^2}$$



$$\}\ \rho g h = (1000\,kg/m^3)(10\,m/s^2)(0.1\,m)$$

$$= \underline{1000\,Pa}$$

* Pascal's principle:

Pressure everywhere at same depth will be the same.