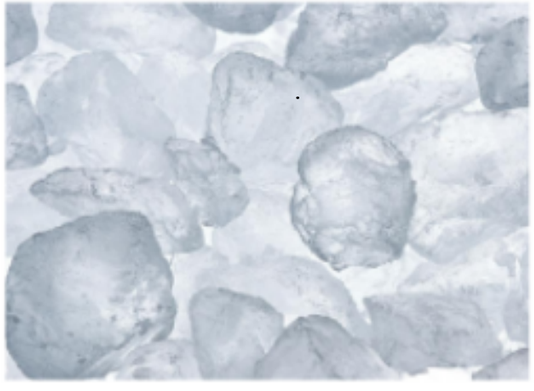
FASI DELLA MATERIA

GAS

LIQUIDO



CRISTALLO

Particella

$\{ m, \vec{r}, \vec{v} \}$

↙ Corpo macroscopico ↘

$\{ m_1, \vec{r}_1, \vec{v}_1, \dots, m_N, \vec{r}_N, \vec{v}_N \}$

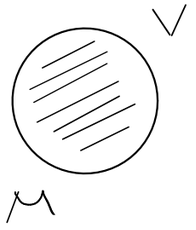
Variabili di stato

Numero di Avogadro : $N_A = 6{,}022 \times 10^{23}\ mol^{-1}$

Numero di particelle : N — macroscopico $N \approx 10^{23}$

Quantità di sostanza : n SI : mol — $n \approx 1$ mol

DENSITÀ



$\rho \equiv \frac{M}{V}$ densità

$\rho_N \equiv \frac{N}{V}$ densità di numero

$M_A \equiv \frac{M}{n}$ massa molare

$M_A[C] = 12{,}01 \frac{g}{mol}$

Es.: calcola la massa molare M_A dell'acqua

$$M_A[H_2O] = 1.01 \times 2 \frac{g}{mol} + 16 \frac{g}{mol} = 18{,}02 \frac{g}{mol}$$

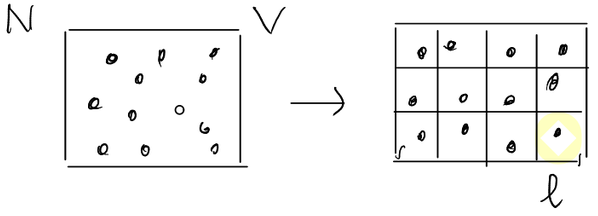
Differenza tra liquido e gas

→ densità !

Liquido : $\rho \approx 10^3 \frac{Kg}{m^3}$ — $10^4 \frac{kg}{m^3}$

Gas : $\rho \approx 1 \frac{Kg}{m^3}$

Es.: calcola l'ordine di grandezza della distanza tra atomi vicini in 1) un liquido e 2) in un gas.



$$M = M_A n = M_A \frac{N}{N_A}$$

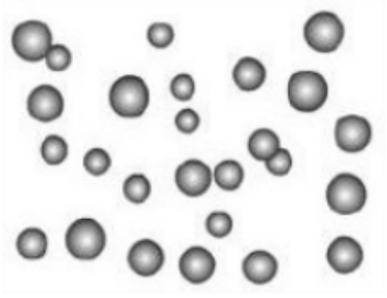
$$\rho = \frac{M}{V} = \frac{M}{l^3 \cdot N} = \frac{M_A \cancel{N}}{N_A l^3 \cancel{N}} = \frac{M_A}{N_A l^3}$$

$$l = \sqrt[3]{\frac{M_A}{\rho N_A}} \qquad H_2O: \quad M_A = 18 \frac{g}{mol} = 18 \times 10^{-3} \frac{kg}{mol} \qquad l \sim \rho^{-1/3}$$

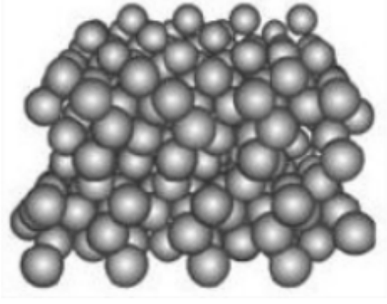
$$l = \left(\frac{18 \times 10^{-3} \ kg/mol}{10^3 \ kg/m^3 \times 6 \times 10^{23} \ mol^{-1}} \right)^{1/3} \approx 3 \times 10^{-10} \ m = 3 \ \text{Å} \qquad \rho = 10^3 \frac{kg}{m^3} \rightarrow \rho' = 10^{-3} \rho$$

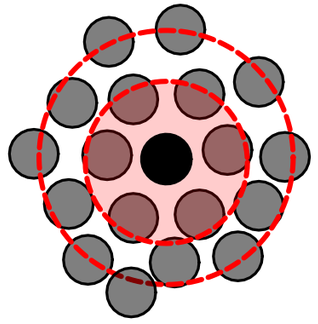
$$l \rightarrow l' = 10 \, l \approx 3 \times 10^{-9} \ m$$

gas



liquido





→ ordine a corto raggio

Differenza tra liquido e solido

Solido → rigido

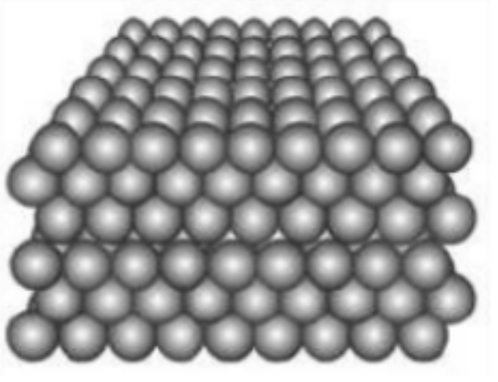
liquido → scorre / fluisce

⚠ visco-elasticità

Solidi cristallini → ordine lungo raggio

es: NaCl

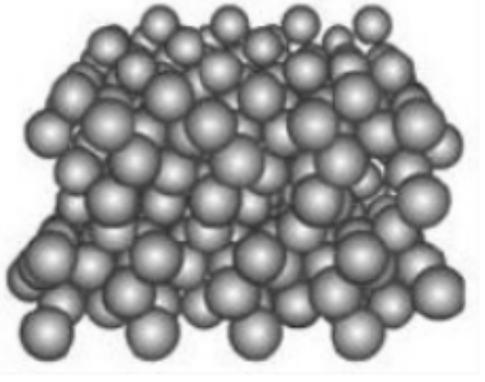
SiO_2 quarzo

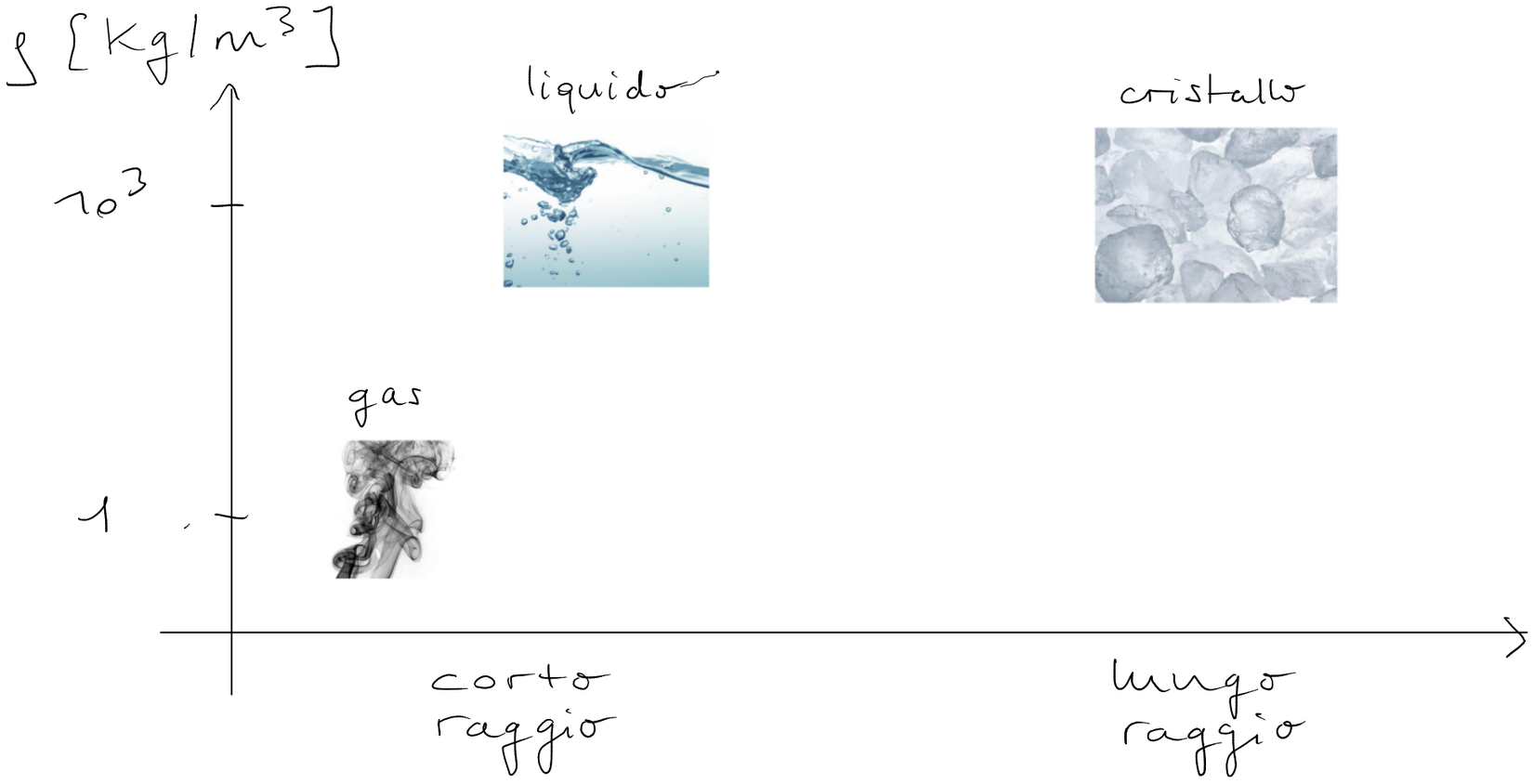


Solidi amorfi

es: vulcanici

SiO_2 amorfa





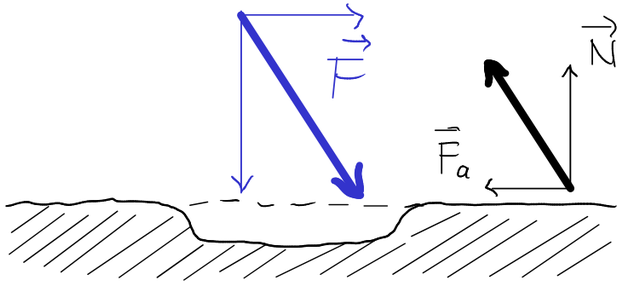
$\rho_{cristallo} > \rho_{liquido}$

ma eccezioni: H_2O

PRESSIONE

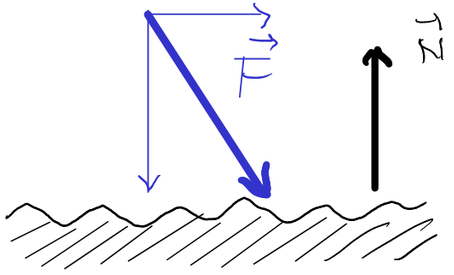
Es: $P_{atm} = 1024\ hPa = 1024 \times 100\ Pa = 1.024 \times 10^5\ Pa$

Es: $P = 2\ bar$



Solido

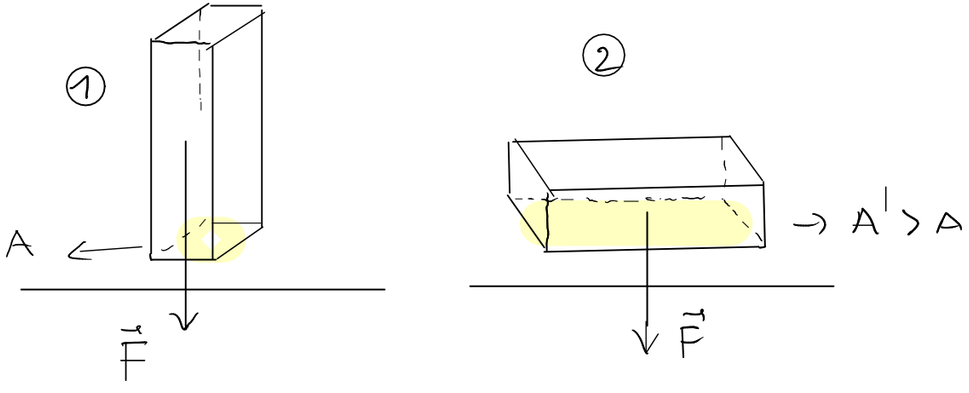
forze contatto normali + tangenziali



fluido

forza normale

→ forze normali alle superfici

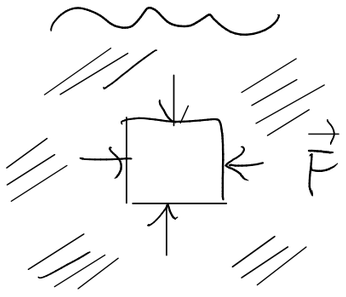


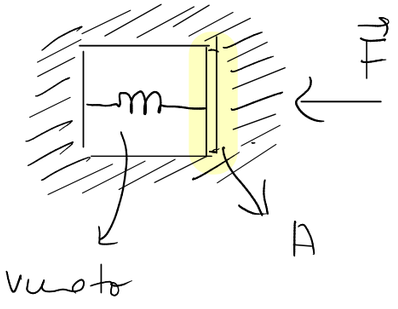
Pressione : $P \equiv \frac{|\vec{F}|}{A}$ Scalare

SI: $\frac{N}{m^2} \equiv Pa$ ⟶ Pascal

Pressione nei fluidi

definizione operativa

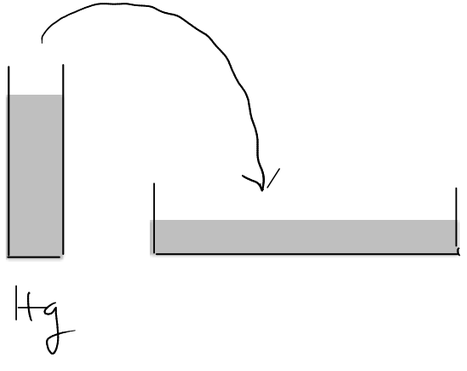


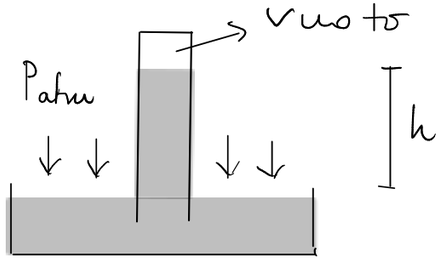


$$p \equiv \frac{|\vec{F}|}{A}$$

manometro

~1600 : Torricelli misura pressione atmosferica





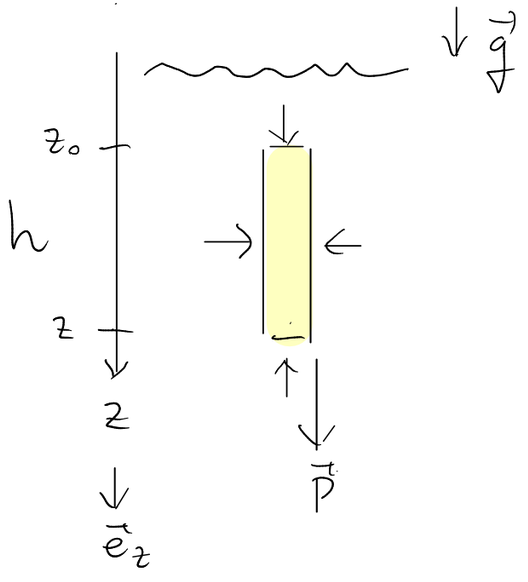
$P_{atm} = 760$ mmHg $= 1{,}013 \times 10^5$ Pa $\equiv 1$ atm

$\rho = 13{,}6 \times 10^3 \frac{kg}{m^3}$

1 bar $= 10^5$ Pa

→ Stevino

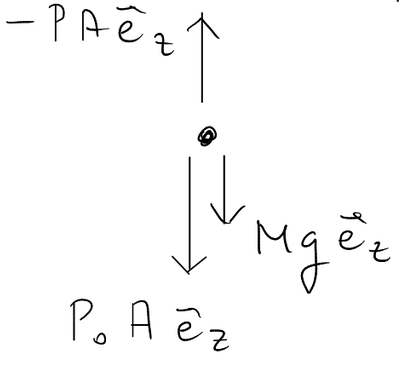
Fluido, densità costante ρ (incompressibile)



Eq. meccanico: $\sum \vec{F} = \vec{0}$ fluido a riposo

Forze: forze dovute a pressione fluido circostante

peso



$$P_0 A - P A + Mg = 0$$

$$P = P_0 + \frac{M}{A} g = P_0 + \rho \frac{V}{A} g$$

$$P = P_0 + \rho g h = P_0 + \rho g (z - z_0)$$

↓

legge di Stevino

$$P = \underset{=0}{P_0} + \rho g h = 13 \times 10^3 \frac{kg}{m^3} \times 9.81 \frac{m}{s^2} \times 0.76\ m = 1.013 \times 10^5\ Pa$$