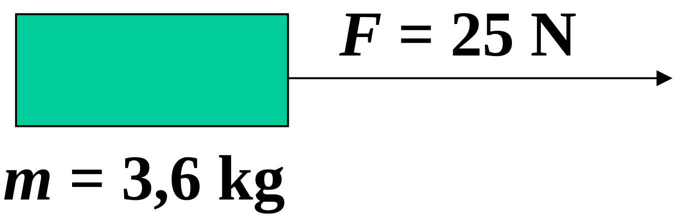
TEKOČINE

togo telo: ***m* , *F***



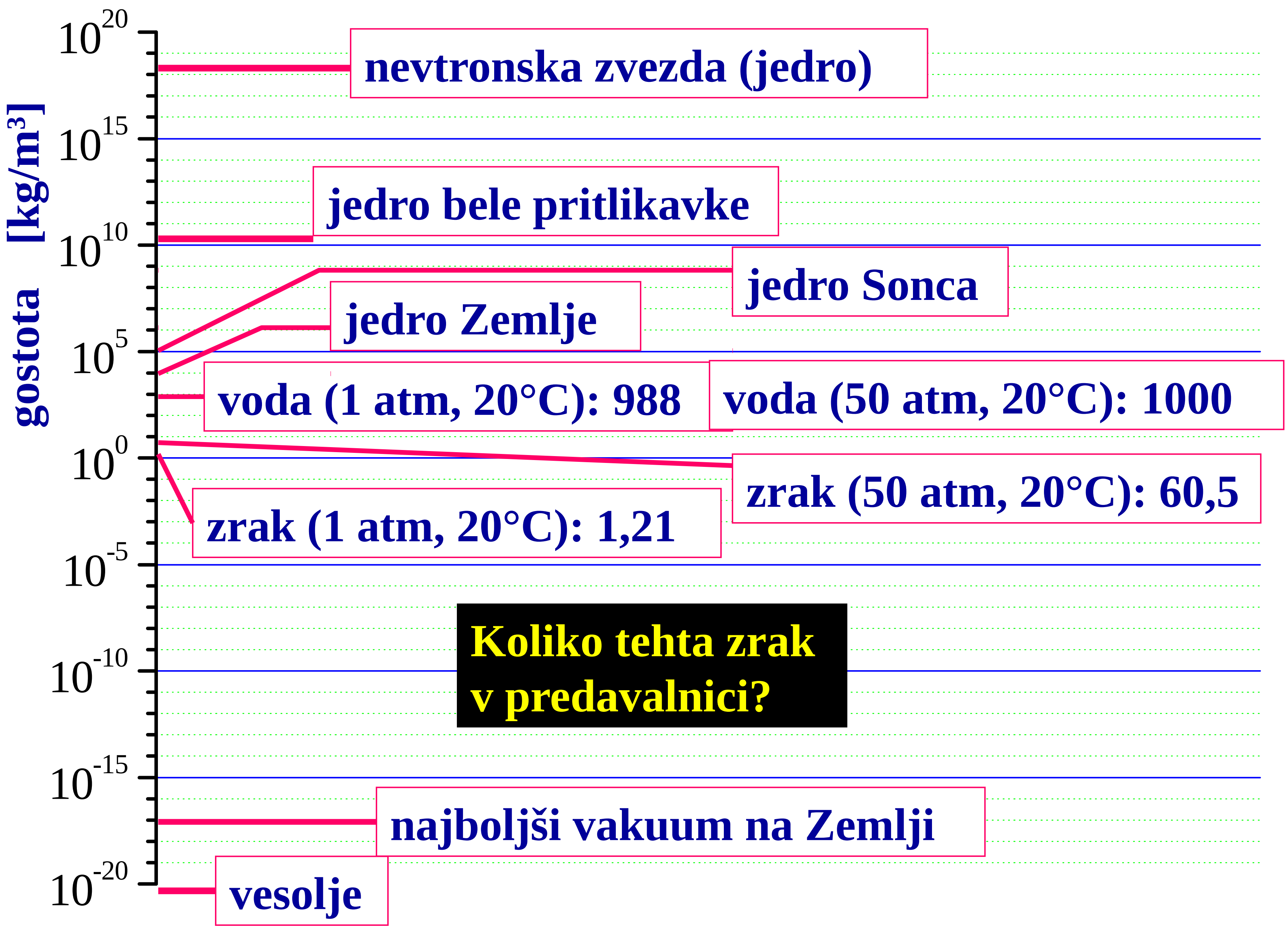
tekočina: **gostota , tlak**

GOSTOTA

$$\rho = \frac{\Delta m}{\Delta V} \quad \left[\frac{\mathrm{kg}}{\mathrm{m}^3} \right]$$

homogen vzorec

$$\rho = \frac{m}{V}$$


gostota [kg/m³]
10^20
10^15
10^10
10^5
10^0
10^-5
10^-10
10^-15
10^-20
nevtronska zvezda (jedro)
jedro bele pritlikavke
jedro Sonca
jedro Zemlje
voda (1 atm, 20°C): 988
voda (50 atm, 20°C): 1000
zrak (50 atm, 20°C): 60,5
zrak (1 atm, 20°C): 1,21
Koliko tehta zrak
v predavalnici?
najboljši vakuum na Zemlji
vesolje

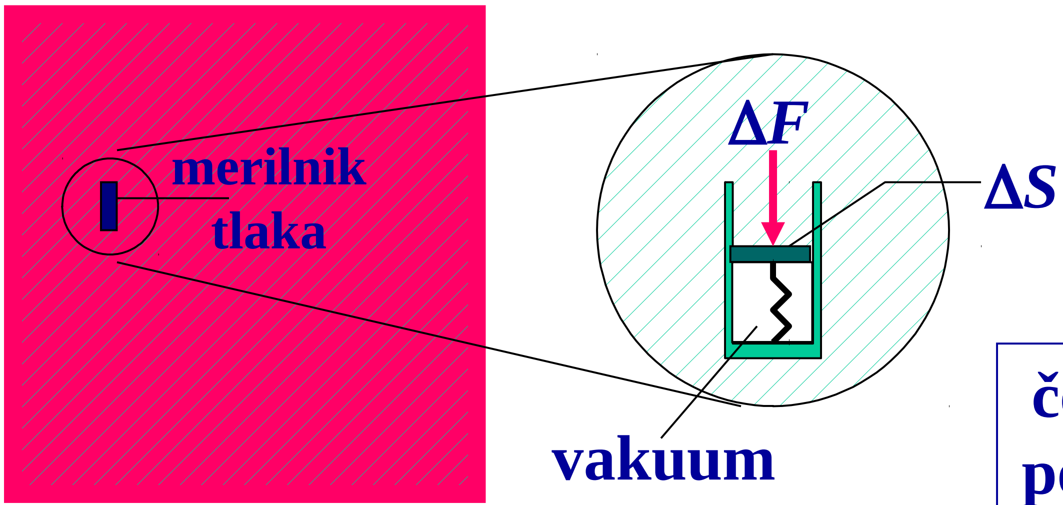
GOSTOTA

$$\rho = \frac{\Delta m}{\Delta V} \quad \left[\frac{\mathrm{kg}}{\mathrm{m}^3}\right]$$

homogen vzorec

$$\rho = \frac{m}{V}$$

TLAK



$$p = \frac{\Delta F}{\Delta S}$$

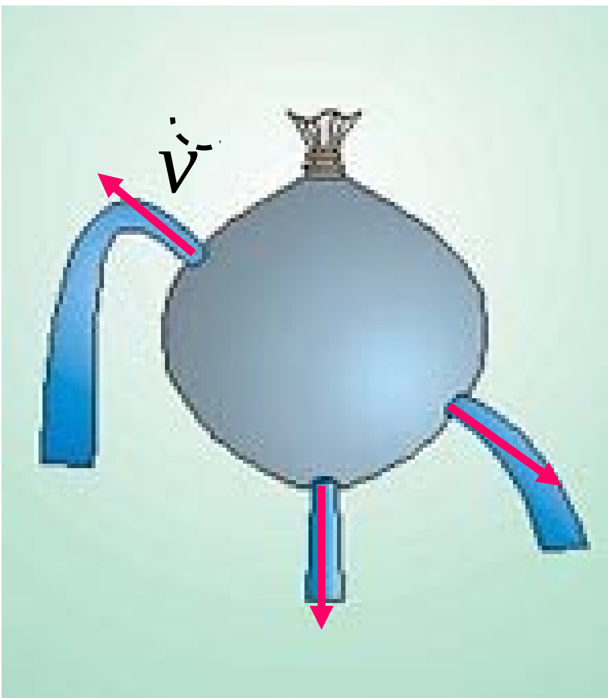
če je sila enaka po vsej površini

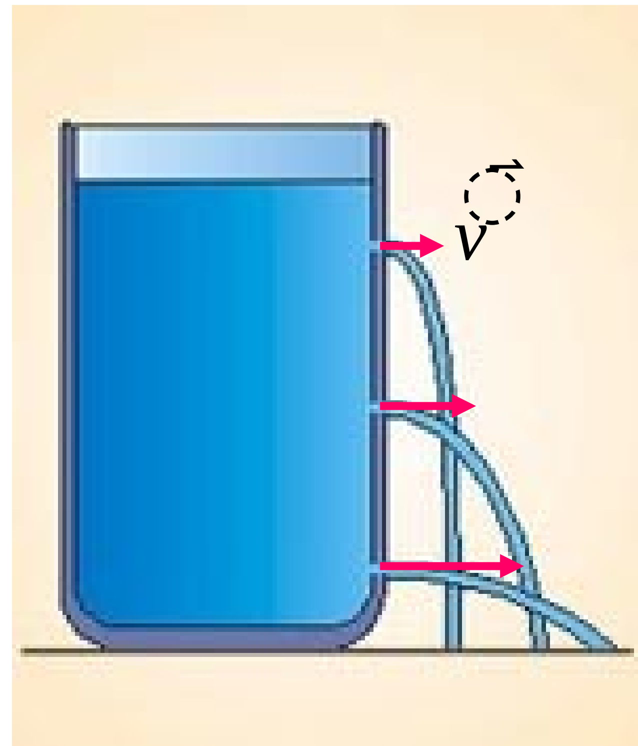
$$p = \frac{F}{S}$$

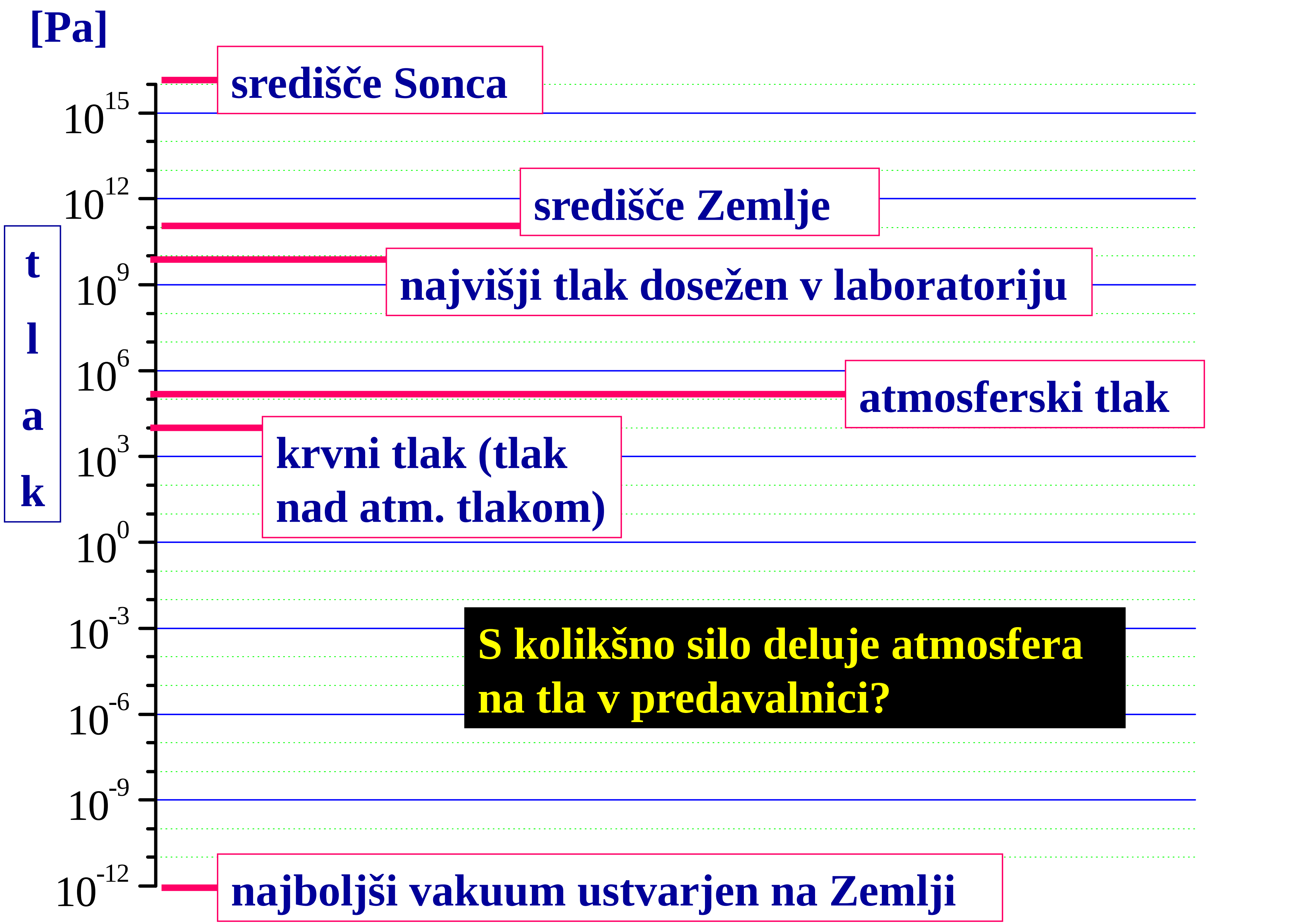
skalarna količina

enota: $\left[\frac{\mathrm{N}}{\mathrm{m}^2} = \mathrm{Pa}\right]$ **paskal**

1 atm = 1,01·10^5 Pa = 760 torr = 760 mmHg


v


v

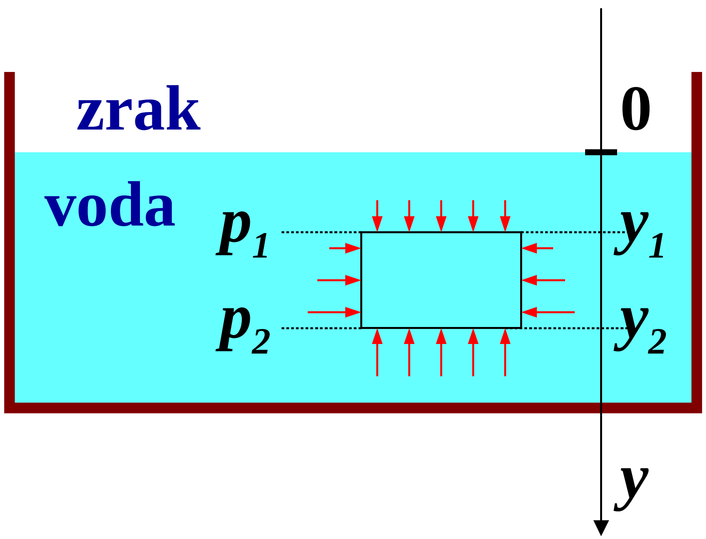

[Pa]
tlak
10^{15}
10^{12}
10^{9}
10^{6}
10^{3}
10^{0}
10^{-3}
10^{-6}
10^{-9}
10^{-12}
središče Sonca
središče Zemlje
najvišji tlak dosežen v laboratoriju
atmosferski tlak
krvni tlak (tlak nad atm. tlakom)
S kolikšno silo deluje atmosfera na tla v predavalnici?
najboljši vakuum ustvarjen na Zemlji

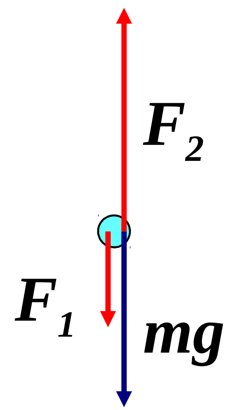
TEKOČINE V MIROVANJU - HIDROSTATIKA

potapljač: tlak narašča z globino

alpinist: tlak se manjša z višino

hidrostatični tlak





$$F_2 = p_2 S$$

$$F_1 = p_1 S$$

$$F_2 = F_1 + mg$$

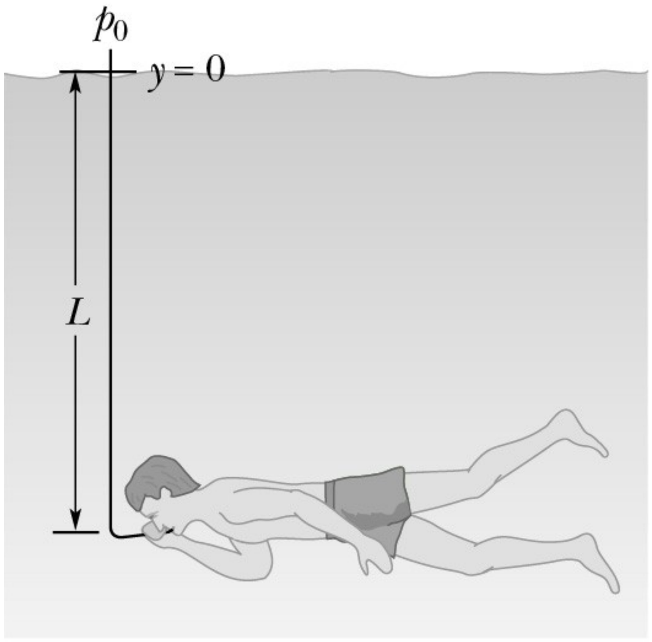
$$p_2 = p_1 + \rho g (y_2 - y_1)$$

$p_2 \rightarrow p(h)$, $p_1 \rightarrow p_0$, $y_2 \rightarrow h$, $y_1 \rightarrow 0$

p_0: **zračni tlak na površini vode**

$$p(h) = p_0 + \rho g h$$

PRIMER:



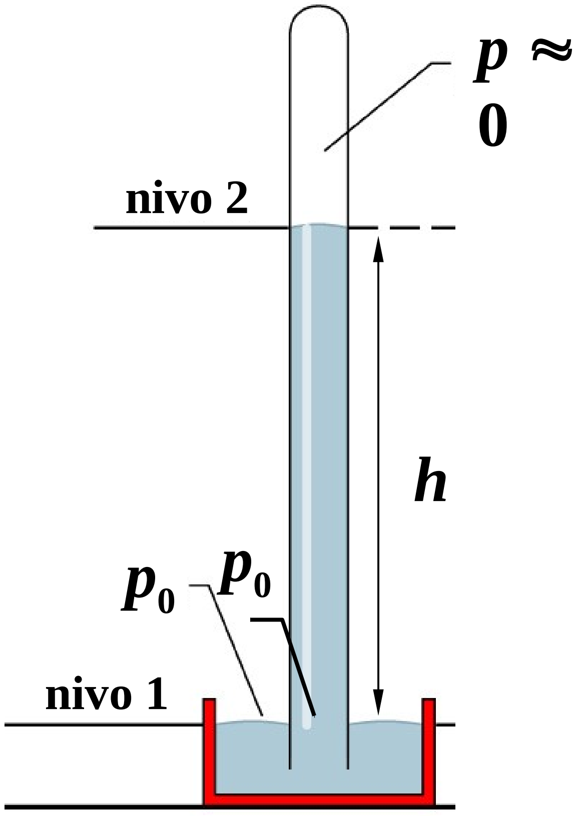
Nespameten potapljač razmišlja: če deluje 20 cm dolga dihalka, deluje tudi 6,0 m dolga cev. Če tako cev res uporabi, je v smrtni nevarnosti!!! Zakaj?

PRIMER:

Potapljač začetnik zajame zrak na dnu bazena z globino 1,0 m. Ko se dviguje, pozabi izdihovati. Zakaj je v smrtni nevarnosti?

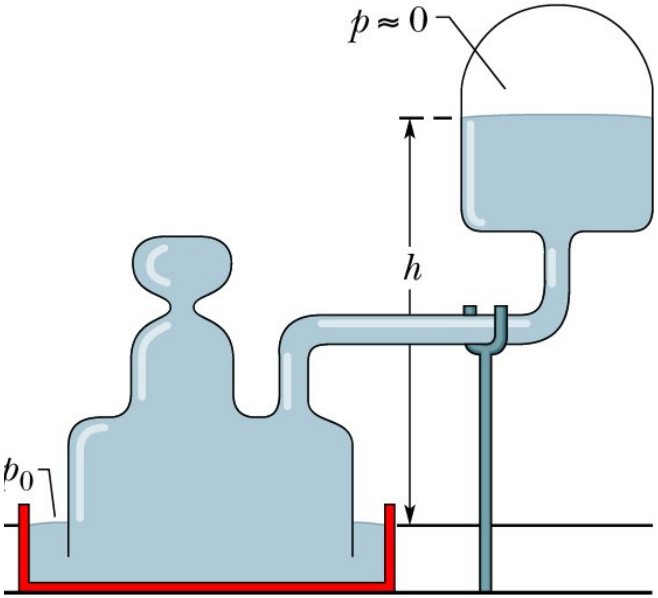
MERJENJE TLAKA

živosrebrni barometer

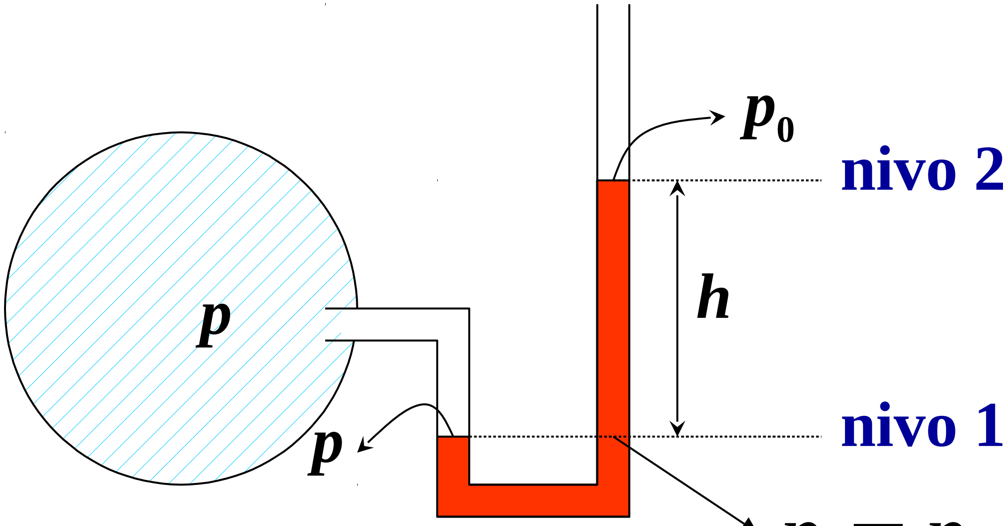


$$p_0 = \rho g h$$

merimo → izračunamo tlak



manometer



$$p = p_0 + \rho g h$$

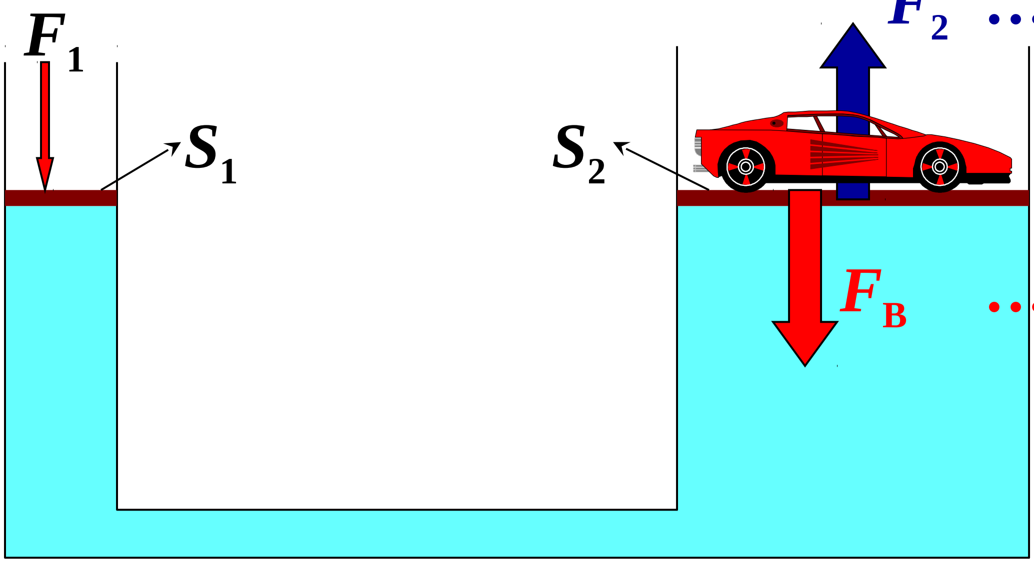
$$p - p_0 = \Delta p = \rho g h$$

razlika tlakov

višinska razlika med gladinama

Bourdonova cevka

PASCALOVO NAČELO



F_2 … sila tekočine na bat

F_B … sila bremena na bat

bat je v ravnovesju:

$$F_2 = F_B$$

tlak pod levim batom se poveča:

$$\Delta p = F_1 / S_1$$

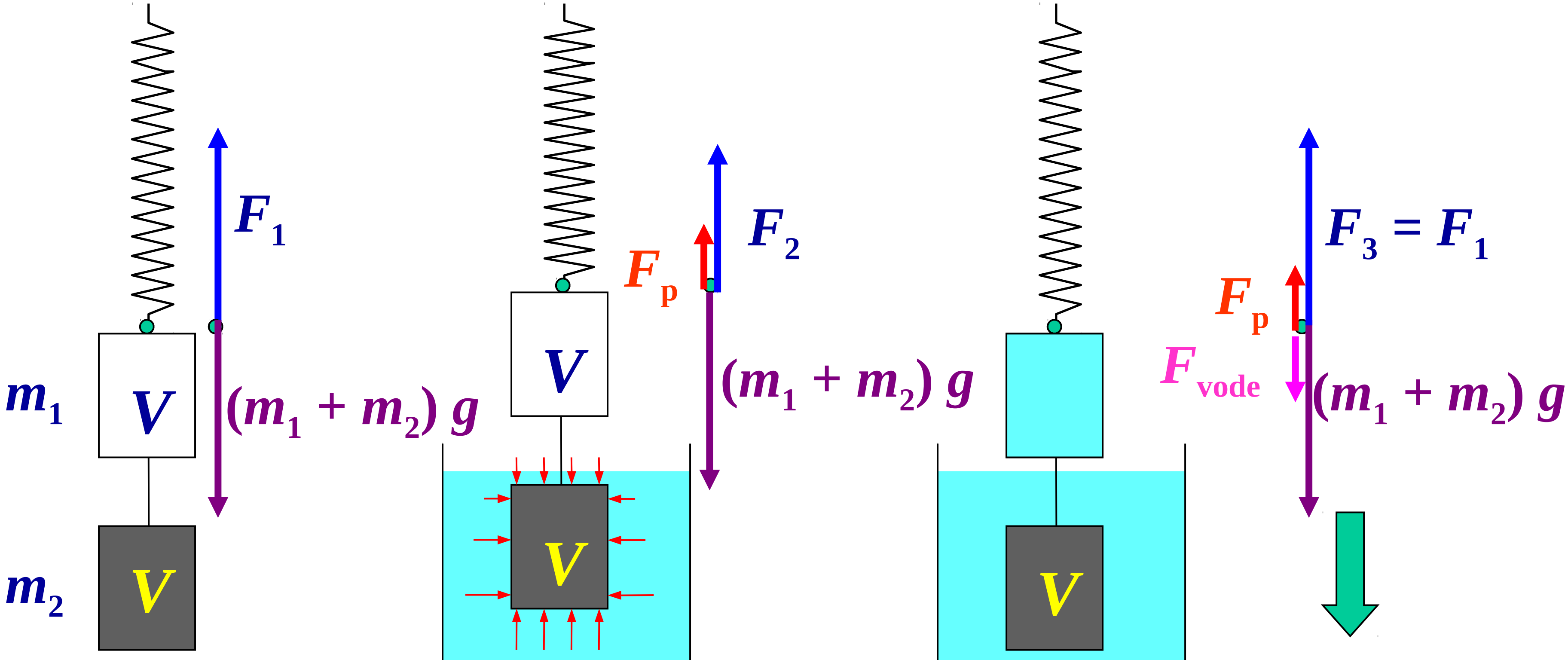
Pascal →

poveča se tlak pod drugim batom:

$$\Delta p = F_2 / S_2$$

$$F_1 / S_1 = F_2 / S_2$$

ARHIMEDOV ZAKON



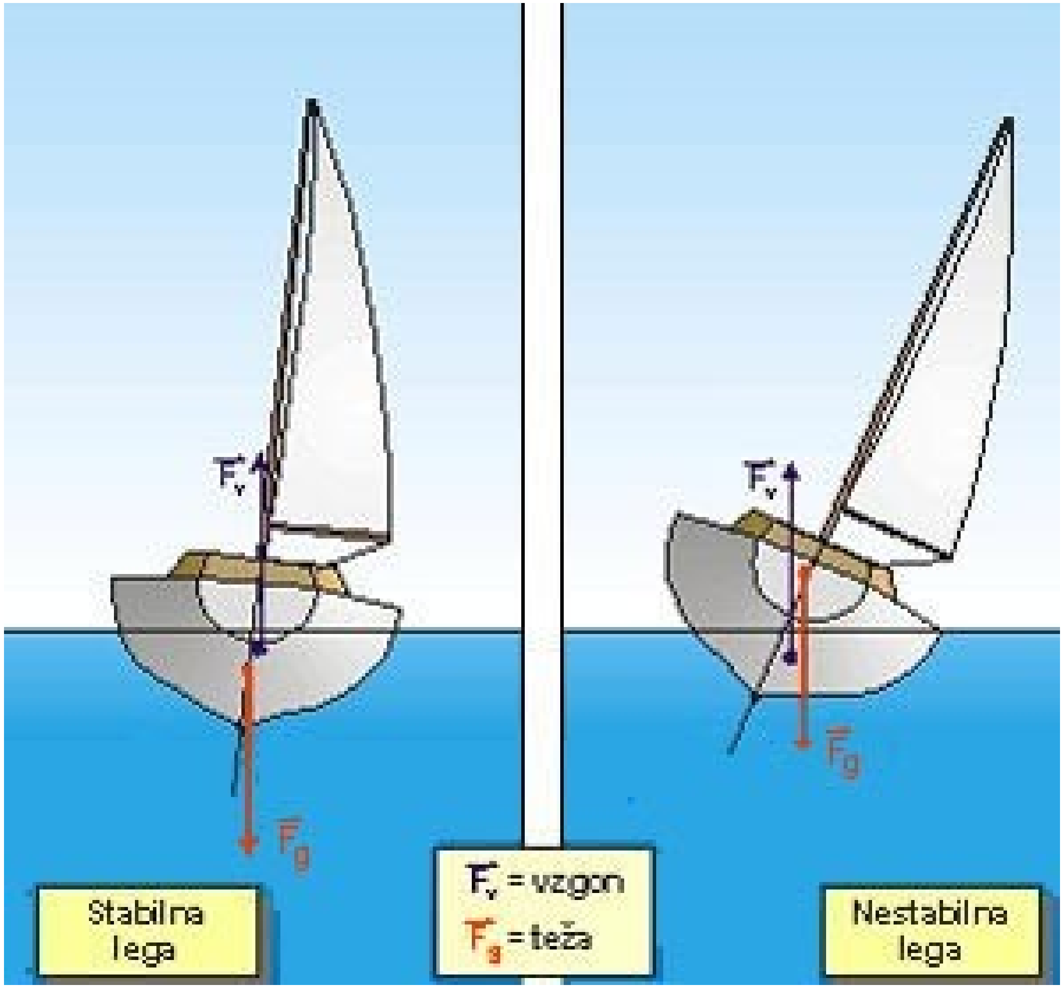
$$F_1 = (m_1 + m_2)g$$

$$F_1 = F_p + (m_1 + m_2)g$$

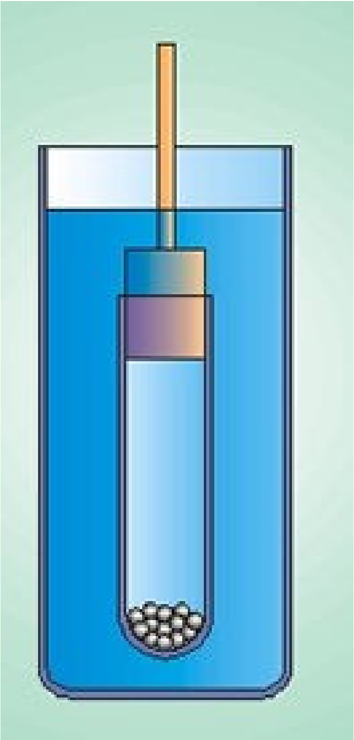
$$F_p = F_{vode}$$

vzgon

teža izpodrinjene tekočine



merilnik za gostoto kapljevine



areometer

GIBANJE IDEALNIH TEKOČIN

približki:

1. **laminarni tok**

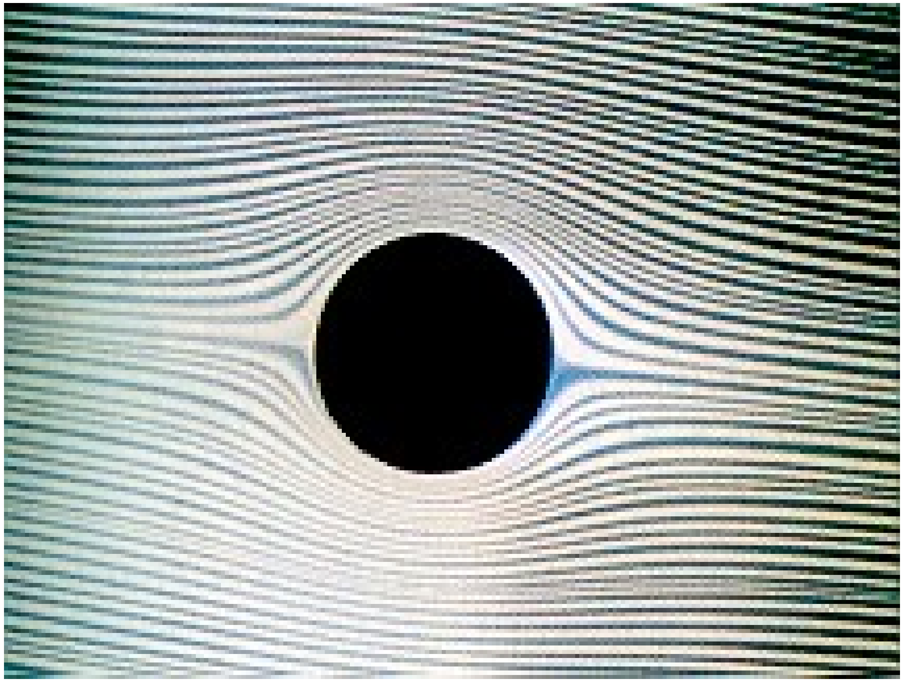
2. **nestisljiva tekočina: ρ = konst.**

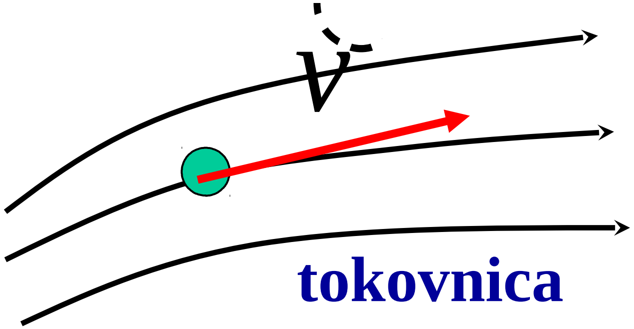
3. **neviskozna tekočina: ni trenja med sosednjimi plastmi tekočine**

4. **irotacionalno gibanje**

KONTINUITETNA ENAČBA

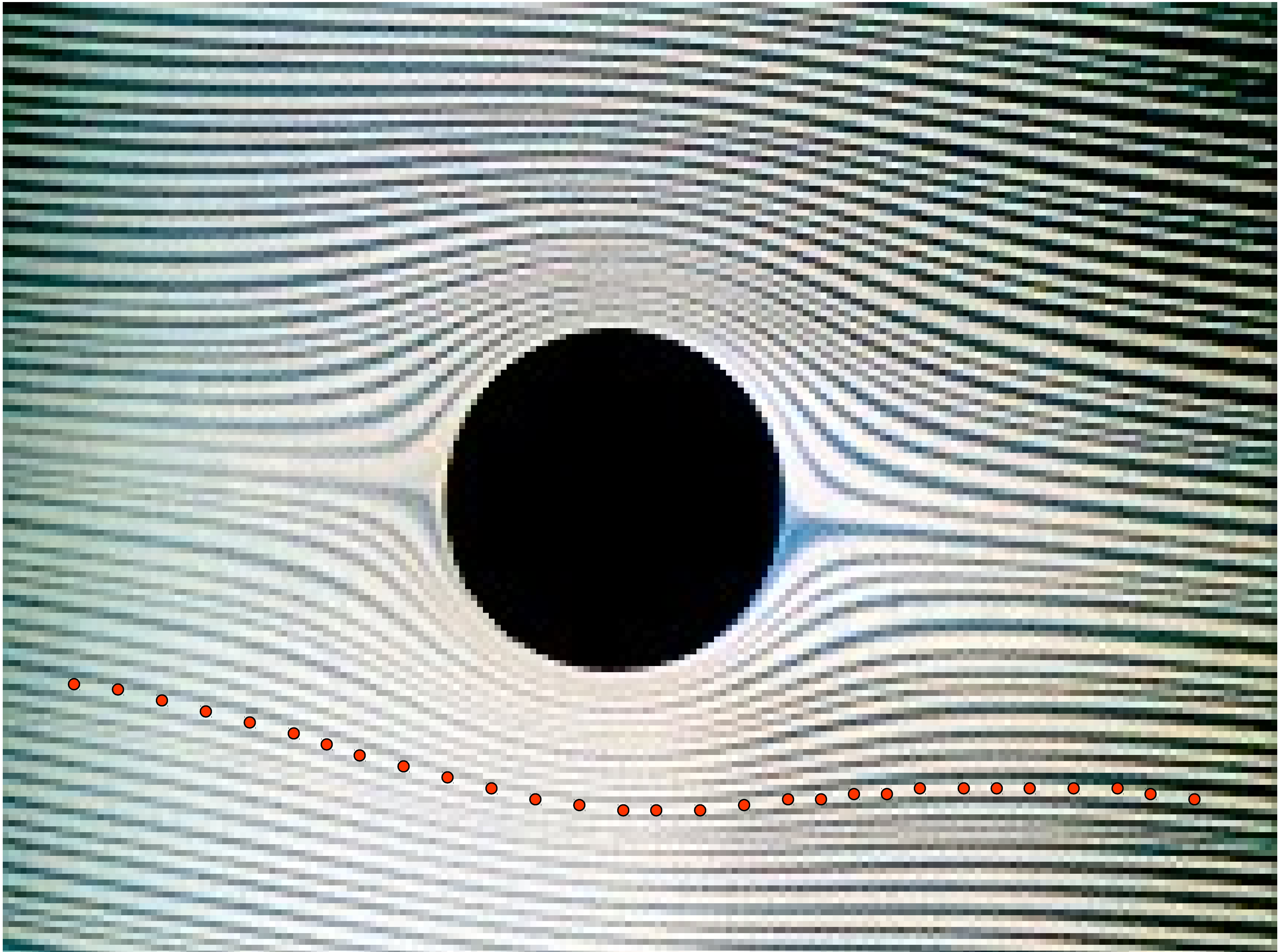
tokovnica → **pot, ki ji sledi delček tekočine**

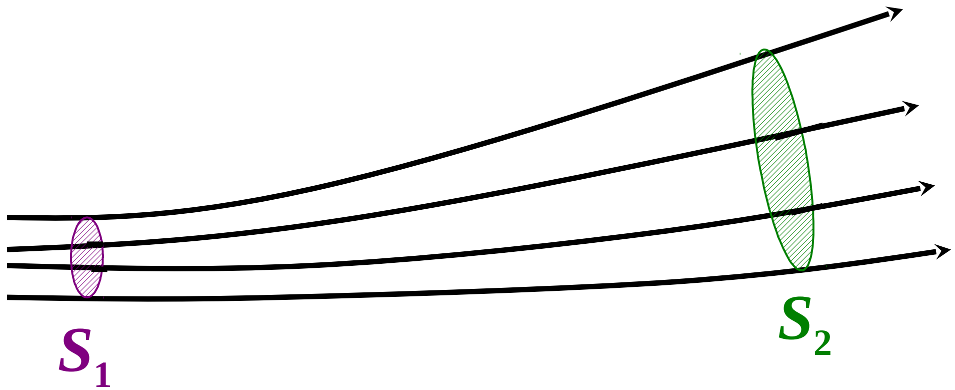




vektor hitrosti je vedno tangenten na tokovnico

tokovnice se nikoli ne sekajo





$$v_1 S_1 \Delta t = \Delta V$$

$$v_2 S_2 \Delta t = \Delta V$$

kontinuitetna enačba

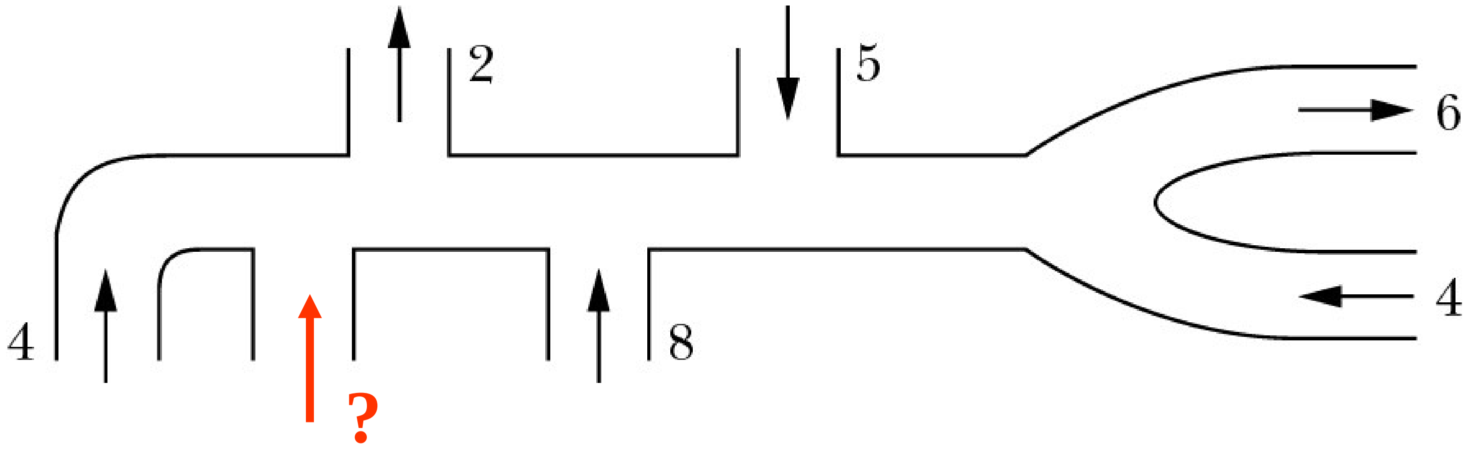
$$v_1 S_1 = v_2 S_2$$

zakon o ohranitvi mase

$$\Phi_V = \frac{\Delta V}{\Delta t} = vS$$ **… volumski pretok**

$$\rho \Phi_V = \Phi_m$$ **… masni pretok**

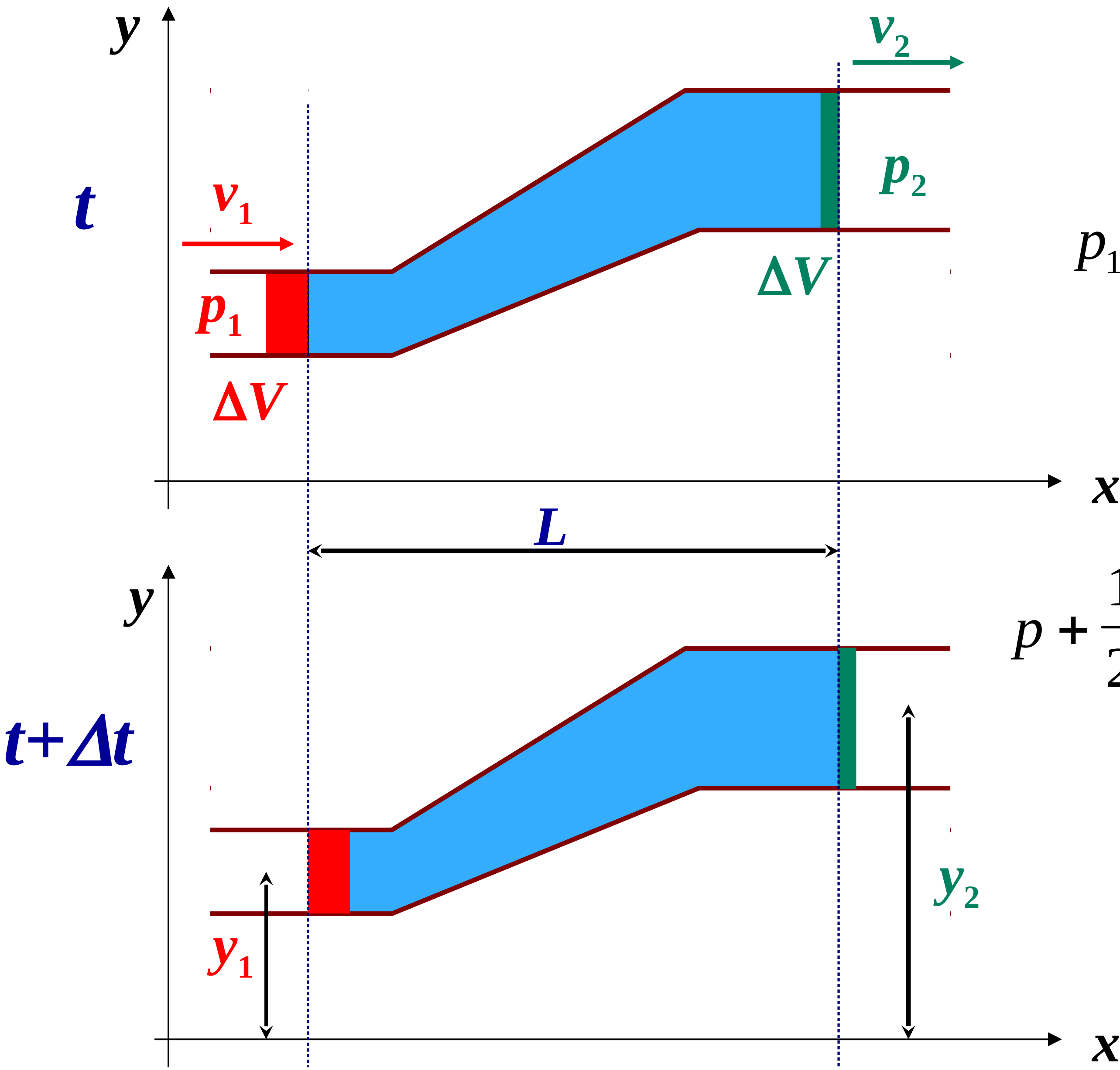
PRIMER:



PRIMER:

Presek aorte pri neki osebi je 3,0 cm^2, hitrost krvi po aorti je 30 cm/s. Presek kapilare je 3,0·10^{-7} cm^2 in hitrost pretakanja krvi po kapilari 0,050 cm/s. Koliko kapilar ima ta oseba?

BERNOULLIJEVA ENAČBA

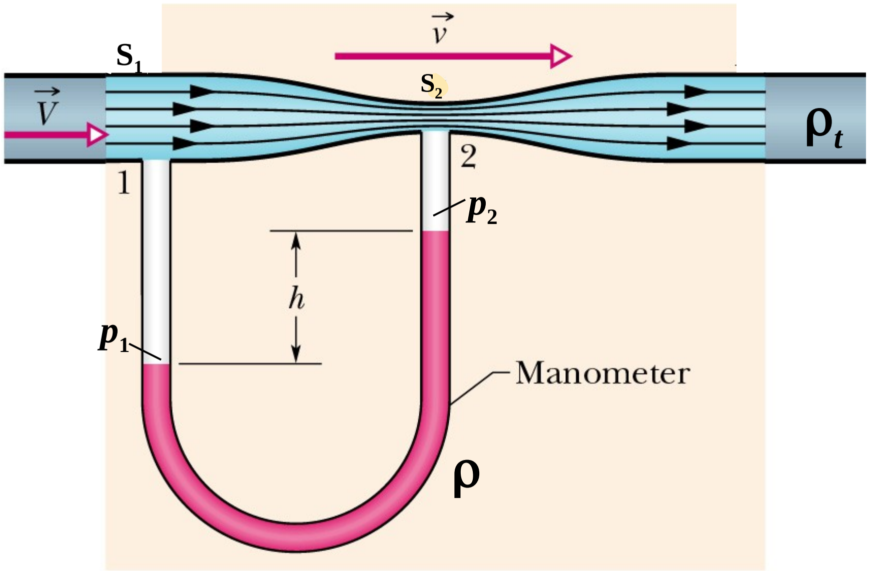


zakon o ohranitvi energije:

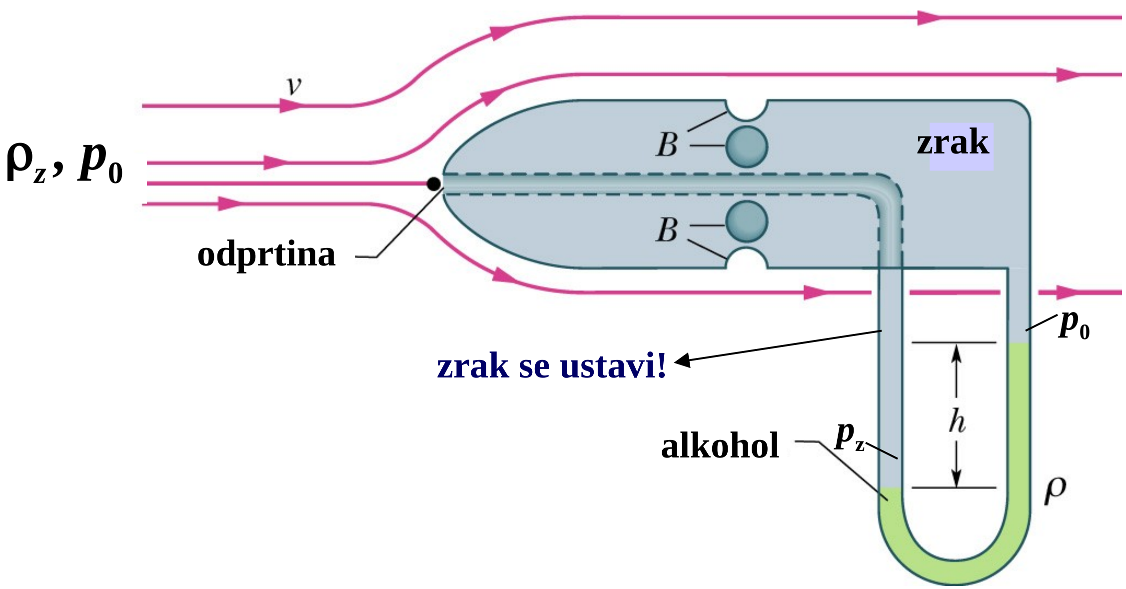
$$p_1 + \frac{1}{2}\rho v_1^2 + \rho g y_1 = p_2 + \frac{1}{2}\rho v_2^2 + \rho g y_2$$

$$p + \frac{1}{2}\rho v^2 + \rho g y = \text{konst}$$

MERJENJE HITROSTI TEKOČINE



VENTURIJEVA CEV



PITOTOVA CEV

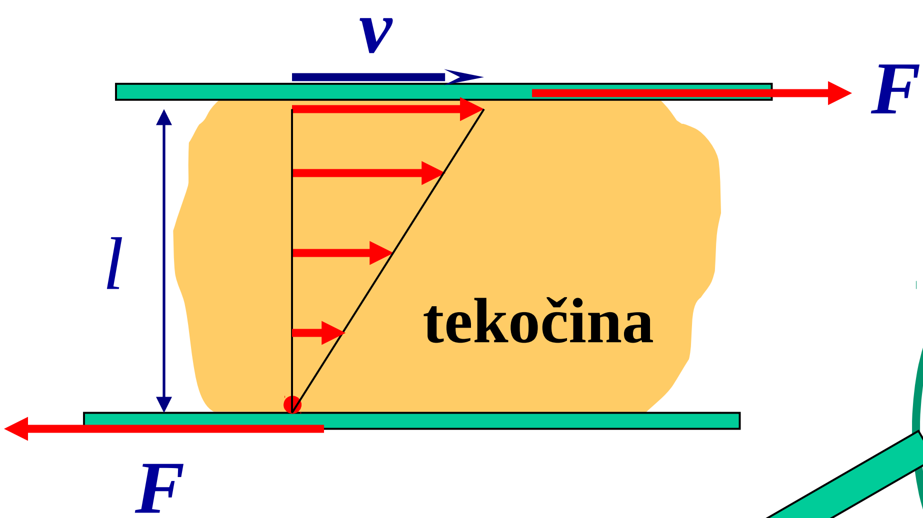
$$p_z - p_0$$

zastojni tlak

VISKOZNOST

kapljevina: **kohezivne sile med molekulami**

plin: **trki med molekulami**



tekočino strižno obremenimo

$$\frac{F}{S} = \eta \frac{v}{l}$$

strižna napetost

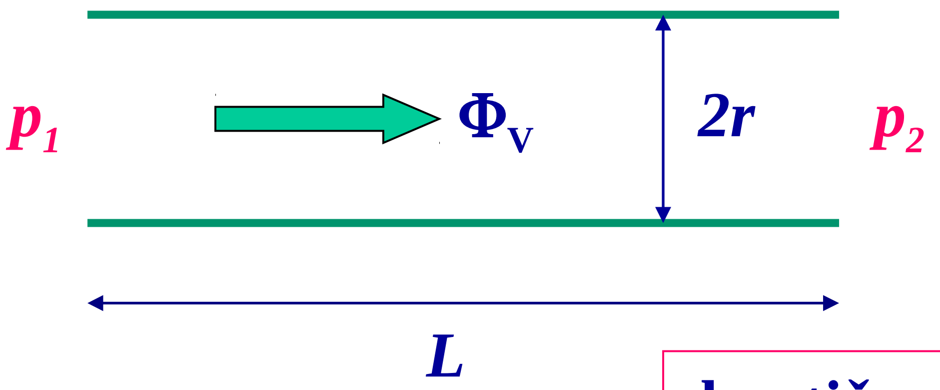
viskoznost

strižna hitrost

$$\left[\frac{g}{cms}\right] = 1 \text{ poise}$$

$$\left[\frac{kg}{ms} = Pas\right]$$

TOK TEKOČINE PO CEVI

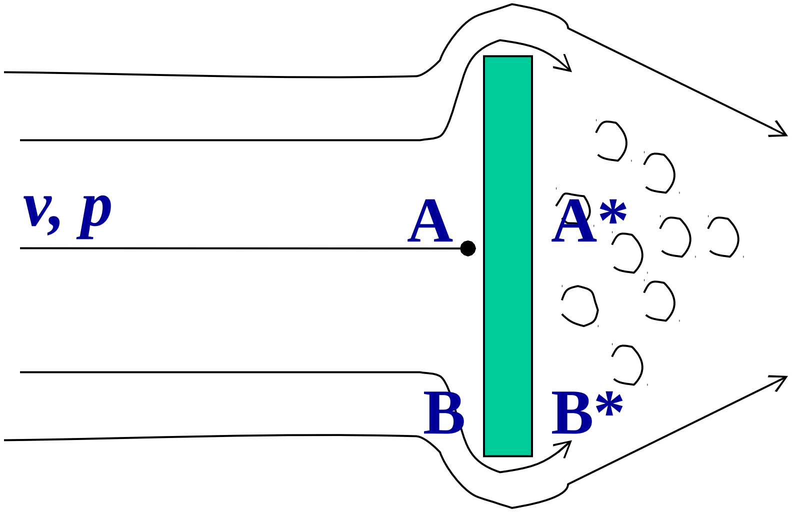


drastičen vpliv !

$$\Phi_V = \frac{\pi r^4}{8\eta} \frac{(p_2 - p_1)}{L}$$

gradient tlaka

UPOR



sila na ploščo:

$$F \approx \left(p_A - p_{A^*}\right)S$$

$$F \propto \rho v^2 S$$

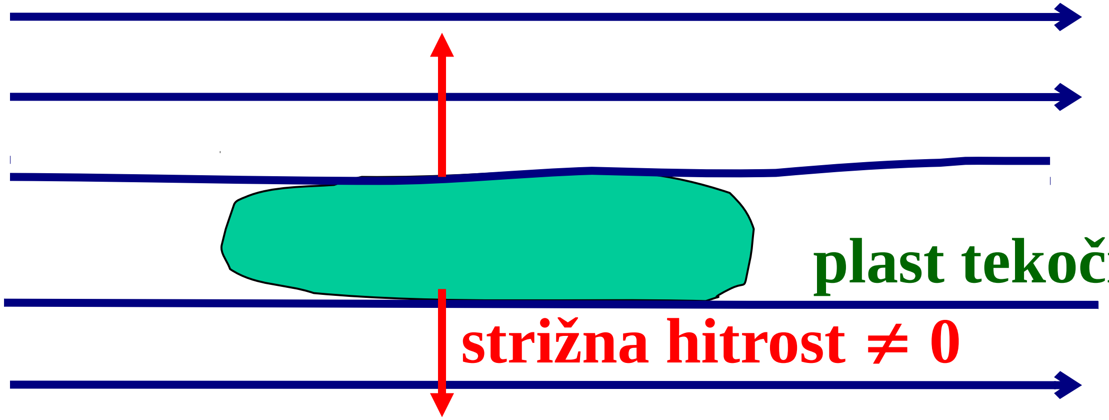
$$F = \frac{1}{2} c_u \rho v^2 S$$

$$\underbrace{p_A - p_{A^*}}_{\approx p_A - p} > p_B - p_{B^*}$$

$\approx p_A - p$ **…zastojni tlak v točki A**

$$p + \frac{1}{2}\rho v^2 = p_A$$

SILA NA TELO ZARADI VISKOZNOSTI OKOLNE TEKOČINE



plast tekočine ob telesu miruje

$$\frac{F}{S} = \eta \frac{v}{l} \quad \textbf{ali} \quad \frac{F}{S} = \eta \frac{dv}{dl}$$

krogla: $S \approx 4\pi R^2 \qquad \frac{dv}{dl} \approx \frac{v}{R} \qquad F \approx 4\pi\eta R v$ **… ocena**

natančen izračun: $F = 6\pi\eta R v$ **Stokes**

upor drugih teles:

značilna razsežnost v čelnem preseku

$$F = koeficient \cdot \eta \, l \, v$$

odvisen od telesa

rel. hitrost telesa glede na tekočino

linearni zakon upora

velja za laminarni tok

Kdaj velja linearni in kdaj kvadratni zakon upora?

majhne v → linearni; **velike** v → kvadratni

$$\frac{F_u^{kvadratni}}{F_u^{linearni}} \approx \frac{v^2 R^2 \rho}{\eta v R}$$

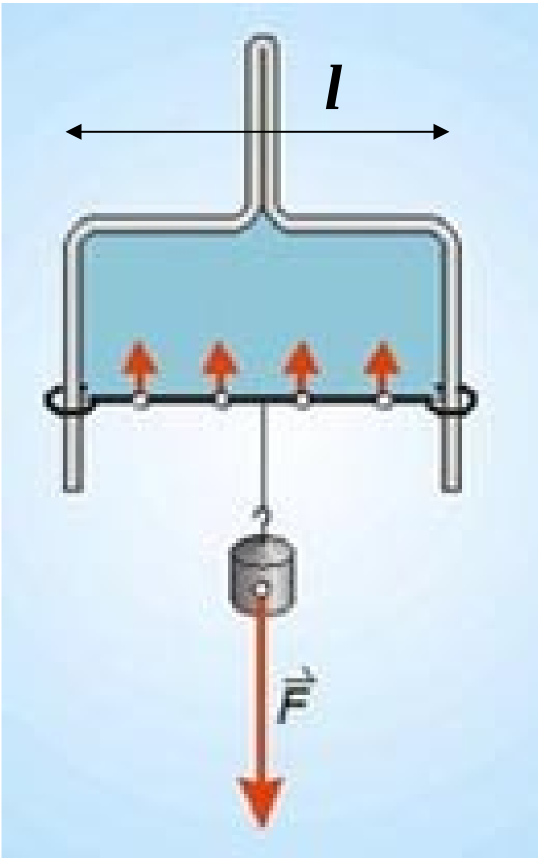
DEF: $\mathrm{Re} = \dfrac{v \rho l}{\eta}$ **Reynoldsovo število**

Re < 0,5 … **linearni zakon upora**

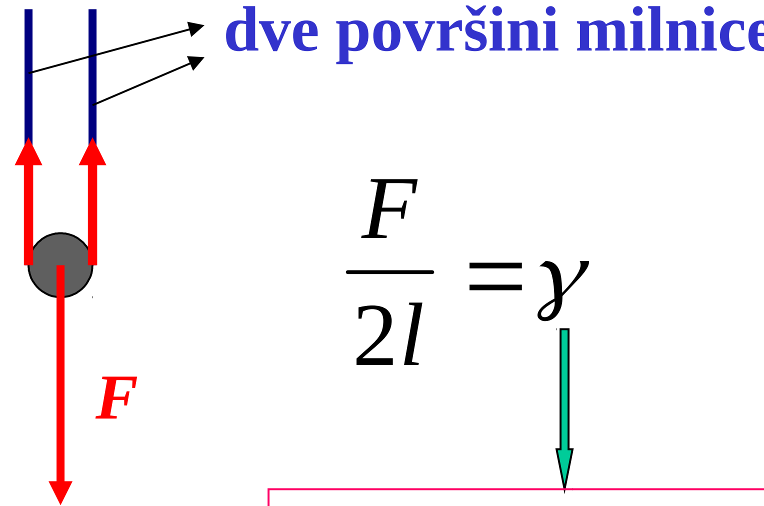
Re > 1000 … **kvadratni zakon upora**

vmes … **uporaba tabel**

POVRŠINSKA NAPETOST



pogled od strani:



$$\frac{F}{2l} = \gamma$$

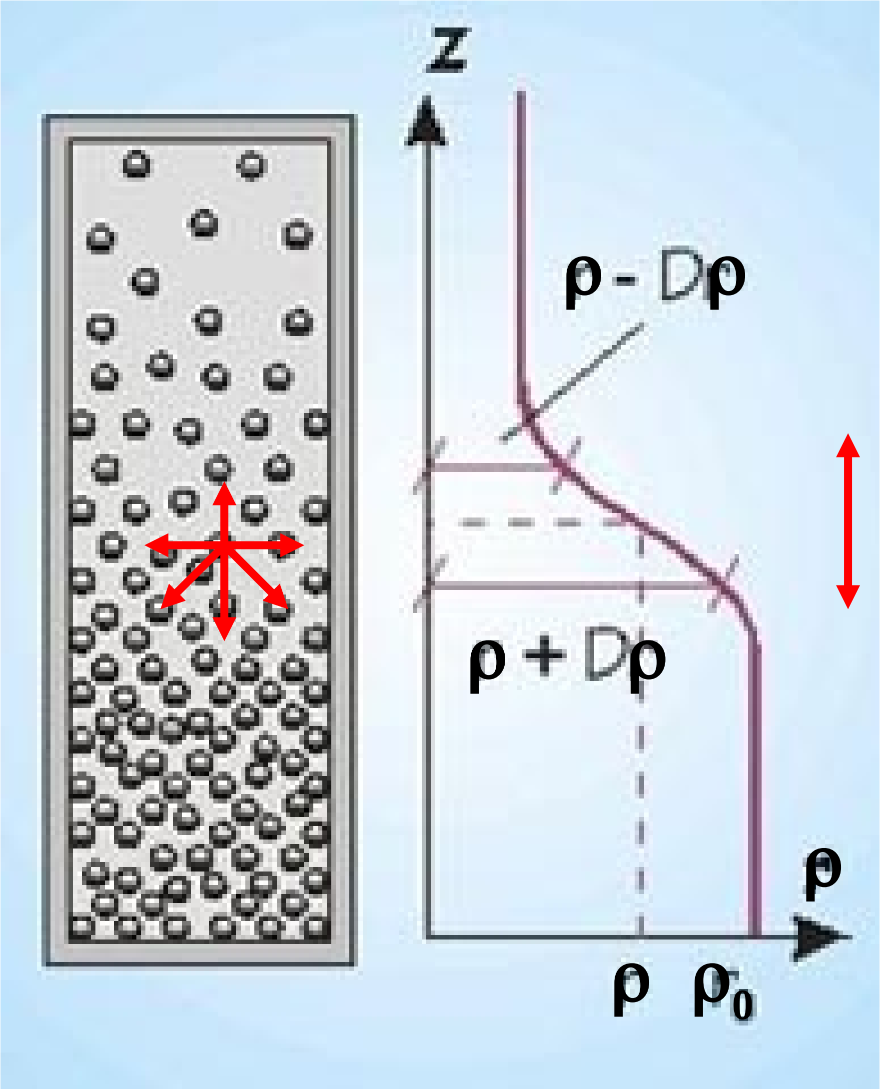
površinska napetost

sila na dolžinsko enoto, ki poskuša prečko potegniti gor, t.j. zapreti površino

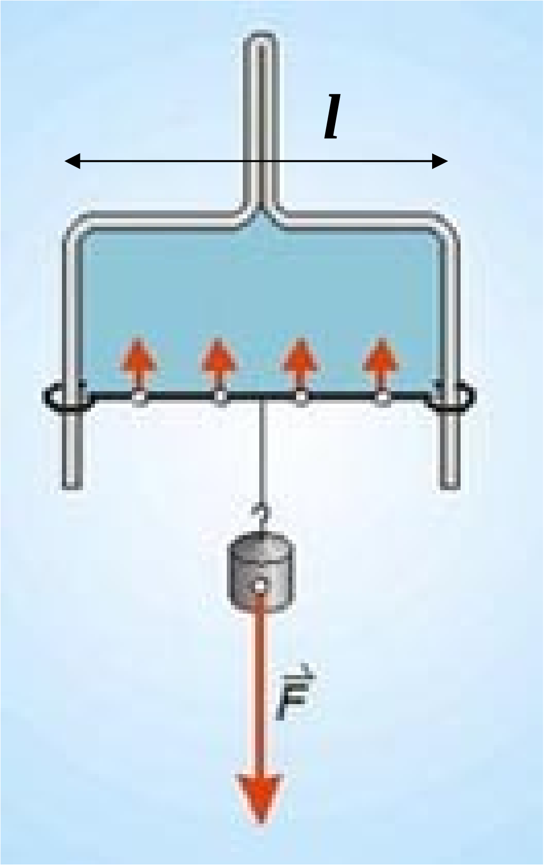
H_20 pri 20°C: γ = 0,072 N/m

milnica pri 20°C: γ = 0,025 N/m

kapljevina postopoma prehaja v paro



nekaj nm debela, neenakomerno gosta plast



površino želimo povečati:

opraviti moramo delo:

$$A = F \Delta x$$

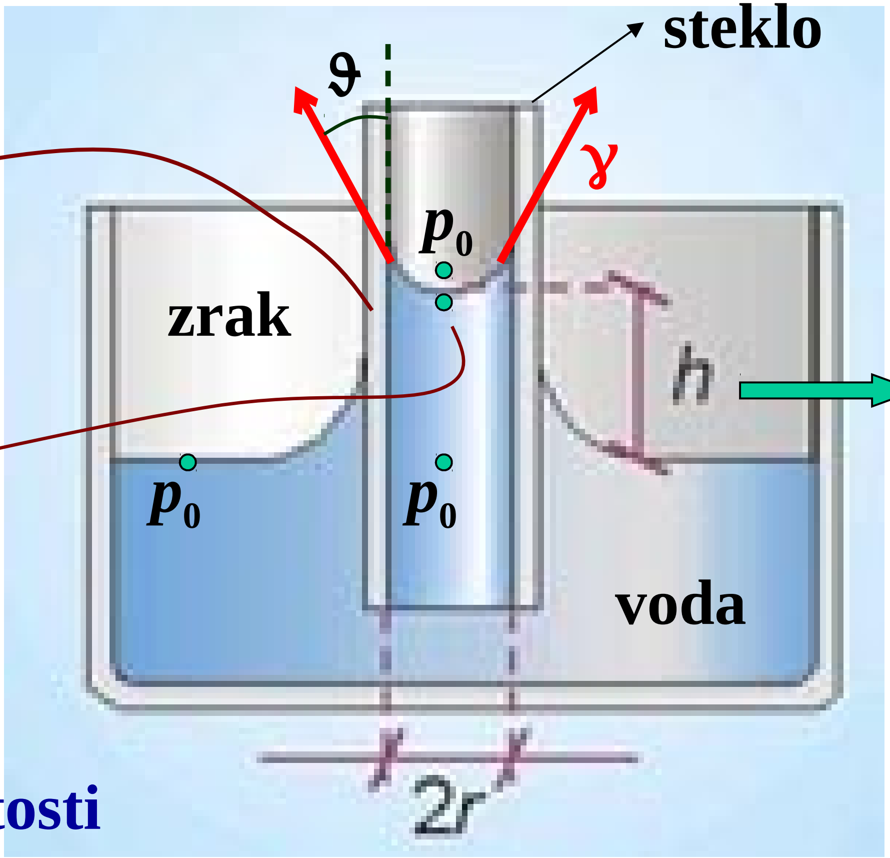
$$A = \gamma L \Delta x \qquad L = 2l$$

$$A = \gamma \Delta S = \gamma S_2 - \gamma S_1$$

površinska energija

poveča potencialno energijo molekul

KAPILARNI DVIG



tri površine

⇒ tri γ

kapilarni dvig

p_0 - ρgh

razliko nadomesti tlak zaradi površinske napetosti

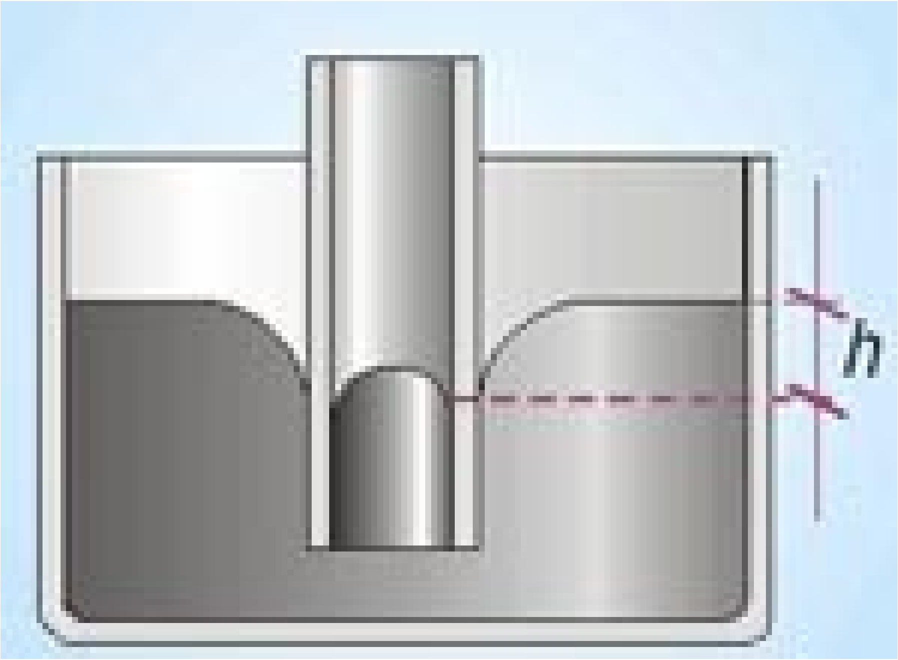
$$F_\gamma \cos\vartheta = S\Delta p$$

$$\gamma 2\pi r \cos\vartheta = \pi r^2 \rho g h$$

$$h = \frac{2\gamma\cos\vartheta}{rg\rho}$$

voda omoči steklo

adhezivne sile večje od kohezivnih



živo srebro ne omoči stekla

kohezivne sile večje od adhezivnih