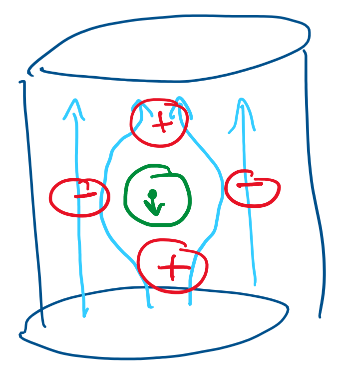
Série 11

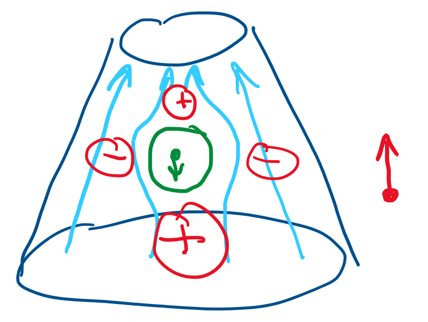
Tuesday, 13 April 2021 18:37

Q1 incompressible : densité = cste. isotherme : temperature = cste ; non-visqueux : pas de frottement

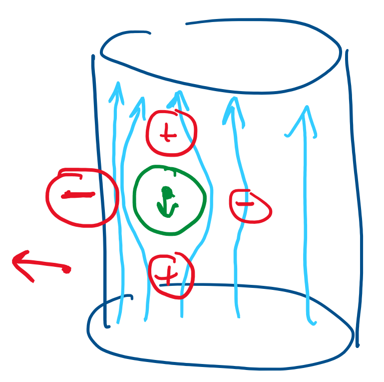
a)



b)



c)



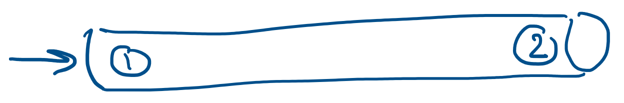
Force gravitationnelle
$\Rightarrow$ sphère tombe

Sur-pression dessous sphère
$\Rightarrow$ Force vers le haut

Depression a gauche
$\Rightarrow$ Force vers le coté

$\Rightarrow$ Independant de la direction d'écoulement

Q2



débit D1 — D_2

surface S1 — S_2

vitesse V_1 — V_2

Fluide incompressible $\Rightarrow D_1 = D_2$

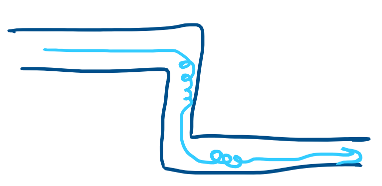
diamètre constant $\Rightarrow S_1 = S_2$

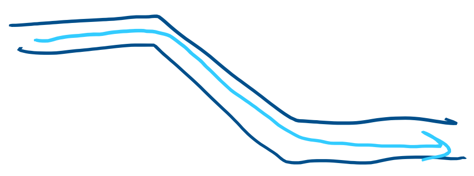
Débit volumique : $D = S \cdot V \; [\frac{m^3}{s}] \Rightarrow V_1 = V_2$

Bernoulli (hydrodynamique) : $P_1 + \cancel{\frac{1}{2} \rho \cdot V_1} = P_2 + \cancel{\frac{1}{2} \rho \cdot V_2} + P_c$

$P_1 = P_2 + P_c$ (pertes)

Q3





P1

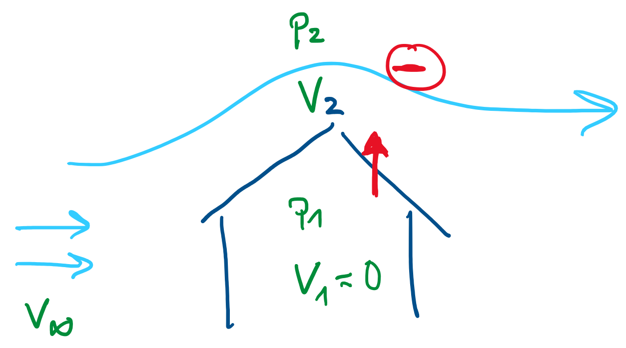
$V_{toit} = V_\infty \cdot 1{,}4 = 100 km/h \cdot 1{,}4 = 38{,}9 \, m/s$

$S_{toit} = 500 \, m^2$

$P_{atm} = 730 \, tor$

$T = 18°C$

$\Rightarrow \rho = 1{,}2929 \cdot \frac{730}{760} \cdot \frac{273}{273+18} = 1{,}165 \frac{kg}{m^3}$



Formules :

Bernoulli : $P_1 + \frac{1}{2} \cdot \rho \cdot V_1^2 = P_2 + \frac{1}{2} \cdot \rho \cdot V_2^2$

Force : $F = m \cdot g = S \cdot \Delta P \; [N]$

a) $\Delta P = P_1 - P_2 = \frac{1}{2} \cdot \rho \cdot (V_2^2 - \underbrace{\cancel{V_1^2}}_{=0})$

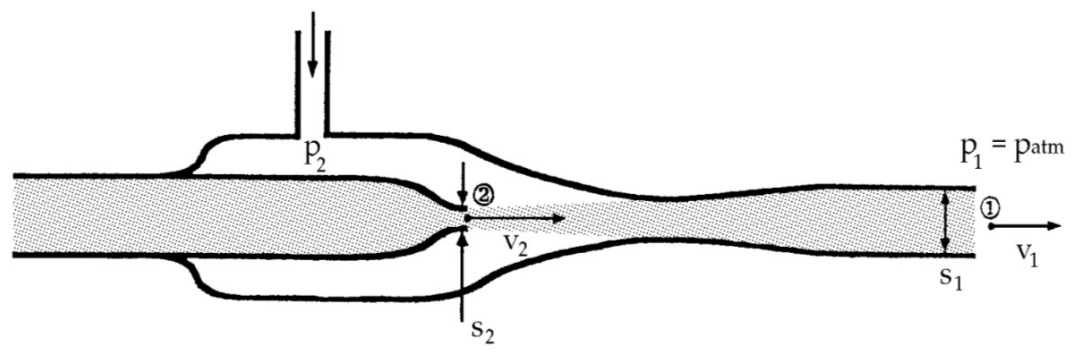
$F = S \cdot \frac{1}{2} \cdot \rho \cdot V_2^2 = 500 \, m^2 \cdot \frac{1}{2} \cdot 1{,}165 \frac{kg}{m^3} \cdot (38{,}9 \frac{m}{s})^2$

$= 440\,700 \, [\frac{kg \, m}{s^2}] / [N]$

b) $F = m \cdot g \Rightarrow m = \frac{F}{g} = \frac{440\,700 \, N}{9{,}81 \frac{m}{s^2}} = 44{,}9$ tonnes

par une surface de $500 m^2 \Rightarrow 89{,}8 \frac{kg}{m^2}$

P2



Fluide incompressible $\Rightarrow D_1 = D_2$

$\hookrightarrow S_1 \cdot V_1 = S_2 \cdot V_2$

$\Rightarrow S_1 > S_2 \Rightarrow V_1 < V_2$

Bernoulli : $P_1 + \frac{1}{2} \rho \cdot V_1^2 = P_2 + \frac{1}{2} \rho \cdot V_2^2$

$\Rightarrow V_1 < V_2 \Rightarrow P_1 > P_2$

b) $V_1 = 2{,}5 \frac{m}{s}$

$\frac{S_1}{S_2} = 4$

$P_{atm} = 1{,}013 \cdot 10^5 \, Pa$

$\rho_{eau} = 1000 \frac{kg}{m^3}$

Solution :

$P_2 = P_1 + \frac{1}{2} \cdot \rho \cdot (V_1^2 - V_2^2)$; $V_2 = \frac{S_1}{S_2} \cdot V_1$

$P_2 = P_1 + \frac{1}{2} \cdot \rho \cdot (V_1^2 - (\frac{S_1}{S_2} \cdot V_1)^2)$

$= 1{,}013 \cdot 10^5 \, Pa + \frac{1}{2} \cdot 1000 \frac{kg}{m^3} \cdot ((2{,}5 \frac{m}{s})^2 - (4 \cdot 2{,}5 \frac{m}{s})^2)$

$= 5{,}4 \cdot 10^4 \, Pa$

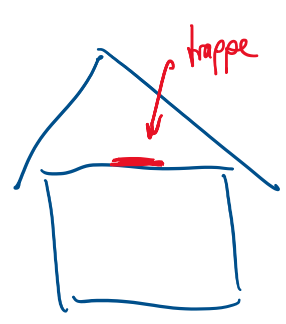
P3

$S = 0.56 \cdot 0.77 \, cm^2 = 0.43 \, m^2$

$m = 4{,}4 \, kg$

$F = m \cdot g = S \cdot \Delta P$

$\Rightarrow \Delta P = \frac{m \cdot g}{S} = \frac{4{,}4 kg \cdot 9{,}81 \frac{m}{s^2}}{0.43 m^2} = 100 \, Pa$



Bernoulli : $\Delta P = \frac{1}{2} \cdot \rho \cdot (V_2^2 - \underbrace{\cancel{V_1^2}}_{=0})$

$V_2^2 = \frac{\Delta P}{\frac{1}{2} \cdot \rho} \Rightarrow V_2 = \sqrt{\frac{\Delta P}{\frac{1}{2} \cdot \rho}} = \sqrt{\frac{100 Pa}{0.5 \cdot 1{,}2}} \approx 13 \frac{m}{s} = 47 \frac{km}{h}$