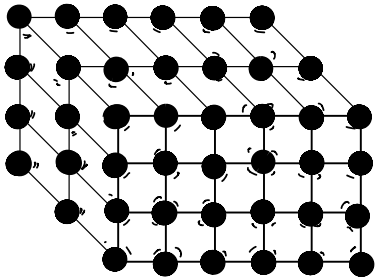
HYDROSTATIQUE

PGC-14

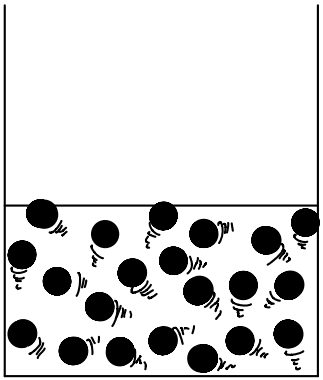
ÉTATS DE LA MATIÈRE

- **solide :** conserve sa forme et son volume.
- **liquide :** coule et prend la forme du récipient dans lequel il est placé, mais conserve un volume constant (si incompressible).
- **gaz :** coule, se disperse prenant la forme et occupant tout le volume du récipient.
- **plasma :** mélange d'atomes, ions et électrons.

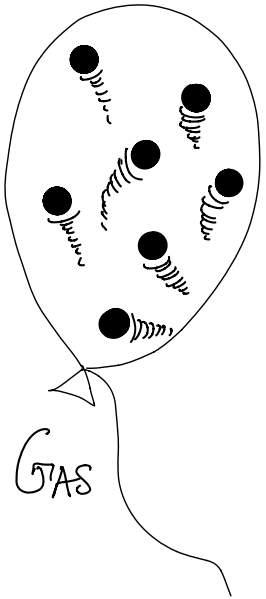
LES PARTICULES DANS LA MATIÈRE



SOLIDE



LIQUIDE



GAS

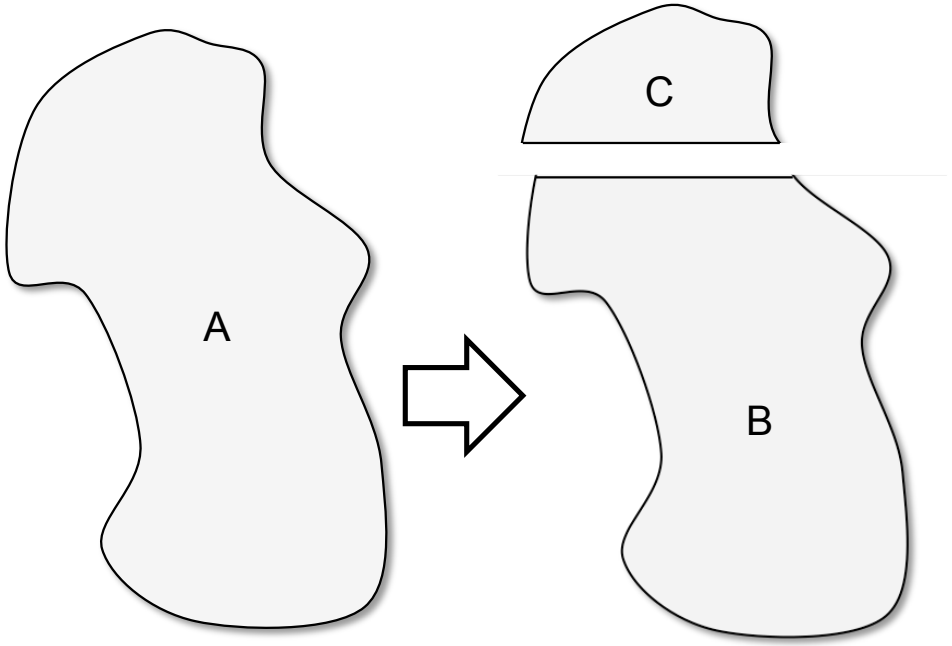
QUESTION

Une pièce de verre est cassée en deux morceaux. Quelle relation décrit la relation entre la densité des trois pièces:

(a) $\rho_A > \rho_B > \rho_C$

(b) $\rho_A = \rho_B = \rho_C$

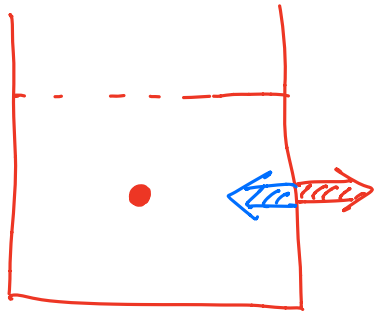
(c) $\rho_A < \rho_B < \rho_C$



HYDROSTATIQUE

PRESSION HYDROSTATIQUE

$$P = \frac{F_\perp}{A} \qquad [P] = \frac{N}{m^2} = Pa$$



Pression Atm P_{atm}

$\sim 10^5$ Pa = 1 bar

1.013×10^5 Pa – 0.87×10^5 Pa

1013 hPa – 870 hPa

PRESSION HYDROSTATIQUE ET PESANTEUR

$$P = \frac{F_\perp}{A} \quad (*)$$

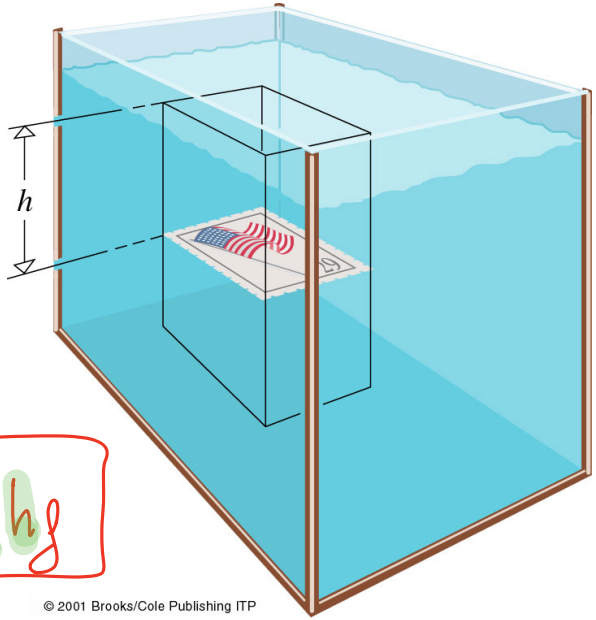
$$F_\perp = F_w = mg \Rightarrow F_w = \rho V g$$

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

$$V = hA$$

$$\Rightarrow F_w = \rho h A g$$

$$(*) \quad P = \frac{\rho A h g}{A} = \rho h g \Rightarrow \boxed{P = \rho h g}$$



EXEMPLE

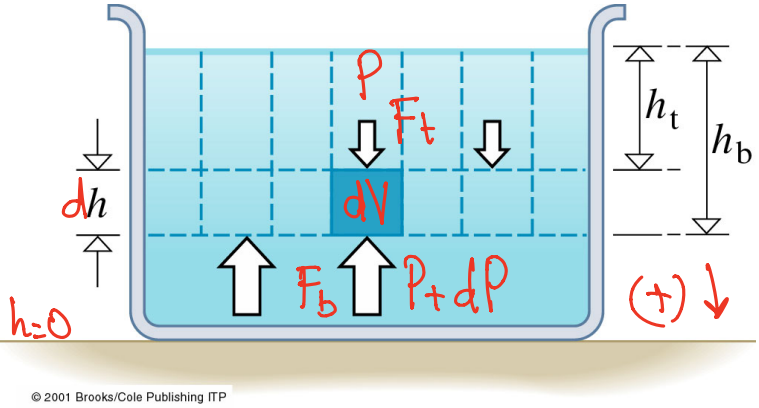
Quelle pression due à l'eau seule subit un nageur à 20m sous l'eau ?

$P_{eau} = \rho g h$

$\simeq 2 \times 10^5$ Pa

$2 \times P_{atm}$

VARIATION DE LA PRESSION AVEC LA PROFONDEUR



A : aire

dh

dm

$F_t = PA$,

$F_b = (P+dP)A$.

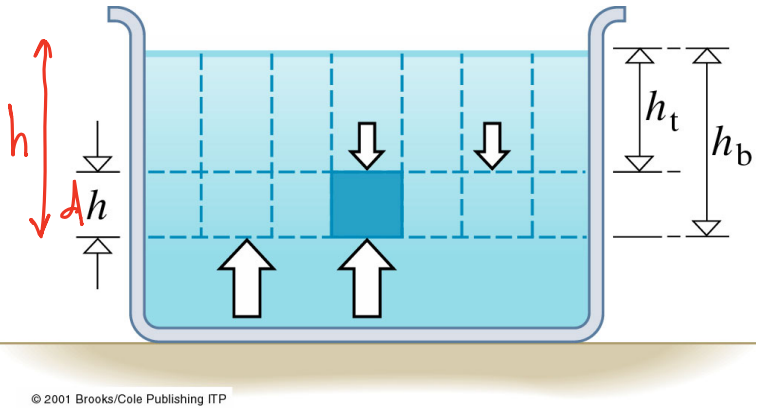
$F_w = (dm)g = \rho A\, dh\, g$.

$F_t - F_b + F_w = 0 \Rightarrow$

$dP = \rho g\, dh \Rightarrow \frac{dP}{dh} = +\rho g$

$\frac{dP}{dh} = -\rho g$

CAS: ρ CONSTANT



$$\frac{dP}{dh} = \rho g \Rightarrow \int dP = \int \rho g \, dh$$

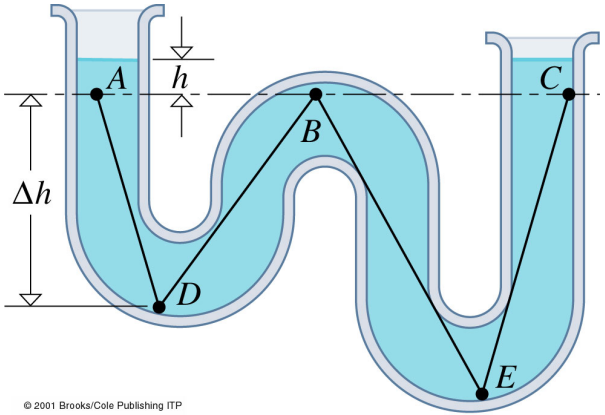
$$\Rightarrow P_b = P_t + \rho g (h_b - h_t)$$

$$\Rightarrow P_b = P_t + \rho g \Delta h.$$

$$P_t = P_{atm}$$

$$P = P_{atm} + \rho g h$$

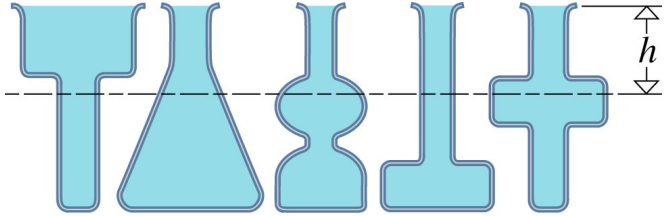
CAS: ρ CONSTANT



$$P_A = P_{atm} + \rho g h$$

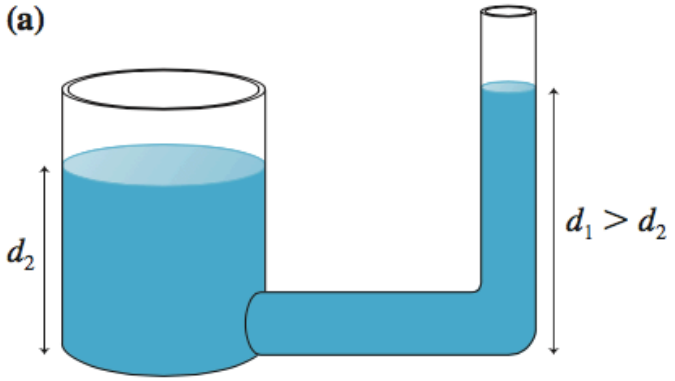
$$P_D = P_A + \rho g \Delta h$$

$$P_D = -\rho g \Delta h + P_D = P_A$$

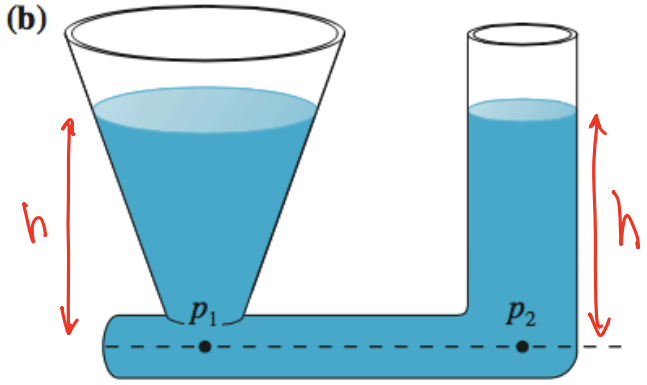


QUESTIONS

$P = \frac{F}{A}$



Is this possible?



Is $p_1 > p_2$?

CAS: ρ NON-CONSTANT

$$\frac{\rho}{\rho_0} = \frac{P}{P_0}$$ niveau mer

$$\left.\begin{aligned} \frac{dP}{dh} &= -\rho g \\ \rho &= \frac{P}{P_0}\rho_0 \end{aligned}\right\} \Rightarrow \frac{dP}{dh} = -\frac{P}{P_0}\rho_0 g \Rightarrow$$

$$P = P_0 e^{-(\rho_0 g/P_0)h}$$

EXEMPLE

A quelle altitude la pression de l'air équivaut-elle à la moitié de sa valeur au niveau de la mer?

$$P = \frac{P_0}{2} = P_0 e^{-(\rho_0 g / P_0) h} \Rightarrow h = 5.5 \text{ km}$$

PRESSION ATMOSPHÉRIQUE – LE BAROMÈTRE

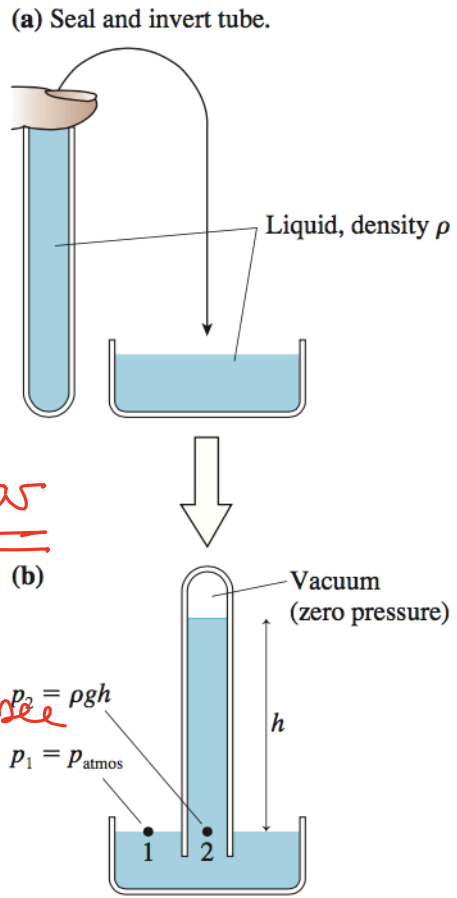
…et les unités de pression.

1 atm h = 760 mm 0°C

$\rho = 13.595 \times 10^3$ kg/m³

$1\,atm = \rho g h = 1.013 \times 10^5$ Pa $= 1.013$ bar

$\rho_{vap} < \rho_{air} \Rightarrow P_{air\ humide} < P_{air\ sec}$

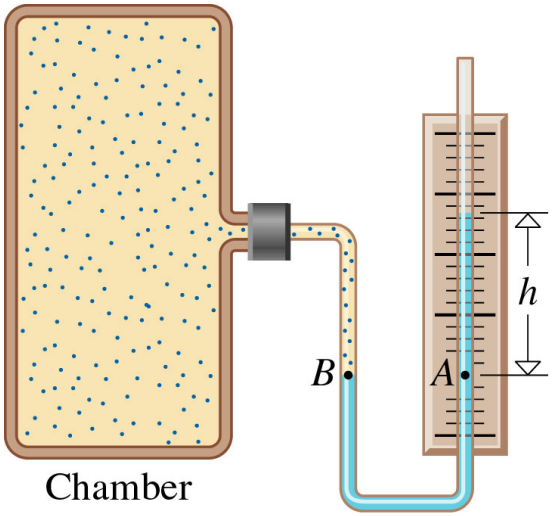


LE MANOMÈTRE

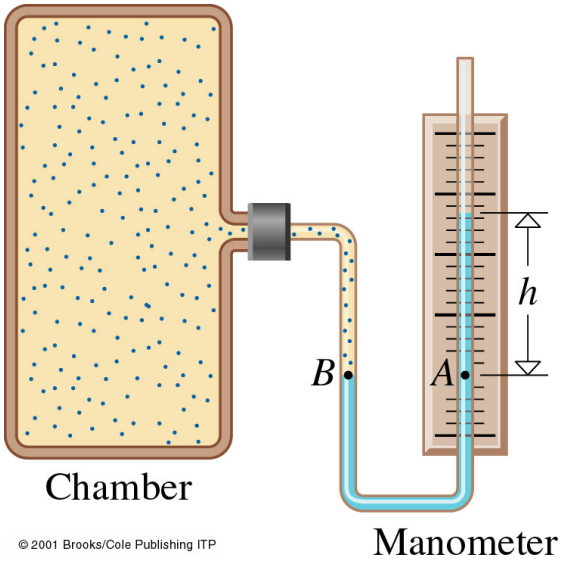
$$\Delta P = P - P_{atm}$$

$$P_A = P_B = \rho g h + P_{atm}$$

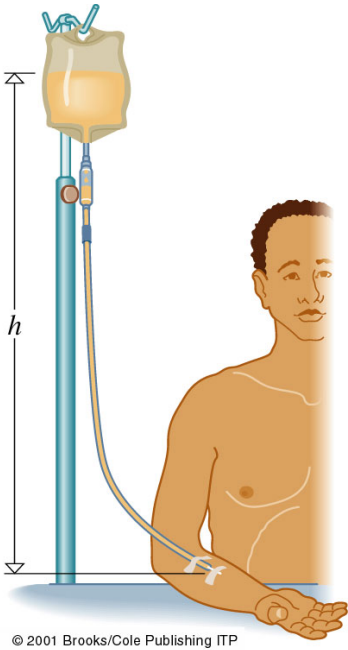
$$P_B - P_{atm} = \rho g h$$



LE MANOMÈTRE

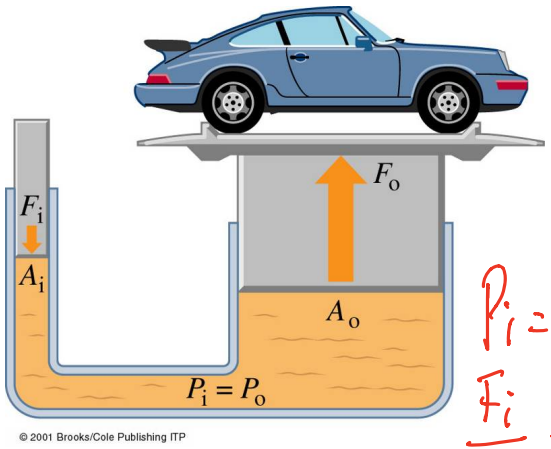


Principe similaire:
Perfusion



PRINCIPE DE PASCAL

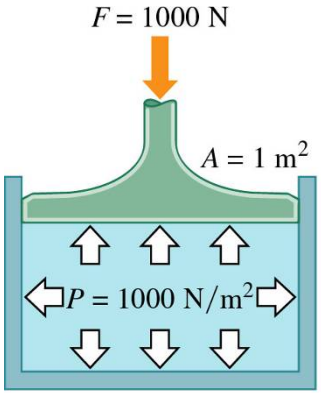
Une pression externe appliquée à un fluide confiné à l'intérieur d'un récipient fermé est transmise intégralement à travers tout le fluide.

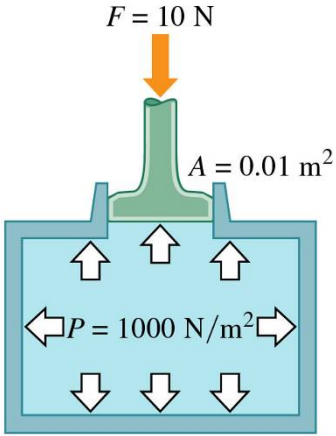


$P_i = P_o$

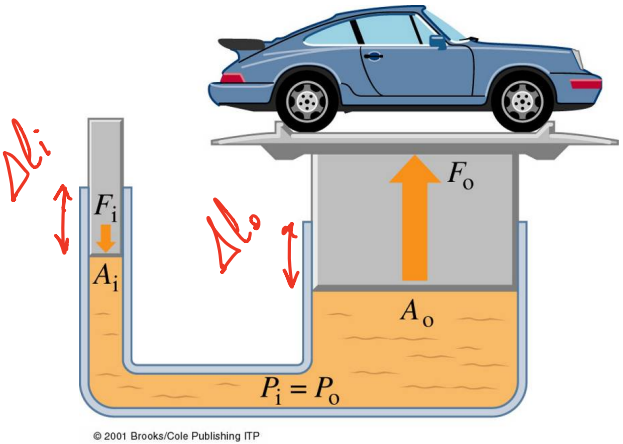
$\frac{F_i}{A_i} = \frac{F_o}{A_o} \Rightarrow$

$F_o = \frac{F_i}{A_i} \cdot A_o$





PRINCIPE DE PASCAL

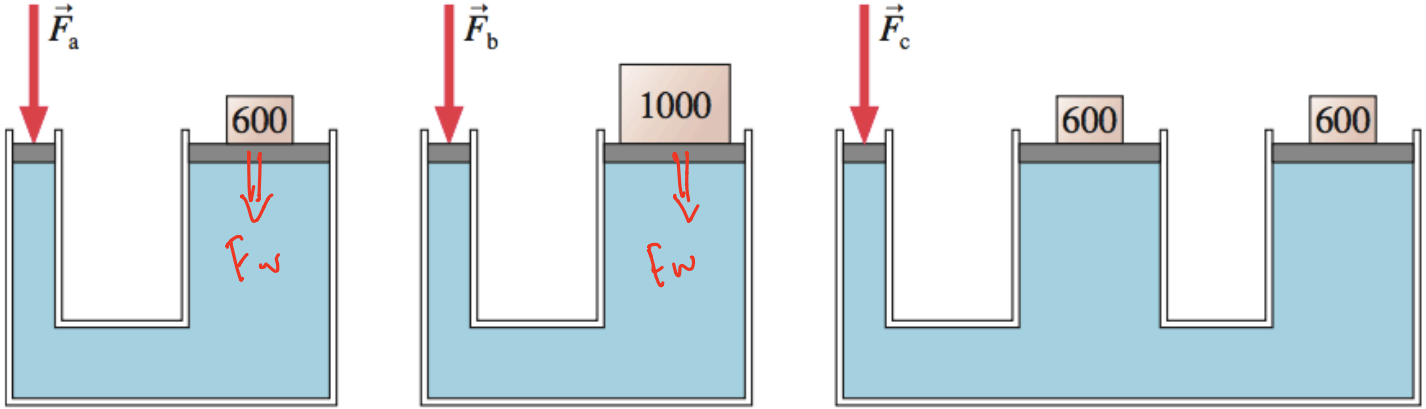


$$W_i = F_i \Delta l_i$$
$$W_o = F_o \Delta l_o$$
$$\Delta l_i \cdot A_i = \Delta l_o \cdot A_o \Rightarrow$$

$$W_i = W_o$$

QUESTION

La force F tient les pistons en équilibre. Quelle est la relation entre les trois forces? Les masses sont indiquées en kg.

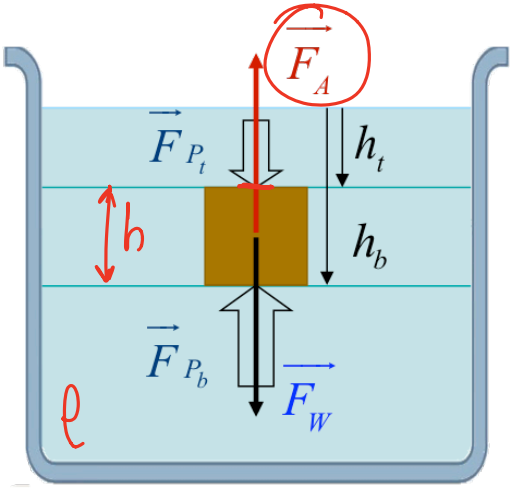


A.
(a) $F_a > F_b$
(b) $F_a = F_b$
(c) $F_a < F_b$

B.
(a) $F_b > F_c$
(b) $F_b = F_c$
(c) $F_b < F_c$

C.
(a) $F_a > F_c$
(b) $F_a = F_c$
(c) $F_a < F_c$

POUSSÉE D'ARCHIMÈDE



$\vec{g}$

$P_t = \rho g h_t \Rightarrow F_t = P_t \cdot A$

$P_b = \rho g h_b \Rightarrow F_b = P_b \cdot A$

$\Rightarrow F_{NET} = F_t - F_b = (P_t - P_b)A =$

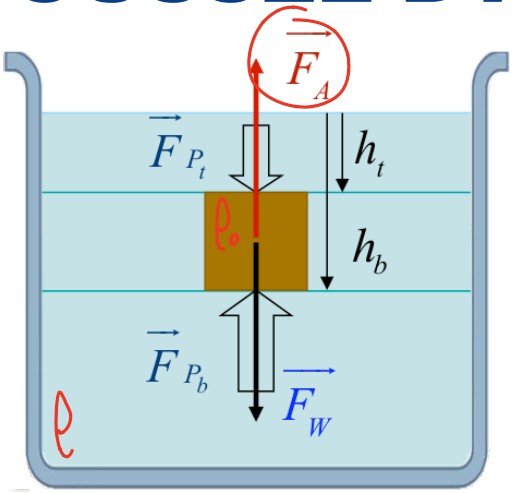
$= (h_t - h_b)\rho g A = -\rho g h A \Rightarrow$

$\Rightarrow F_{NET} = -\rho g V = -\rho V g$

$\rho V = m_{liquide}$

$\Rightarrow F_{NET} = -m_{eau} g = -F_{w\,eau}$

POUSSÉE D'ARCHIMÈDE - FORCE



$$F = F_W - F_{NET} = F_W - F_A$$

$$= mg - m_{eau}\, g$$

$$= \rho_o V g - \rho V g$$

$$= (\rho_o - \rho) V g$$

$\rho_o > \rho$: F (+) descend coule

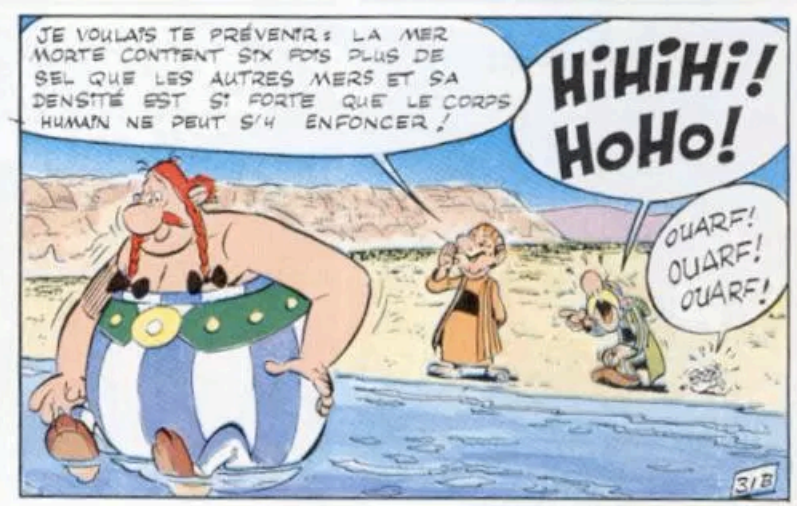
$\rho_o < \rho$: F (-) monte

$F = m_o g < mg$ (!!)

$\Downarrow$

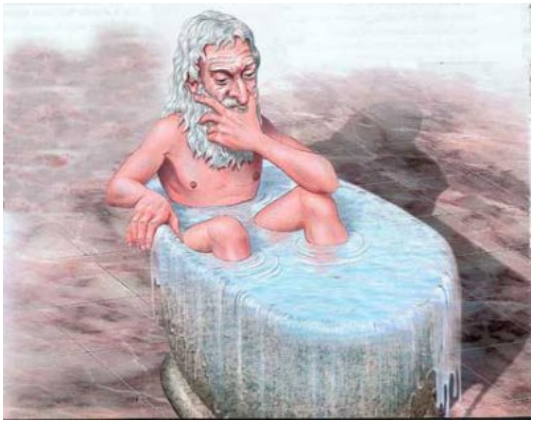
$(\rho_o - \rho) V$


?
FLOP!
FLOP!
FLOP!
FLOP!


JE VOULAIS TE PRÉVENIR : LA MER MORTE CONTIENT SIX FOIS PLUS DE SEL QUE LES AUTRES MERS ET SA DENSITÉ EST SI FORTE QUE LE CORPS HUMAIN NE PEUT S'Y ENFONCER !
HiHiHi! HoHo!
OUARF! OUARF! OUARF!
31B

PRINCIPE D'ARCHIMÈDE

Tout corps plongé dans un fluide subit une poussée de bas en haut égale (et opposée) au poids du volume de fluide déplacé



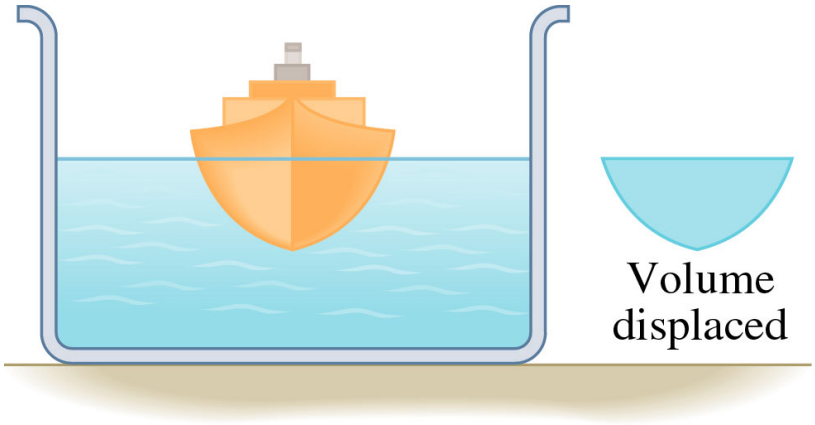
EXEMPLE

On parle souvent de la partie visible de l'iceberg sous-entendant que la plus grande partie de l'iceberg est cachée sous l'eau. Quelle est la fraction visible?

ρ_o = 917kg/m^3 la masse volumique de la glace.

ρ_l = 1025kg/m^3 la masse volumique de l'eau de mer.

FLOTTABILITÉ



TENSION SUPERFICIELLE