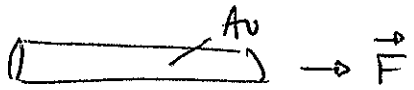
Physique – ED1 2009-2010

E. Roulin

1. Allonger de l'or



$L_0 = 10$ cm
$m = 30$ g

1.1. $V = \frac{m_{Au}}{\rho_{Au}} = \frac{m_{Au}}{d_{Au}\,\rho_{eau}} = \frac{30 \cdot 10^{-3}}{19{,}25 \times 10^{3}} = 1{,}56 \cdot 10^{-6}\ m^3$

1.2. $V = S_0 \times L_0 \Rightarrow S_0 = \frac{V}{L_0} = \frac{1{,}56 \cdot 10^{-6}}{10 \cdot 10^{-2}} = 1{,}56 \cdot 10^{-5}\ m^2$

1.3. $\frac{F}{S} = E\,\frac{L - L_0}{L_0} \Rightarrow F = ES\,\frac{L - L_0}{L_0}$

$= 78 \cdot 10^{9} \times 1{,}56 \cdot 10^{-5} \times \frac{0{,}1}{100}$

$= 1{,}217 \cdot 10^{3}\ N$

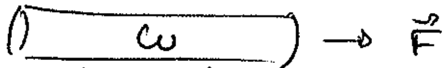
1.4. $\frac{D_0 - D}{D_0} = \nu\,\frac{L - L_0}{L_0} \Rightarrow D = D_0\left(1 - \nu\,\frac{L - L_0}{L_0}\right)$

or $S_0 = \pi\left(\frac{D_0}{2}\right)^2 \Rightarrow D_0 = 2\sqrt{\frac{S_0}{\pi}} = 2 \times \sqrt{\frac{1{,}56 \cdot 10^{-5}}{\pi}} = 4{,}457 \cdot 10^{-3}\ m$

donc $D = 2\sqrt{\frac{S_0}{\pi}}\left(1 - \nu\,\frac{L - L_0}{L_0}\right)$

$= 2 \times \sqrt{\frac{1{,}56 \cdot 10^{-5}}{\pi}}\left(1 - 0{,}42 \times \frac{0{,}1}{100}\right) = 4{,}455 \cdot 10^{-3}\ m$

1.5.



$L_0 = 10$ cm
$m = 30$ g

$\frac{L - L_0}{L_0} = \frac{F}{ES} = \frac{F}{E}\,\frac{d\,\rho_{eau} L_0}{m_{Cu}} = 0{,}03\ \%$

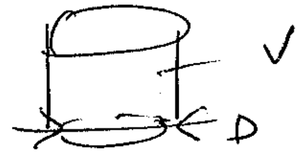
$S_0 = \frac{V}{L_0} = \frac{m_{Cu}}{d_{Cu}\,\rho_{eau}\,L_0} = \frac{30 \cdot 10^{-3}}{19{,}25 \times 10^{3} \times 10 \cdot 10^{-2}} = 3{,}359 \cdot 10^{-5}\ m^2$

$\frac{D_0 - D}{D_0} = \nu\,\frac{L - L_0}{L_0} = \nu\,\frac{F}{ES}$ $D_0 = 2\sqrt{\frac{S_0}{\pi}} = 6{,}540 \cdot 10^{-3}\ m$

$D = D_0\left(1 - \nu\,\frac{F}{ES}\right) = 2\sqrt{\frac{S_0}{\pi}}\left(1 - \nu\,\frac{F}{ES}\right) = 2 \times \sqrt{\frac{3{,}359 \cdot 10^{-5}}{\pi}}\left(1 - 0{,}42 \times \frac{1{,}217 \cdot 10^{3}}{124 \cdot 10^{9} \times 3{,}359 \cdot 10^{-5}}\right)$

$= 6{,}539 \cdot 10^{-3}\ m$

2. Magique ?



2.1 $m_{eau} = \rho_{eau} V_{eau} = 1 \times 250.10^{-3} = 250.10^{-3}$ kg

2.2. $F_{eau} = m_{eau} \times g = 250.10^{-3} \times 9{,}8 = 2{,}45$ N

2.3. $P_{eau} = \frac{F_{eau}}{S} = \frac{F_{eau}}{\pi\left(\frac{D}{2}\right)^2} = \frac{2{,}45}{\pi\left(\frac{6{,}8.10^{-2}}{2}\right)^2} = 675$ Pa

2.4. $F_{atm} = P_{atm} S = 1{,}013.10^5 \times \pi\left(\frac{6{,}8.10^{-2}}{2}\right)^2 = 378 \text{ N} < F_{eau}$

3. Composition de l'air.

3.1 $x_{O_2} = 0{,}22$ $x_{N_2} = 0{,}78$

$M_{air} = x_{O_2} M_{O_2} + x_{N_2} M_{N_2} = 0{,}22 \times 2 \times 16 + 0{,}78 \times 2 \times 14 = 28{,}88$ g.mol⁻¹

3.2 $P_{O_2} = x_{O_2} P_{atm} = 0{,}22 \times 1{,}013.10^5 = 2{,}2.10^4$ Pa

$P_{N_2} = x_{N_2} P_{atm} = 0{,}78 \times 1{,}013.10^5 = 7{,}9.10^4$ Pa

3.3. Etat 1 : Etat 2 :

$P_1 = P_{atm}$ $P_2 = P_{atm}$

$V_1 = 1L$ $V_2 = ?$

$T_1 = 20°C$ $T_2 = 37°C$

$n_1 = \frac{\cancel{P_1} V_1}{\cancel{R} T_1} = \frac{\cancel{P_2} V_2}{\cancel{R} T_2} \Rightarrow V_2 = V_1 \frac{T_2}{T_1}$

$V_2 = 1 \times \frac{37 + 273}{20 + 273} = 1{,}058$ L

3.4. $P_{atm} = \sum_i P'_i \Rightarrow P'_{N_2} = P_{atm} - \left(P'_{O_2} + P'_{H_2O} + P'_{CO_2}\right) = 75819$ Pa

3.5. $M'_{air} = \sum_i x'_i M_i = \sum_i \frac{P'_i}{P_{atm}} M_i = 28{,}77$ g.mol⁻¹

4. Jeux de température

4.1 $L(T_1) = L(T_0)\left(1 + \lambda(T_1 - T_0)\right)$

$L(0°C) = 10^5 \left(1 - 20 \times 12{,}10^{-6}\right) = 0{,}99976.10^5$ m

$40{,}26 \times 0{,}99976.10^{-2} = 40{,}25$ mm

4. Jeux de température

4.1. $L(T_1) = L(T_0)\left(1 + \lambda(T_1 - T_0)\right)$

$$L(0°C) = 10^{-5}\left(1 - 20 \times 12.10^{-6}\right) = 0{,}99976 . 10^{-5}\ m$$

$$\Rightarrow \quad 40{,}26 . 10^{-3} \times 0{,}99976 . 10^{-5} = 40{,}25\ mm$$

4.2 $\underline{\text{à } 0°C}$ $\quad V^{liq}_{(0°C)} = 1L \qquad V^{sol}_{(0°C)} = 1L$

$\underline{\text{à } 95°C}$ $\quad V^{l}_{(95°C)} = V^{l}_{(0°C)}\left(1 + \delta \times 95\right) = 1 \times \left(1 + 2{,}1 10^{-4} \times 95\right) = 1{,}01995\,L$

$$V^{s}_{(95°C)} = V^{s}_{(0°C)}\left(1 + 3\lambda \times 95\right) = 1 \times \left(1 + 3 \times 8.10^{-6} \times 95\right) = 1{,}00228\,L$$

$$\Delta V = V^{l}_{(95°C)} - V^{s}_{(95°C)} = 1{,}767 . 10^{-2}\,L$$

4.3

$\underline{\text{Etat 1}}$	$\underline{\text{Etat 2}}$
$T_1 = 140°C$	$T_2 = 20°C$
$P_1 = 3\ bar$	$P_2 = ?$

$$n_1 = \frac{\cancel{P_1} V_1}{\cancel{R} T_1} = \frac{P_2 V_2}{\cancel{R} T_2}$$

$$P_2 = P_1 \frac{T_2}{T_1} = 3 \times \frac{20 + 273}{37 + 273}$$

$$P_2 = 2{,}13\ bar$$

4.4. $L(T_1) = L(T_0)\left(1 + \lambda(T_1 - T_0)\right)$

$$L(T_1 = 15°C) = 300\ m$$

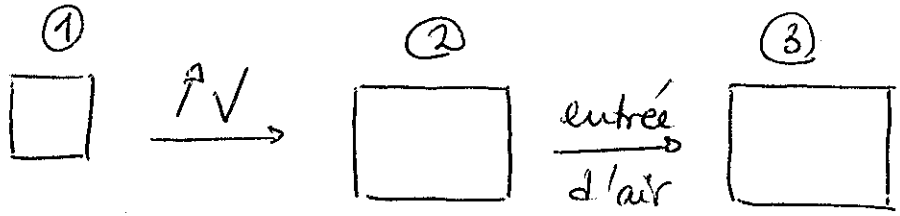
$$L(T_0 = 0°C) = 300 - 5{,}4 . 10^{-2} = 299{,}946\ m$$

$$\lambda = \left(\frac{L(T_1)}{L(T_0)} - 1\right) \times \frac{1}{T_1 - T_0}$$

$$= \left(\frac{300}{299{,}946} - 1\right) \times \frac{1}{15}$$

$$= 12 . 10^{-6}\ °C^{-1} = \lambda_{Acier}$$

5. Respiration et ventilation assistée



$P_1 = P_{atm}$	P_2	$P_3 = P_{atm}$
$V_1 = 2{,}5L$	$V_2 = 3L$	$V_3 = V_2 = 3L$
$T_1 = T_{air}$ $=$	T_2 $=$	T_3 $= 37°C$
n_1	$n_2 = n_1$	$n_3 > n_1$

5.1. $n_1 = \frac{P_1 V_1}{R\cancel{T_1}} = \frac{P_2 V_2}{R\cancel{T_2}}$ $\qquad P_2 = P_1 \frac{V_1}{V_2} = 760 \times 133{,}3 \times$

$P_2 = P_1 \frac{V_1}{V_2} =$

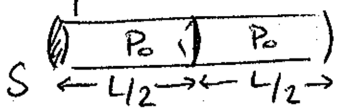
5.2. $n = n_3 - n_1 = \frac{P_3 V_3}{RT_3} - \frac{P_1 V_1}{RT_1} = \frac{P_{atm}}{RT_{air}} (V_3 - V_1)$

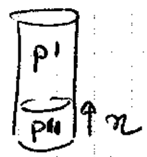
$= \frac{760 \times}{8{,}31 \times (37 + 273)} (0{,}5.10^{-3}) = 0{,}02 \text{ mol}$

5.3. $F = F_{int} - F_{ext} = (P_v - P_{atm}) S_{poumon}$

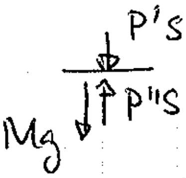
$= (763 - 760) \times 133{,}3 \times 200 = 80.10^3 \text{ N}$

6. Un piston dans un tube





6.1. Equilibre



$Mg + P'S - P''S = 0$

6.2. $n_0 = \frac{P_0 V_0}{R\cancel{T_0}} = n' = \frac{P'V'}{R\cancel{T'}} = n'' = \frac{P''V''}{R\cancel{T''}}$ $\qquad \left\{ \begin{array}{l} V_0 = S\frac{L}{2} \\ V' = S(L-x) \\ V'' = Sx \end{array} \right.$

$P' = \frac{P_0 V_0}{V'} \qquad P'' = \frac{P_0 V_0}{V''}$

$P' = P_0 \frac{L}{2(L-x)} \qquad P'' = P_0 \frac{L}{2x}$

6.3. $Mg + P'S - P''S = 0 = Mg + P_0 \frac{L}{2(L-x)} - P_0 \frac{L}{2x} = 0$

$(*) \Leftrightarrow 2x^2 - 2(1+a)x + a = 0$ avec $a = \frac{SP_0}{Mg}$

6.4. $a = \frac{SP_0}{Mg} = \frac{1.10^{-4} \times 1{,}013.10^5}{0{,}5 \times 10} = 2$

$(*) \Leftrightarrow x^2 - 3x + 1 = 0 \qquad \Delta = 5 \qquad \begin{array}{l} x_1 = 0{,}382 \text{ m} \\ \cancel{x_2 = 2{,}618 \text{ m}} > L \end{array}$

$x = 0{,}382 \text{ m}$

$P' = P_0 \frac{L}{2(L-x)} = 1 \times \frac{1}{2(1 - 0{,}382)} = 0{,}81 \text{ bar}$

$P'' = P_0 \frac{L}{2x} = 1 \times \frac{1}{2 \times 0{,}382} = 1{,}31 \text{ bar}$