

DILATATION

- $\alpha_L \approx 15 \cdot 10^{-5} \text{ K}^{-1}$ ($\frac{\Delta l}{l_0 \cdot \Delta \theta} = \alpha_L$)
- a) $l_{20} \approx 20,006 \text{ m}$ ($l = l_0 (1 + \alpha_L \cdot \Delta \theta)$)
b) $\theta' \approx 35^\circ \text{C}$ ($\theta' = 20^\circ \text{C} + \Delta \theta$; $\Delta \theta = \frac{\Delta l}{\alpha_L \cdot l}$)
- $d_0 \approx 1,68 \text{ m}$ ($l_0 = \frac{l}{1 + \alpha_L \cdot \Delta \theta}$; $\pi \cdot d_0 = \frac{\pi \cdot d}{1 + \alpha_L \cdot \Delta \theta}$ soit $d_0 = \frac{d}{1 + \alpha_L \cdot \Delta \theta}$)
- $\Delta l \approx 6 \cdot 10^{-6} \text{ m}$ soit $\Delta l \approx 1,5 \mu\text{m}$ ($\Delta l = \frac{F \cdot l}{E \cdot S}$)
- De 20°C à 40°C , la Tour Eiffel se dilate
De 20°C à -10°C , elle se contracte

variation de hauteur entre -10°C et $+40^\circ \text{C}$

$$l_{40} = \frac{l_{20}}{1 + \alpha_L \cdot \Delta \theta_2}$$

$$l_{40} = l_{20} \cdot (1 + \alpha_L \cdot \Delta \theta_1)$$

$$\Delta l = l_{40} - l_{20}$$

$$\Delta l = l_{20} \left[(1 + \alpha_L \cdot \Delta \theta_1) - \left(\frac{1}{1 + \alpha_L \cdot \Delta \theta_2} \right) \right]$$

$$\Delta l \approx 18 \text{ cm}$$

6.

Diagram showing two horizontal bars AB. The top bar is at 0°C and has length l_0 . The bottom bar is at 20°C and has length L . The diagram shows the expansion of the 20°C bar as the sum of the expansion of the 0°C bar and the contraction of the 0°C bar.

$$L = (l_0 + \alpha_{LA} \cdot l_0 \cdot \Delta \theta) + (l_0 + \alpha_{LB} \cdot l_0 \cdot \Delta \theta) - (l_0 + \alpha_{LA} \cdot l_0 \cdot \Delta \theta)$$

$$\Delta l = (l_0 + \alpha_{LB} \cdot l_0 \cdot \Delta \theta) - (l_0 + \alpha_{LA} \cdot l_0 \cdot \Delta \theta)$$

formons un système de 2 équations à 2 inconnues α_{LA} et α_{LB}

$$\begin{cases} l_0 + \alpha_{LA} \cdot l_0 \cdot \Delta \theta + l_0 + \alpha_{LB} \cdot l_0 \cdot \Delta \theta = L \\ l_0 + \alpha_{LB} \cdot l_0 \cdot \Delta \theta - l_0 - \alpha_{LA} \cdot l_0 \cdot \Delta \theta = \Delta l \end{cases}$$

(après de rudés efforts mathématiques :)

$$\alpha_{LA} \approx 2,3 \cdot 10^{-5} \text{ K}^{-1}$$

$$\alpha_{LB} \approx 2,9 \cdot 10^{-5} \text{ K}^{-1}$$

7. a)

Diagram of a square with side length l_0 and area S_0 . The side length is labeled l .

$$l = l_0 (1 + \alpha_L \cdot \Delta \theta)$$

b) cube

$$V_0 = l_0^3$$

$$V = l^3$$

$$\Delta V = V - V_0 \approx 3 \cdot \alpha_L \cdot V_0 \cdot \Delta \theta$$

$$S_0 = l_0^2$$

$$S = l^2 = [l_0 + \alpha_L \cdot l_0 \cdot \Delta \theta]^2$$

$$= l_0^2 + 2 \alpha_L \cdot l_0^2 \cdot \Delta \theta + \alpha_L^2 \cdot l_0^2 \cdot \Delta \theta^2$$

$$S \approx S_0 + 2 \alpha_L \cdot l_0^2 \cdot \Delta \theta$$

$$\Delta S = S - S_0 \approx 2 \cdot \alpha_L \cdot S_0 \cdot \Delta \theta$$

α_S

α_S à cause du fait que $\alpha_L^2 \cdot (10^{-5})^2 = 10^{-10}$

$$8. \Delta S = \alpha_S \cdot S_0 \cdot \Delta \theta$$

$$(\alpha_S = 2\alpha_L)$$

$$\Delta S = 2\alpha_L \cdot S_0 \cdot \Delta \theta$$

$$\Delta S \approx 0,0028 \text{ m}^2$$

$$28 \text{ cm}^2$$

$$9. S = S_0 (1 + 2\alpha_L \cdot \Delta \theta)$$

$$S \approx 0,1965 \text{ m}^2$$

$$10. a) \Delta S \approx 0,048 \text{ cm}^2$$

$$(4,8 \text{ mm}^2)$$

$$\Delta V \approx 0,0234 \text{ cm}^3$$

$$(23,4 \text{ mm}^3)$$

$$b) S_{100} \approx 12,61 \text{ cm}^2$$

$$V_{100} \approx 4,2127 \text{ cm}^3$$

$$11. a) \text{ Surface latérale } \approx 1,4137 \text{ m}^2$$

$$\text{Volume } \approx 0,1060 \text{ m}^3$$

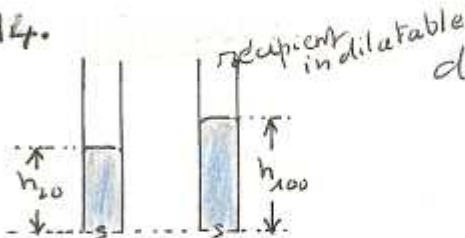
$$b) S_{u0} \approx 1,4143 \text{ m}^2 \text{ or } V_{u0} \approx 0,1061 \text{ m}^3$$

$$12. \text{contraction } C(-30) = \frac{C(20)}{1 + 3\alpha_L \cdot \Delta \theta}$$

$$(\Delta \theta = 70^\circ \text{C})$$

$$C(-30) \approx 998,2 \text{ L} < 1000 \text{ L}$$

14.



dilatation volumique

$$V_{100} = V_{20} \cdot (1 + \alpha_V \cdot \Delta \theta)$$

$$h_{100} = h_{20} \cdot (1 + \alpha_V \cdot \Delta \theta)$$

$$h_{100} = h_{20} (1 + \alpha_V \cdot \Delta \theta)$$

$$h_{100} \approx 16,23 \text{ cm}$$

$$15. V_{80} = V_0 (1 + \alpha \cdot \Delta \theta)$$

$$V_{80} \approx 29,0 \text{ L} \quad (\Delta V \approx 6,6 \text{ L})!$$

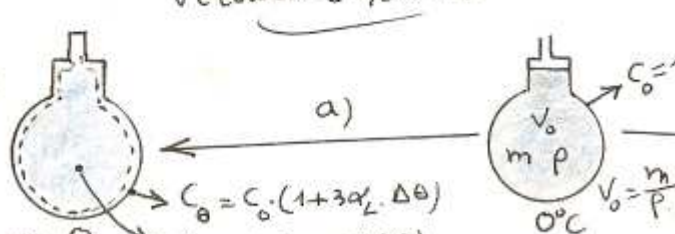
$$16. V_{\text{écoulé}} = \Delta V_{\text{mercure}} - \Delta V_{\text{récepteur}}$$

$$\alpha \cdot V_0 \cdot \Delta \theta - 3\alpha_L \cdot V_0 \cdot \Delta \theta \quad (V_0 = \frac{m}{\rho})$$

$$V_{\text{écoulé}} = \frac{m}{\rho} \cdot \Delta \theta \cdot (\alpha - 3\alpha_L)$$

$$V_{\text{écoulé}} \approx 0,805 \text{ cm}^3$$

17.



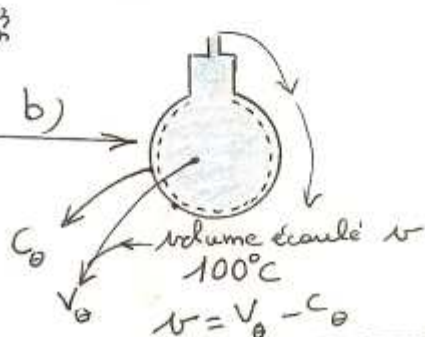
$$C_\theta = C_0 (1 + 3\alpha_L \cdot \Delta \theta)$$

$$V_\theta = V_0 (1 + \alpha \cdot \Delta \theta)$$

$$V_\theta = C_\theta : C_0 (1 + 3\alpha_L \cdot \Delta \theta) = V_0 (1 + \alpha \cdot \Delta \theta)$$

$$\theta = \frac{C_0 - V_0}{V_0 \alpha - 3\alpha_L C_0}$$

$$\theta \approx 58,5^\circ \text{C}$$



$$v = V_\theta - C_\theta$$

$$v = V_0 (1 + 100\alpha) - C_0 (1 + 300\alpha_L)$$

$$v \approx 0,636 \text{ cm}^3$$

$$c) v = V_0 (1 + \alpha \cdot \theta) - C_0 (1 + 3\alpha_L \cdot \theta)$$

$$v = \theta (\alpha \cdot V_0 - 3\alpha_L \cdot C_0) + (V_0 - C_0)$$

$$v = 0,01534 \cdot \theta - 0,84798$$

Extraits BTS!...

TP 1991

$$1. T = 2\pi \sqrt{\frac{l}{g}}$$

$$T \approx 3,173495$$

2. sous l'effet de la dilatation, le câble s'allonge

$$l' = l \cdot (1 + \alpha_L \cdot \Delta \theta)$$

$$l' = 2,5006 \text{ m}$$

$$T' = 2\pi \sqrt{\frac{l'}{g}}$$

$$T' \approx 3,173875$$

3. incertitude relative $\frac{\Delta T}{T} \approx 1,2\text{‰} (0,012\%)$

X₁ 1. $\Delta l = \alpha_L \cdot l \cdot \Delta \theta$ $\Delta l \approx 1,8 \cdot 10^{-3} \text{ m}$
1,8 mm

2. $\Delta l = \frac{F \cdot l_0}{E \cdot S}$ $F = \frac{E \cdot S \cdot \Delta l}{l_0}$ $F_{30} \approx 3600 \text{ N}$
3,6 kN

3. $P = \frac{F}{S}$ $P_{30} = \frac{E \cdot \Delta l}{l_0}$ $P_{30} \approx 36\,000\,000 \text{ Pa}$
36 MPa

4. $P_{30} \gg P_{adm} (100\,000 \text{ Pa})$ \leftarrow c'est énorme!!!

5. $\alpha_L \text{ béton} \approx \alpha_L \text{ acier}$ \rightarrow les joints de dilatation permettent \propto agrandissement des plaques sans risque de fissures ... n'importe!!!