le,.....

- Correction TD n° 2 -

Exercice 1 :

$$\ln(d) = \ln(m) - \ln(a) - \ln(b) - \ln(c)$$

$$\frac{dd}{d} = \frac{dm}{m} - \frac{da}{|a|} - \frac{db}{b} - \frac{dc}{c}.$$

$$\frac{\Delta d}{d} = \frac{\Delta m}{m} + \frac{\Delta a}{a} + \frac{\Delta b}{b} + \frac{\Delta c}{c}.$$

$$= 1 + 1 + 2 + 0,5 = 4,5\ \%.$$

Exercice 2 :

1° $R_{eq} = 37,2 \pm 0,7\ \Omega$.

2° $R_{eq} = \dfrac{R_1 R_2}{R_1 + R_2}$

$$\ln R_{eq} = \ln(R_1) + \ln(R_2) - \ln(R_1 + R_2).$$

$$\frac{dR_{eq}}{R_{eq}} = \frac{dR_1}{R_1} + \frac{dR_2}{R_2} - \frac{d(R_1 + R_2)}{R_1 + R_2}.$$

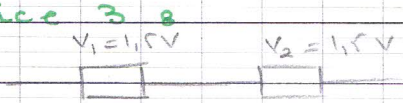
$$= \left(\frac{1}{R_1} - \frac{1}{R_1 + R_2}\right) dR_1 + \left(\frac{1}{R_2} - \frac{1}{R_1 + R_2}\right) dR_2.$$

$$\frac{\Delta R_{eq}}{R_{eq}} = \left(\frac{1}{R_1} - \frac{1}{R_1 + R_2}\right) \Delta R_1 + \left(\frac{1}{R_2} - \frac{1}{R_1 + R_2}\right) \Delta R_2. = 1,87\ \%$$

$R_{eq} = 7,62\ \Omega \Rightarrow \Delta R_{eq} = 0,14\ \Omega$.

$\Rightarrow R_{eq} = 7,62 \pm 0,14\ \Omega$.

Exercice 3 :



$$V = V_1 + V_2 = 3\ V$$

$$\frac{\Delta V_1}{V_1} = \frac{\Delta V_2}{V_2} = 1\ \%.$$

$$\Delta V = \Delta V_1 + \Delta V_2 = 1,5 \times 0,01 + 1,5 \times 0,01 = 0,03\ V$$

le,.....

Exercice 4 :

$$A = \frac{V_c - V_s}{V_i - V_s}$$

$$\ln(A) = \ln(V_c - V_s) - \ln(V_i - V_s)$$

$$\frac{dA}{A} = \frac{d(V_c - V_s)}{V_c - V_s} - \frac{d(V_i - V_s)}{V_i - V_s}$$

$$= \frac{1}{V_c - V_s} dV_c - \frac{1}{V_i - V_s} dV_i + \left(\frac{1}{V_i - V_s} - \frac{1}{V_c - V_s}\right) dV_s$$

$$\Delta A = A\left(\left(\frac{1}{V_c - V_s}\right)\Delta V_c + \left(\frac{1}{V_i - V_s}\right)\Delta V_i + \left(\frac{1}{V_c - V_s} - \frac{1}{V_i - V_s}\right)\Delta V_s\right)$$

$$= A\,\Delta V\left(\frac{1}{V_c - V_s} + \frac{1}{V_i - V_s} + \frac{1}{V_c - V_s} - \frac{1}{V_i - V_s}\right)$$

$$= A\,\Delta V \frac{2}{V_c - V_s} = \frac{2\,\Delta V}{V_i - V_s}$$

Exercice 5 :

$$V = \frac{4}{3}\pi R^3$$

$$dV = \frac{3 \times 4}{3}\pi R^2 dR = 4\pi R^2 dR$$

$$\Rightarrow \Delta V = 4\pi R^2 \Delta R$$

$$= 4\pi \frac{d^2}{4} \frac{\Delta d}{2}$$

$$= \frac{\pi}{2} d^2 \Delta d$$

A.N $\quad \Delta V = \frac{\pi}{2} \times 100^2 \times 10^{-6} \times 0,05 \times 10^{-3} = 0,7\,9 \cdot 10^{-7}\ m^3$

$$= 0,0\,7\,9\ mm^3$$

Exercice 6 :

$$E(T) = T_{int} - T_{ext}$$

$$\Delta E = \Delta T_{int} + \Delta T_{ext} = 2\,\Delta T$$

Précision par rapport à l'échelle totale $= \frac{\Delta T}{\frac{\text{pleine échelle}}{50\,^\circ C}} = 1\%$

$$\Delta T = 0,5\,^\circ C$$

$$\Rightarrow \Delta E = 2 \times \Delta T = 1\,^\circ C$$

le,.....

$$\frac{\Delta E}{E} = \frac{1}{15} = 0,06\%$$

Exercice 7 :

1° $\ln(g) = \ln(4\pi^2) + \ln(L) - 2\ln(T)$.

$$\frac{dg}{g} = \frac{dL}{L} - 2\frac{dT}{T}.$$

$$\frac{\Delta g}{g} = \frac{\Delta L}{L} + 2\frac{\Delta T}{T}.$$

$$\Delta g = \frac{4\pi^2 L}{T^2}\left(\frac{\Delta L}{L} + 2\frac{\Delta T}{T}\right).$$

$$= \frac{4\pi^2}{T^2}\Delta L + \frac{8\pi^2}{T^3}\Delta T.$$

2° $T = \frac{t}{N}$, $\frac{dT}{T} = \frac{dt}{Nt}$.

$$\frac{\Delta T}{T} = \frac{\Delta t}{t} \Rightarrow t = \frac{\Delta t}{\Delta T} * T = 10\,s$$

3° $T = 0,625\,s = \frac{10}{16}$.

4° $g = 10,53\ m.s^{-2}$

$\Delta g = 0,22\ m.s^{-2}$

Exercice 6 : (TD 2')

1° Le capteur est constitué de deux lames soudées à plat dont les coefficients de dilatation sont très différent. Lors d'un changement de température le rayon de courbure varie.

2° $\Delta l = \alpha . l_0 . \Delta T$

$\Delta l_1 = \alpha_1 . l_0 . \Delta T$. A.N : $\Delta l_1 = 0,0004188\ m$

$\Delta l_2 = \alpha_2 . l_0 . \Delta T$ A.N : $\Delta l_2 = 0,00002\,6\ m$.

3° $\rho = 1,26$

le,.....

4° - sensibilité = $\frac{dP}{d(\Delta T)}$

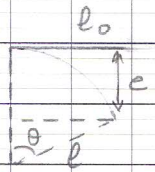
$P = \frac{k}{\Delta T} \Rightarrow dP = -\frac{k}{\Delta T^2} d(\Delta T)$.

$\frac{dP}{d(\Delta T)} = -\frac{k}{\Delta T^2} = \left| -\frac{P}{\Delta T} \right| = \frac{1,26}{110} = 0,01 \text{ m/C°}$.

5° - sensibilité = $\frac{\Delta P_{min}}{\Delta T_{min}}$: résolution

$\Rightarrow$ résolution = $\frac{\Delta P_{min}}{6} = 10^{-4} °C$

6° -



$e = P - P\cos\theta$.

$= P - P\cos\left(\frac{L}{P}\right)$

$= P\left(1 - \cos\left(\frac{L}{P}\right)\right)$.

7° - $e = P\left(1 - \cos\left(\frac{l}{P}\right)\right)$.

$de = \frac{\partial e}{\partial P} dP + \frac{\partial e}{\partial l} dl$.

$= \left(1 - \cos\left(\frac{l}{P}\right)\right) - \frac{l}{P^2} \sin\left(\frac{l}{P}\right) dP + \sin\left(\frac{l}{P}\right) dl$