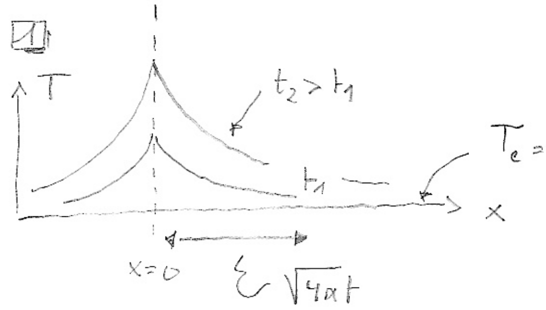
EX 6

1



2

$$\underbrace{\alpha}_{[m^2/s]} = \frac{k}{\rho c} \quad \text{DIFFUSIVITE THERMIQUE}$$

3

$$\boxed{\begin{aligned} &T(x,0) = T_e \\ &-k\frac{\partial T}{\partial x}(0,t) = q \\ &\lim_{x\to\infty} T(x,t) = T_e \end{aligned}}$$

4

$$T(x,t) - T_e = \underbrace{\frac{q\sqrt{4\alpha t}}{k\sqrt{\pi}}}_{D\sqrt{4\alpha t}} \, f\Big(\underbrace{\frac{x}{\sqrt{4\alpha t}}}_{\eta}\Big)$$

- $\frac{\partial T}{\partial t} = D\sqrt{4\alpha t}\, f' \underbrace{\frac{d\eta}{dt}}_{= -\frac{\eta}{2t}} + D f \sqrt{4\alpha}\,\frac{1}{2\sqrt{t}}$:-)

$= D\sqrt{\frac{\alpha}{t}}\,(f - \eta f')$

- $\frac{\partial T}{\partial x} = D\sqrt{4\alpha t}\, f' \underbrace{\frac{d\eta}{dx}}_{\frac{1}{\sqrt{4\alpha t}}} = D f'$

- $\frac{\partial^2 T}{\partial x^2} = D f'' \frac{1}{\sqrt{4\alpha t}}$

$$\frac{1}{\alpha}\sqrt{\frac{\alpha}{t}}\,(f - \eta f') = \frac{1}{\sqrt{4\alpha t}}\, f''$$

$$\boxed{2(f - \eta f') = f''}$$

5

- $f = A\exp(-\eta^2) + B\eta + C\,\mathrm{erf}(\eta)\,\eta$
- $f' = -2\eta A\exp(-\eta^2) + B + C\,\mathrm{erf}(\eta) + \frac{2C}{\sqrt{\pi}}\exp(-\eta^2)\,\eta$

$= \left(\frac{2C}{\sqrt{\pi}} - 2A\right)\eta\exp(-\eta^2) + B + C\,\mathrm{erf}(\eta)$

- $f'' = \left(\frac{2C}{\sqrt{\pi}} - 2A\right)\left[(-2\eta^2)\exp(-\eta^2) + \exp(-\eta^2)\right] + \frac{2C}{\sqrt{\pi}}\exp(-\eta^2)$

DANS

$$\exp(-\eta^2)\left[4A - \frac{4C}{\sqrt{\pi}}\right] + \eta\left[\cancel{2B - 2B}\right]$$
$$+ \eta\,\mathrm{erf}(\eta)\left[\cancel{2C - 2C}\right]$$
$$+ 2\eta^2\exp(-\eta^2)\left[\cancel{-\left(\frac{2C}{\sqrt{\pi}} - 2A\right) + \left(\frac{2C}{\sqrt{\pi}} - 2A\right)}\right] = 0$$

$$\boxed{A = \frac{C}{\sqrt{\pi}}}$$

- $\left.\frac{\partial T}{\partial x}\right|_{x=0} = -\frac{q}{k}$

$$\boxed{B = -\sqrt{\pi}}$$

$$\boxed{\underbrace{\frac{q}{k\sqrt{\pi}}}_{D}\ \underbrace{f'(0)}_{= B\ :-)} = -\frac{q}{k}}$$

- $\lim_{x\to\infty} T - T_e = 0$

$$D\sqrt{4\alpha t}\lim_{\eta\to\infty}\Big[A\underbrace{\exp(-\eta^2)}_{\to 0} + \underbrace{\underbrace{\eta}_{\to\infty}\overbrace{\big(B + C\,\underbrace{\mathrm{erf}(\eta)}_{\to 1}\big)}^{\to 0 \text{ si } C=-B}}_{\to 0}\Big]$$

$$\boxed{C = -B}$$

EN APPLIQUANT LA REGLE DE L'HOSPITAL :-)

$$\frac{1-\mathrm{erf}(\eta)}{1/\eta} \to \frac{\exp(-\eta^2)}{-1/\eta^2}$$

L'EXPONENTIELLE TEND PLUS VITE VERS ZERO !

CA SE VERIFIE AUSSI AVEC PYTHON :-)

CONCLUSION

$$f(\eta) = \Big[\exp(-\eta^2) + \sqrt{\pi}\,\eta\,\big[\mathrm{erf}(\eta) - 1\big]$$

6

DECCELERATION CONSTANTE SERA NEGATIVE

$v_f = at + v_i$

$L = \frac{at^2}{2} + v_i t$

MRUA :-)

SO EASY!

$$\boxed{a = \frac{v_f - v_i}{t}}$$

$$\boxed{L = \frac{v_f - v_i}{2} t + v_i t = \frac{v_f + v_i}{2} t}$$

$100 \times \frac{1000}{3600} = 100$ m/s

$180 \times \frac{1000}{3600} = 50$ m/s

$$\boxed{t = \frac{100}{75} = \frac{4}{3}\ s}$$

$$\boxed{a = \frac{v_f - v_i}{t} = -50\ \frac{3}{4} = -37,5\ m/s^2}$$

$$\boxed{+/-\ 3,8\ g}$$

8

$$E = \frac{1}{2} \underbrace{M}_{480} \left(\underbrace{v_i^2}_{10000} - \underbrace{v_f^2}_{2500} \right) = 24 \times 75\ 10^3 = 18\ 10^5\ J$$

$$\boxed{q = \frac{18\ 10^5}{8\ 50\ 10^{-4}\ \underbrace{4/3}} = \underbrace{\frac{27}{8}}_{3,375} 10^7\ W/m^2}$$

4 ROUES
2 PLAQUETTES

TEMPS
DE FREINAGE

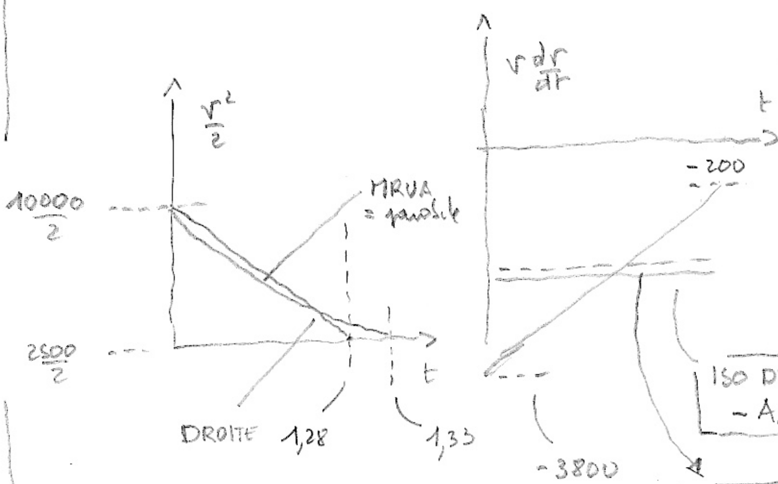
?!

EST-CE
QUE CETTE VALEUR
MOYENNE D'UN MRUA
EST UNE BONNE ESTIMATION ?

CALCUL
D'UNE DECELLERATION
AVEC DISSIPATION CONSTANTE

$$\frac{d}{dt}\left(\frac{v^2}{2}\right) = at$$

$$\boxed{v_f = \sqrt{v_i^2 - At}}$$



$$\boxed{\begin{aligned} A &= 5833 \\ t &= 1,28\ sec \end{aligned}}$$

BEL EXERCICE
A FAIRE
AU PASSAGE !

ISO DISSIPATIF
$-A/2 = -2917$

MOYENNE
MRUA $= -2885$:-)

EFFECTUER
LA MOYENNE DU MRUA
EST UNE EXCELLENTE ESTIMATION !

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$$T(0,t) - T_e = \frac{q}{k\sqrt{\pi}} \sqrt{4\alpha t} \left[\underbrace{\exp(0)}_{=1} + \sqrt{\pi}\ 0 \left(\mathrm{erf}(0) - 1 \right) \right]$$

$$\boxed{\begin{aligned} T(0,t) = T_e &+ 2q \sqrt{\frac{\frac{k}{\rho c} t}{k^2 \pi}} \\ &+ 2q \sqrt{\frac{t}{k \rho c \pi}} \end{aligned}}$$

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COMME
ON EXIGE

$$T(0,t) - T_e$$

IDENTIQUE
POUR LES DEUX MILIEUX :-)

$$\boxed{\frac{q_d}{q_p} = \frac{\sqrt{k_d \rho_d c_d}}{\sqrt{k_p \rho_p c_p}} = \frac{\sqrt{81\ 10^6}}{\sqrt{1350 \times 135000}} = \frac{9\ 10^3}{13{,}5\ 10^3} = \frac{2}{3}}$$

$$q = q_d + q_p$$
$$+ \frac{3}{2} q_d$$
$$= \frac{5}{2} q_d$$

$$\boxed{\begin{aligned} q_d &= \tfrac{2}{5}\, q \\ q_p &= \tfrac{3}{5}\, q \end{aligned}}$$

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$$T_f = 2 \underbrace{\sqrt{\frac{4}{3}\pi \frac{1}{9\,10^3}}}_{\sqrt{\frac{t_f}{k_d \rho_d c_p \pi}}} \underbrace{\underbrace{33{,}75\ 10^6}_{q}\ \frac{2}{5}}_{q_d}$$

$$= \frac{8 \times 33{,}75}{45\sqrt{3\pi}}\, 10^3 = \underbrace{1954\,°C}$$

REMPLACER
L'ACIER PAR
LE CARBONE ?

OK CARBONE
KO ACIER