18

$$k\frac{q^2}{r^2} = G\frac{m^2}{r^2}$$

$$\boxed{q = m\sqrt{\frac{G}{k}}}$$

LES DEUX CHARGES DOIVENT AVOIR LE MÊME SIGNE !

$$\sqrt{\frac{6{,}674\ 10^{-11}}{8{,}988\ 10^{9}}} = 0{,}8617\ 10^{-10}\ [C/kg]$$

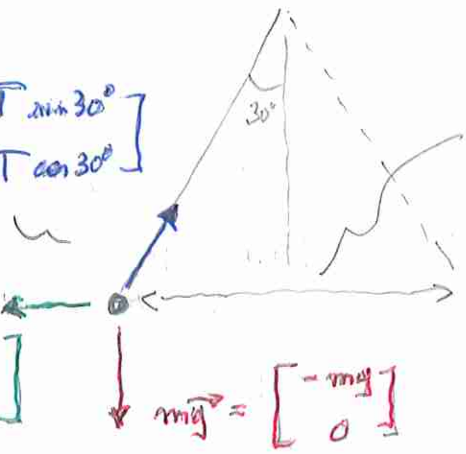
1 Tonne $\rightarrow 10^3$ kg $\longrightarrow$ $q = 0{,}8617\ 10^{-7}\ [C]$

NOMBRE DE CHARGES ELEMENTAIRES POUR UNE TONNE $= \frac{q}{e} = 0{,}5379\ 10^{12}$

AH OUI QUAND MEME :-)

19

$$\vec{T} = \begin{bmatrix} T\sin 30^\circ \\ T\cos 30^\circ \end{bmatrix}$$



$r = \underbrace{2L\sin(30^\circ)}_{=1}$:-) EH OUI !!

LE DESSIN DONNAIT LA REPONSE !

$$\vec{F_E} = \begin{bmatrix} -\frac{kq^2}{r^2} \\ 0 \end{bmatrix} \qquad m\vec{g} = \begin{bmatrix} -mg \\ 0 \end{bmatrix}$$

$$\boxed{\sum \vec{F} = 0}$$

$$\begin{cases} T\sin 30^\circ = kq^2/r^2 \\ T\cos 30^\circ = mg \end{cases}$$

$T = mg/\cos 30^\circ$

$$\frac{mg}{k}\frac{\sin(30^\circ)}{\cos(30^\circ)} = \frac{q^2}{\underbrace{r^2}_{=1}}$$

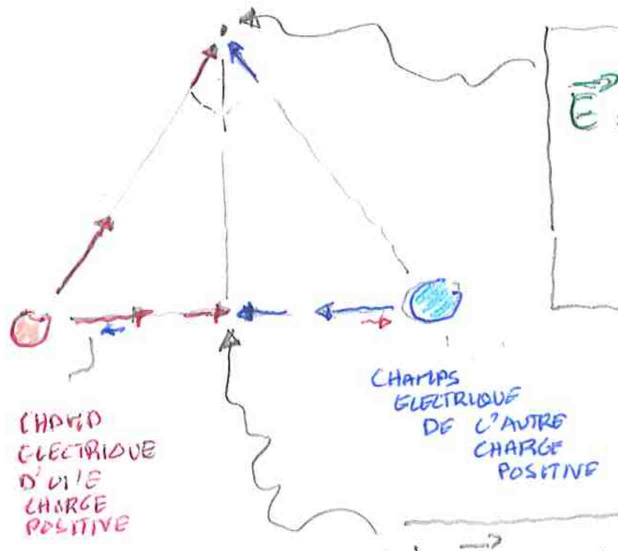
$$\boxed{\sqrt{\overbrace{\frac{mg}{k}}^{0.1 \cdot 9{,}81}\ \frac{1}{\sqrt{3}}} = q}$$

$k = 8{,}988\ 10^9$

$0.0794\ 10^{-4}\ [C]$

$$\boxed{q = 7.9\ \underbrace{10^{-6}\ [C]}_{[\mu C]}}$$

LA MEME SITUATION PEUT ETRE OBTENUE POUR DES CHARGES DIFFERENTES SI $q_1 q_2 = q^2$:-)



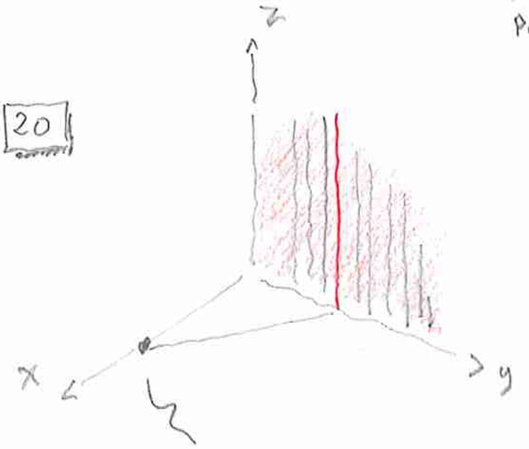
$$\vec{E} = \begin{bmatrix} 2\cos(30°)\, kq \\ 0 \end{bmatrix}$$

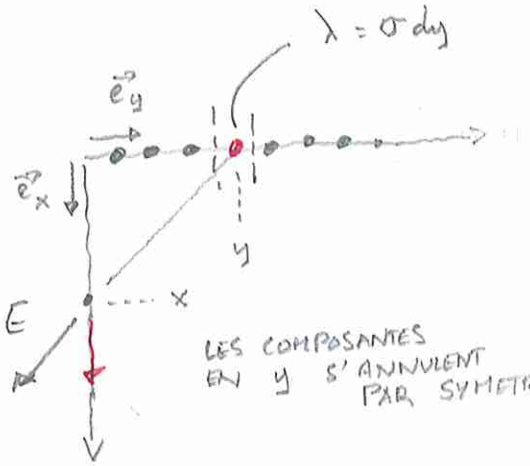
$$\boxed{\begin{aligned} E &= \sqrt{3}\, kq \\ &= 1{,}2\ 10^5\ [N/C] \end{aligned}}$$

Ici $\vec{E} = 0$:-)
PAR SYMETRIE !

POSITION STABLE POUR UNE CHARGE POSITIVE
INSTABLE POUR UNE CHARGE NEGATIVE

$\boxed{20}$





LES COMPOSANTES EN y S'ANNULENT PAR SYMETRIE !

$$E_x(x) = \frac{\lambda}{2\pi\varepsilon_0} \underbrace{\frac{x}{\sqrt{x^2+y^2}}}_{\text{POUR AVOIR LA COMPOSANTE EN } x\ !} \underbrace{\frac{1}{\sqrt{x^2+y^2}}}_{\frac{1}{r}\ :-)}$$

$$E(x) = \frac{\sigma}{2\pi\varepsilon_0} \int_{-\infty}^{\infty} \frac{x}{x^2+y^2}\, dy$$

$$= \frac{\sigma}{2\pi\varepsilon_0} \int_{-\infty}^{\infty} \frac{1}{1+\underbrace{(y/x)^2}_{t^2}} \overbrace{1/x\, dy}^{dt}$$

$$= \frac{\sigma}{2\pi\varepsilon_0} \underbrace{\int_{-\infty}^{\infty} \frac{1}{1+t^2}\, dt}$$

$$\left[\arctan(t)\right]_{-\infty}^{+\infty} = (\pi/2 + \pi/2) = \pi$$

$$\longrightarrow \boxed{E(x) = \frac{\sigma}{2\varepsilon_0}}$$

$\square$

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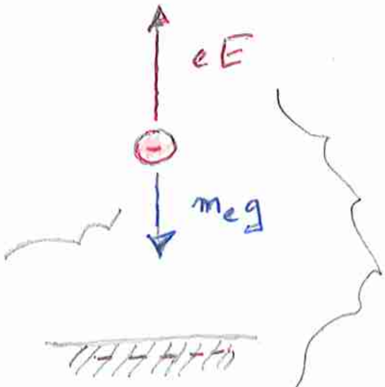
$$\boxed{\begin{aligned} x(t) &= v_0 t + x_0 \\ y(t) &= \Big(\underbrace{\frac{eE}{m_e}}_{\simeq 26\ 10^{12}\ [m/s^2]} - \underbrace{g}_{\simeq 9{,}81\ [m/s^2]}\Big)\frac{t^2}{2} + y_0 \end{aligned}}$$ MRUA



LA GRAVITE FAIT TOMBER L'e⁻

LA FORCE DE COULOMB LE FAIT MONTER

LA FORCE ELECTRIQUE L'EMPORTE SUR LA GRAVITE !
NO DISCUSSION :-)

$$\boxed{E_* = \frac{m_e g}{e} = \underbrace{5{,}6\ 10^{-11}}_{\text{AH OUI C'EST PETIT !}}\ [N/C]}$$

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$F_D = 6\pi R \mu\, v(t)$

$F_e = qE$

$v(t)$

$$\underbrace{\frac{4}{3}\pi R^3(\rho_h - \rho_a)g}_{F_g - F_a}$$

$$\boxed{m\vec{a} = \sum \vec{F}}$$

$$\boxed{\underbrace{\frac{4}{3}\pi R^3 \rho_h}_{m}\frac{dv}{dt}(t) = \underbrace{\frac{4}{3}\pi R^3(\rho_h - \rho_a)g}_{F_g - F_a} - \overbrace{6\pi R \mu\, v(t)}^{F_D} - qE}$$

- VITESSE TERMINALE

$$\frac{4}{3}\cancel{\pi} R^3(\rho_h - \rho_a)g = 6\cancel{\pi} R \mu v_c$$

$$\boxed{\begin{aligned} m\frac{dv}{dt} &= 0 \quad :-) \\ E &= 0 \quad :-) \end{aligned}}$$

$$\boxed{R = \sqrt{\frac{9}{2}\,\frac{\mu v_c}{g(\rho_h - \rho_a)}}}$$

- GOUTTE EN EQUILIBRE

$$\boxed{\begin{array}{l} m\dfrac{dv}{dt} = 0 \text{ :-)} \\ v = 0 \text{ :-)} \end{array}}$$

$$\frac{4}{3}\pi R^3 (\rho_h - \rho_a) g = qE$$

$$R^3 = \left(\frac{9}{2} \, \frac{\mu \, v_c}{g(\rho_h - \rho_a)} \right)^{3/2}$$

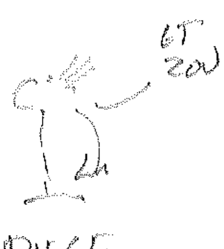
$$q = \frac{4\pi}{3E} \sqrt{\frac{9^3}{2^3} \, \frac{\mu^3 \, v_c^3}{g(\rho_h - \rho_a)}}$$

$$= \frac{\pi}{E} \sqrt{\frac{9^3}{9} \, \frac{2^4}{2^3} \, \frac{\mu^3 \, v_c^3}{g(\rho_h - \rho_a)}}$$

$$\boxed{q = \frac{\pi}{E} \sqrt{162} \sqrt{\frac{\mu^3 \, v_c^3}{g(\rho_h - \rho_a)}}}$$

LES 4 EXPERIENCES :-)

$q =$	$1{,}59 \cdot 10^{-19}$	[C]	$\simeq$	e
	$3{,}23 \cdot 10^{-19}$	[C]	$\simeq$	$2e$
	$4{,}79 \cdot 10^{-19}$	[C]	$\simeq$	$3e$
	$8{,}09 \cdot 10^{-19}$	[C]	$\simeq$	$5e$



PIECE OF CAKE :-)