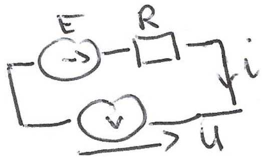
Correction DS2 PCSI2
6 novembre 2024.

Ex1
Partiel

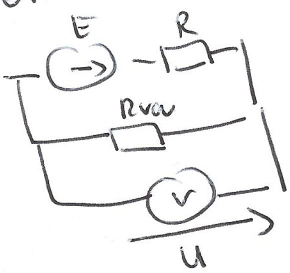
1- On démarche le générateur et on branche un voltmètre à ses bornes

a) 

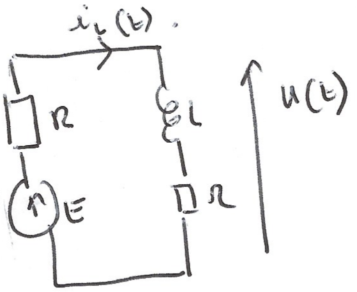
$i = \frac{E}{R+R_V} \to 0$ si $R_V \gg R$.

On mesure $U = E$.

On insère ds le circuit une résistance variable R_{var}.

b) 

$U = \frac{R_{var}}{R+R_{var}} \cdot E$ lorsque $R_{var} = R$ $U = \frac{E}{2}$.

2]. 

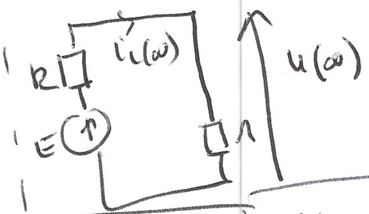
à $t=0^-$ $E(t)=0 \Rightarrow i_L(0^-)=0$.

i_L continue $\Rightarrow \boxed{i_L(0^+)=0}$

$u(t) = E - Ri_L(t)$

d'où $\boxed{u(0^+)=E}$

à l'∞ L ⟺ —



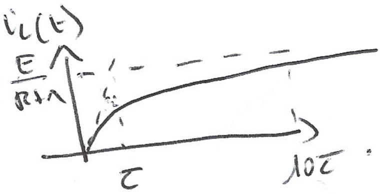
$\boxed{i_L(\infty)=\frac{E}{R+r}}$ $\boxed{u_L(\infty)=\frac{r}{R+r}}$

3] $E = (R+r)i_L + L\frac{di_L}{dt}$ (loi des mailles).

4] $\frac{di_L}{dt} + \frac{R+r}{L} i_L = \frac{E}{L}$ $\Rightarrow \tau = \frac{L}{R+r}$ $t > 10\tau$ $i_L(t) \to$ régime permanent $= S_p$.

5] $i_L(t) = Ae^{-\frac{t}{\tau}} + S_p$ avec $S_p = \frac{E}{R+r}$

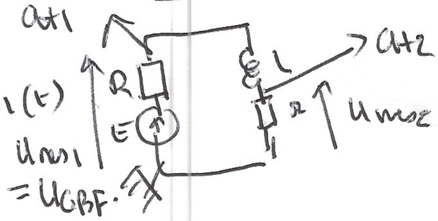
à $t=0^+$ $i_L(0^+)=0$ $\Rightarrow$ $\boxed{i_L(t) = \frac{E}{R+r}\left(1-\exp^{-\frac{t}{\tau}}\right)}$

6) 

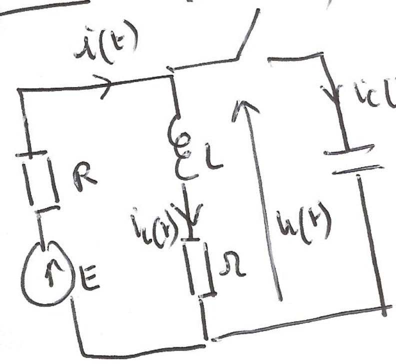
7) $u_L(t) = E - Ri_L(t) = E - \frac{RE}{R+r} + \frac{RE}{R+r}e^{-\frac{t}{\tau}} = \boxed{\frac{r\,E}{R+r} + \frac{R.E}{R+r}e^{-\frac{t}{\tau}}} = u_L(t)$

$u_L(\infty) = \frac{rE}{R+r}$.

8] $u_r(t) = r.i_L(t)$ à visualiser pour observer $i_L(t)$



...cice 2   9]



a) ($t=0^-$) correspond au régime permanent quand K ouvert depuis longtemps. (Le condensateur n'est pas branché).

$$i_L(\infty) = \frac{E}{r+R} = i(\infty)$$

$$u(\infty) = \frac{r}{R+r}\cdot E \qquad i_C(\infty)=0$$

constitue $t=0^-$ ...

On ferme K $\Rightarrow$

b) $\underline{t=0^+}$ le condensateur était déchargé $\Rightarrow$ $\boxed{u(0^+)=0}$ par continuité.

$\boxed{i_L(0^+) = i_L(0^-) = \frac{E}{r+R}}$ (Le courant ds la bobine est continu.

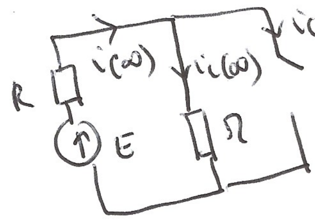
$$u(t) = E - Ri(t) \Rightarrow \boxed{i(0^+) = \frac{E}{R}}$$

$$i(t) = i_C + i_L \Rightarrow i_C(t) = i(t) - i_L(t)$$

$$i_C(0^+) = \frac{E}{R} - \frac{E}{r+R} = \boxed{\frac{r\cdot E}{R(r+R)} = i_C(0^+)}$$

c) $t\to\infty$. —m— $\Rightarrow$ —— donc le circuit devient.

—||— $\Rightarrow$ —/—



$$\rightarrow i_C(\infty)=0$$

$$\boxed{i(\infty) = i_L(\infty) = \frac{E}{r+R}} \qquad \boxed{u(\infty) = \frac{r}{R+r}E}$$

10) $\underline{\text{eq. diff}}$ sur $i_L(t)$

(1) $u(t) = E - Ri(t) \Rightarrow i(t) = \frac{E-u}{R} \overset{2}{=} \frac{E}{R} - \frac{L}{R}\frac{di_L}{dt} - \frac{r i_L}{R}$

(2) $u(t) = L\frac{di_L}{dt} + r i_L(t)$

(3) $i_C(t) = C\frac{du}{dt} \overset{2}{\Rightarrow} i_C(t) = LC\frac{d^2 i_L}{dt^2} + rC\frac{di_L}{dt}$

(4) $i(t) = i_C(t) + i_L(t)$

(4) $\Rightarrow \frac{E}{R} - \frac{L}{R}\frac{di_L}{dt} - \frac{r}{R}i_L = LC\frac{d^2 i_L}{dt^2} + rC\frac{di_L}{dt} + i_L.$

$$\cancel{LC}\frac{d^2 i_L}{dt^2} + \underbrace{\frac{1}{LC}\left(rC + \frac{L}{R}\right)}_{\frac{\omega_0}{Q}}\frac{di_L}{dt} + \underbrace{\frac{\left(1+\frac{r}{R}\right)}{LC}}_{\omega_0^2} i_L = \frac{E}{RLC}$$

$$\boxed{\omega_0^2 = \frac{1+\frac{r}{R}}{LC}}$$

$$\frac{\omega_0}{Q} = \frac{rC + \frac{L}{R}}{LC}.$$

d'où $Q = \frac{LC}{rC+\frac{L}{R}} \cdot \omega_0 = \frac{LC}{rC+\frac{L}{R}} \cdot \frac{\sqrt{1+\frac{r}{R}}}{\sqrt{LC}}$ $\Rightarrow$ $\boxed{Q = \frac{\sqrt{1+\frac{r}{R}}}{rC+\frac{L}{R}}\cdot\sqrt{LC}}$

D'après l'éq. diff $[Q] = 1$ $[\omega_0] = T^{-1}$.

or $\omega_0 = \sqrt{\dfrac{1+\frac{r}{R}}{LC}}$ $\left[1+\frac{r}{R}\right] = 1$ et $\left[\frac{L}{R}\right]$ et $[RC] = T \Rightarrow [LC] = T^2$.

donc ω_0 est bien homogène et Q aussi.

$$Q = \frac{\overbrace{\sqrt{1+\frac{r}{R}}}^{\to 1} \cdot \overbrace{\sqrt{LC}}^{\to T}}{\underbrace{rC + \frac{L}{R}}_{\to T}}$$

12] $\begin{cases} i_L(0^+) = \dfrac{E}{r+R} \\ \dfrac{di_L}{dt}(0^+) = -\dfrac{r \cdot E}{L(R+r)} \end{cases}$ et $u = ri_L + L\dfrac{di_L}{dt} \Rightarrow \dfrac{di_L}{dt}(0^+) = \dfrac{u(0^+) - r\,i_L(0^+)}{L}$

$$i_L(t) = Ae^{-\frac{\omega_0 t}{2Q}} \cos(\omega t + \varphi) + \frac{E}{r+R} \qquad \omega = \omega_0\sqrt{1-\frac{1}{4Q^2}}.$$

$$i_L(0) = A\cos\varphi + \frac{E}{r+R} = \frac{E}{r+R} \to A\cos\varphi = 0 \to \boxed{\varphi = -\frac{\pi}{2} \text{ ou } +\frac{\pi}{2}}$$

$$i_L(t) = Ae^{-\frac{\omega_0 t}{Q}} \sin\omega t + \frac{E}{R+r}.$$

$$\frac{di_L}{dt} = -A\frac{\omega_0}{2Q} e^{-\frac{\omega_0}{Q}t} \sin\omega t + A\omega e^{-\frac{\omega_0}{Q}t} \cos\omega t \Rightarrow \frac{di_L}{dt}(0^+) = \boxed{A\omega = -\frac{rE}{L(R+r)}}$$

d'où $\boxed{i_L(t) = \dfrac{E}{R+r}\left(1 - \dfrac{r}{L\omega} e^{-\frac{\omega_0}{2Q}t} \sin\omega t\right)}$.

13] a] D'après la courbe $i_L(\infty) = \dfrac{E}{R+r} = 237,5$ mA.

$R + r = 55\,\Omega \to E = 12$ V.

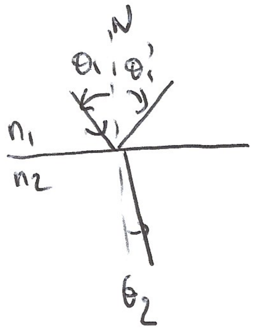
$$\delta = \ln\frac{i_L(t+T) - i_L(\infty)}{i_L(t) - i_L(\infty)} = \frac{\omega_0 T}{2Q} = \frac{\omega_0\, 2\pi}{2Q \cdot \omega_0\sqrt{1-\frac{1}{4Q^2}}} = \frac{\pi}{\sqrt{Q^2 - \frac{1}{4}}} \Rightarrow \boxed{Q = \sqrt{\left(\frac{\pi}{\delta}\right)^2 + \frac{1}{4}}}$$

Graphiquement. $\delta = \ln\dfrac{4,5}{2,25} = 0,69 \Rightarrow \boxed{Q = 4,6 > \frac{1}{2}}$ $\boxed{T = 10\text{ ms}}$ $T_0 = T\sqrt{1-\dfrac{1}{4Q^2}}$

d'où $T_0 = 9,9$ ms

Ex2 .

A 1. $n = \frac{c}{v}$ v = vitesse de la lumière ds le milieu d'indice n.
c " " ds le vide.

2] 

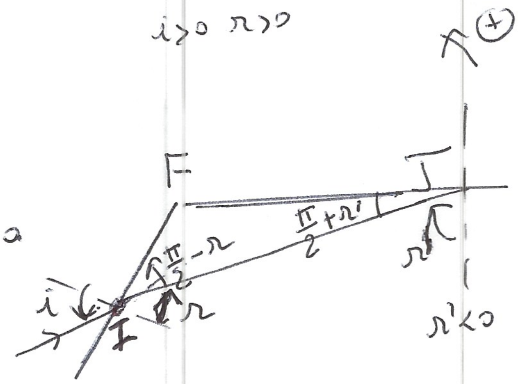
* rayon refracté et reflechi $\in$ plan d'incidence = plan (rayon incident, normale).

* $\theta_1' = -\theta_1$
$n_1 \sin\theta_1 = n_2 \sin\theta_2$

3] $n_1 > n_2 \Rightarrow \sin\theta_2 = \underbrace{\frac{n_1}{n_2}}_{>1} \underbrace{\sin\theta_1}_{<1}$ doit etre $<1 \Rightarrow \sin\theta_1 < \frac{n_2}{n_1}$

$\boxed{\sin\theta_{lim} = \frac{n_2}{n_1}}$ 4°) $\boxed{\theta_{lim} = 49{,}8°}$

$i>0$ $r>0$



B]. 1. a] $\widehat{FIJ} = \frac{\pi}{2} - r$ $FJI = \frac{\pi}{2} + r'$ car $r'<0$

car $r>0$.

donc $\pi = \gamma + \frac{\pi}{2} - r + \frac{\pi}{2} + r' \Rightarrow \boxed{\gamma = r - r'}$

b) $i = \frac{\pi}{2} \Rightarrow \boxed{r_{max} = \arcsin \frac{n_{air}}{n_{glace}} = 49{,}8°} \overset{c)}{\Rightarrow} \boxed{r' = r - \gamma = -70{,}2°}$.

d $|r'| > \theta_{lim} \Rightarrow$ Il y a reflexion totale sur la face (EF).

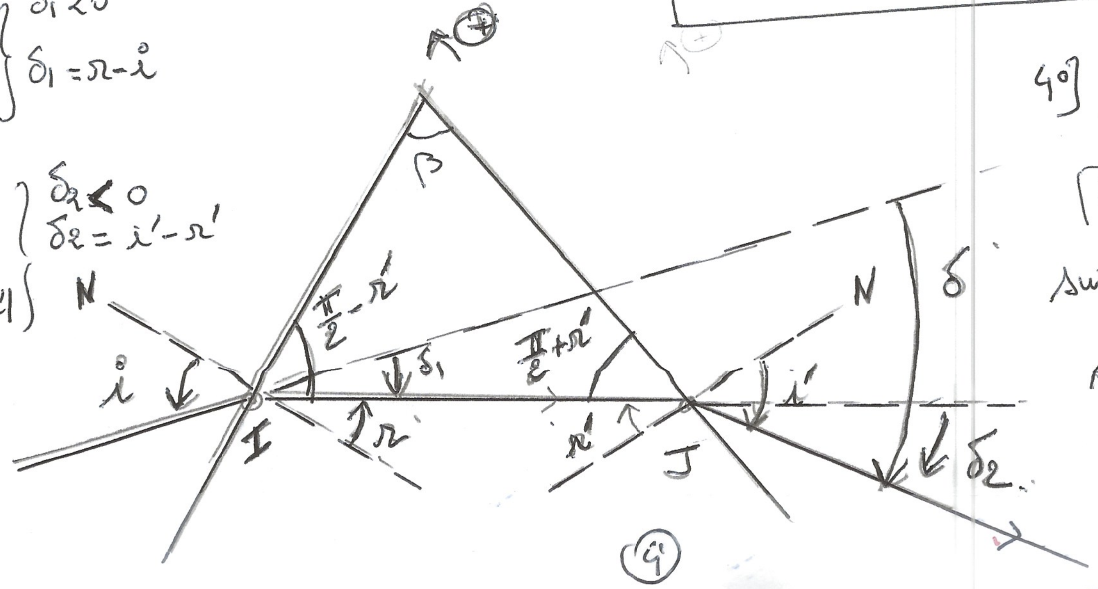
2] CD et AF sont // $\Rightarrow$ $r = -r'$ ou
$i = -i'$

3°] $\pi = \beta + \left(\frac{\pi}{2} - r\right) + \frac{\pi}{2} + r' \Rightarrow \boxed{\beta = r - r'}$ (1)

$\boxed{\delta = \delta_1 + \delta_2 = r - i + i' - r'}$ (2)

$i>0$, $r>0$ et $r<i$ } $\delta_1 < 0$, $\delta_1 = r - i$

$r'<0$, $i'<0$ et $|i'|>|r'|$ } $\delta_2 < 0$, $\delta_2 = i' - r'$



4°] $i = -i' \Rightarrow r = -r'$
$\Rightarrow \boxed{2r = \beta}$ d'après (1)
$\boxed{\delta = -2i + \beta}$ d'après (2)

$\sin i = \frac{n_g}{n_a} \sin\frac{\beta}{2}$

AN $\beta = 60°$
$r = 30°$
$i = 40{,}7°$
$\boxed{\delta = -21{,}4°}$

6] δ est une fonction de i pour i proche de i_0.

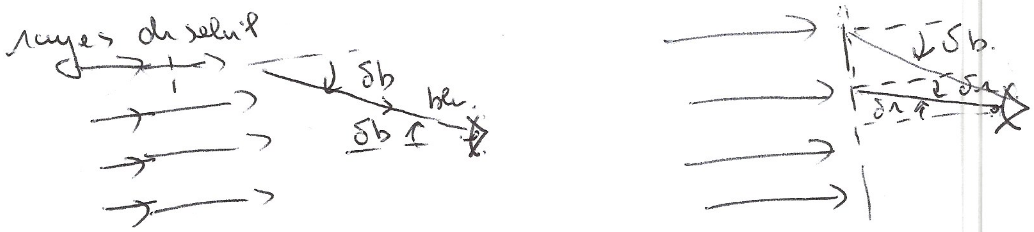
$$\delta(i) = \delta(i_0) + (i - i_0)\underbrace{\left(\frac{\partial \delta}{\partial i}\right)(i_0)}_{=0} \Rightarrow \delta(i) \simeq \delta(i_0).$$

Donc plusieurs rayons avec des i proches vont donner le même δ

$\Rightarrow$ accumulation d'énergie ds cette direction

7°) $\lambda_b < \lambda_r \Rightarrow n_b > n_r$ or $\sin i = \frac{n_g}{n_a} \sin \frac{\beta}{2}$.

$\sin i_B > \sin i_{rouge}$. et $|\delta| = 2i - b \Rightarrow \delta_b > \delta_R$.



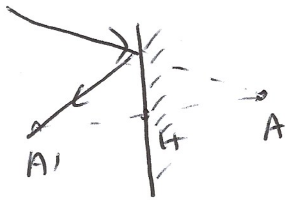
rouge à l'intérieur
bleu à l'extérieur.

exercice 3

Partie 1.

1-a. MP $\quad A \xrightarrow{MP} A' \Rightarrow \overline{HA'} = -\overline{HA}$ $\quad$ H : intersection de la normale passant par A, au MP.

b -
c d.

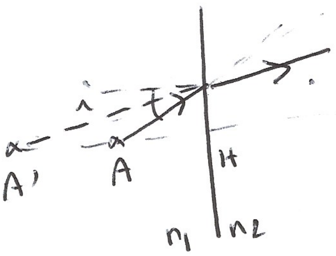


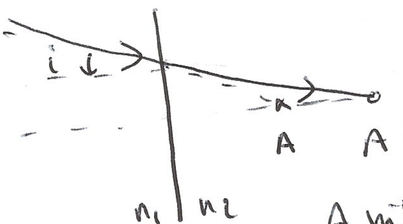
A réel
A' virtuelle

2- DP $\quad A \xrightarrow{n_1/n_2} A'$ $\quad \dfrac{\overline{HA}}{n_1} = \dfrac{\overline{HA'}}{n_2}$ $\quad$ H : intersection de la normale passant par A, au dioptre.

$\overline{HA'} = \dfrac{n_2}{n_1} \overline{HA}$ $\quad$ si $n_2 > n_1$ $\quad \overline{HA'} > \overline{HA}$
$\quad$ si $n_2 < n_1$ $\quad \overline{HA'} < HA$.

Cas $n_1 < n_2$ $\quad \overline{HA'} > \overline{HA}$.



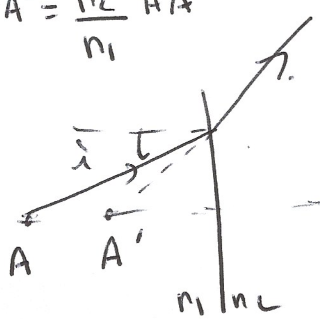


A virtuel
A' réelle.

A réel
A' virtuelle.

Cas $n_1 > n_2$
$\overline{HA'} = \dfrac{n_2}{n_1} \overline{HA}$.

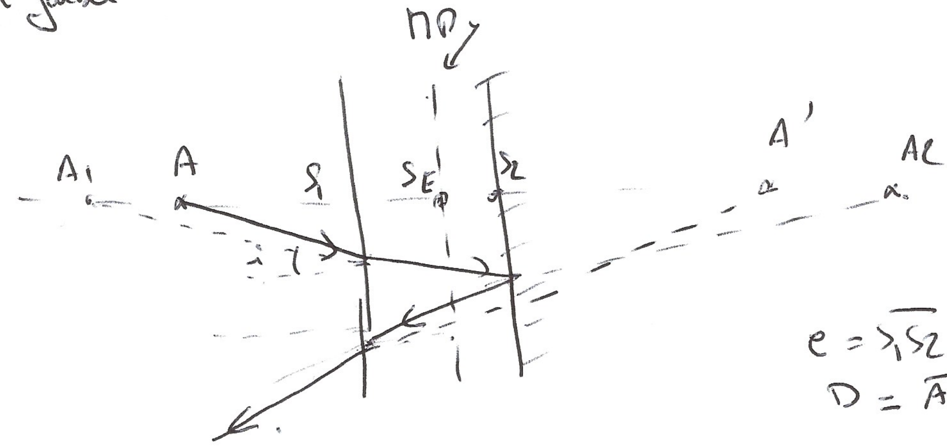
Cas



A virtuel
A' réelle –

A réel
A' virtuelle

3°] i faible.



$e = \overline{S_1S_2}$

$D = \overline{AS}$

$$A \xrightarrow[1/n]{DP} A_1 \xrightarrow{mP} A_2 \xrightarrow[n/1]{DP} A'$$

$$\overline{S_1A} = \frac{\overline{S_1A_1}}{n} \rightarrow \overline{S_1A_1} = n \cdot \overline{S_1A} \Rightarrow \boxed{\overline{S_1A_1} = -D \cdot n.}$$

$$\overline{S_2A_2} = -\overline{S_2A_1} = -(\overline{S_2S_1} + \overline{S_1A_1}) = -(-e - D\cdot n) = e + Dn.$$

$$\overline{S_1A_2} = \overline{S_1S_2} + \overline{S_2A_2} \rightarrow \overline{S_1A_2} = \overline{S_1S_2} + \overline{S_2A_2} = e + e + Dn. = \boxed{2e + D.n. = \overline{S_1A_2}}$$

$$\overline{S_1A'} = \frac{\overline{S_1A_2}}{n} = \boxed{D + \frac{2e}{n} = \overline{S_1A'}}$$

$$\overline{AA'} = \overline{AS_1} + \overline{S_1A'} = 2D + \frac{2e}{n} \quad \text{et} \quad \boxed{\frac{\overline{AA'}}{2} = \overline{AS_E} = D + \frac{e}{n}.}$$