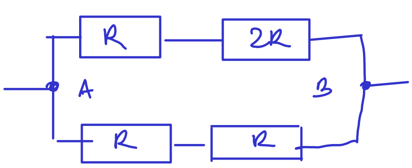
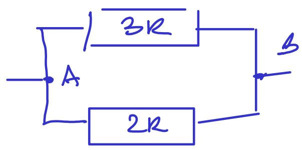
TD 39 - Corrigé

S1 - Résistance équivalente

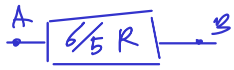
a/



$\Longleftrightarrow$



$\Longleftrightarrow$



$3R \,//\, 2R$:

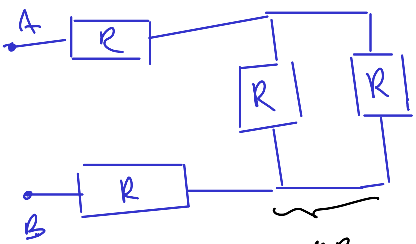
$$\frac{1}{R_{eq}} = \frac{1}{3R} + \frac{1}{2R}$$

$$= \frac{1}{R}\left(\frac{1}{3} + \frac{1}{2}\right)$$

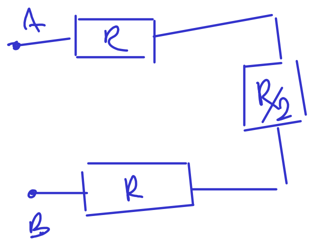
$$= \frac{1}{R} \times \frac{5}{6}$$

$$\Leftrightarrow R_{eq} = \frac{6}{5} R$$

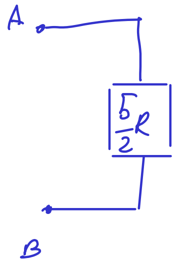
b/



$\Longleftrightarrow$



$\Longrightarrow$

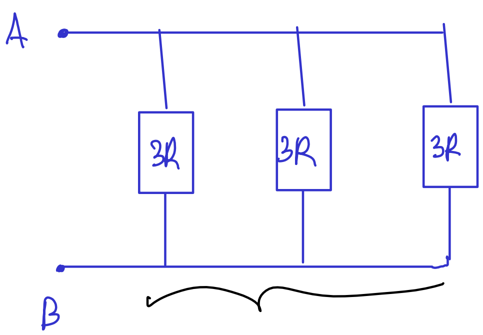


$R \,//\, R$

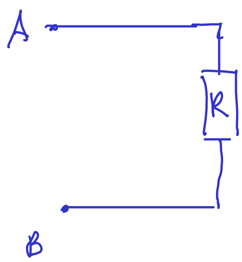
$$R_{eq} = \frac{R^2}{2R} = \frac{R}{2}$$

$$R + \frac{R}{2} + R = \frac{5}{2} R$$

c/



$\Longleftrightarrow$



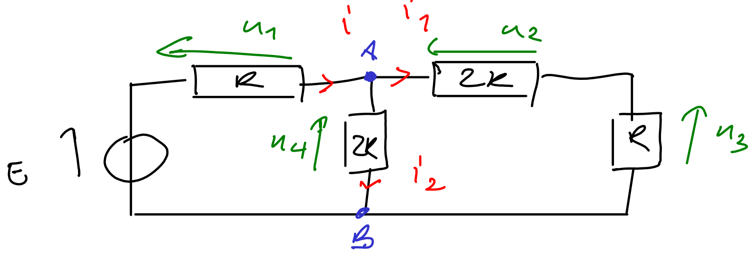
$3R \,//\, 3R \,//\, 3R$

$$\frac{1}{R_{eq}} = \frac{1}{3R} + \frac{1}{3R} + \frac{1}{3R}$$

$$= \frac{1}{R}$$

$$\Leftrightarrow R_{eq} = R$$

S2 - Etude d'un circuit

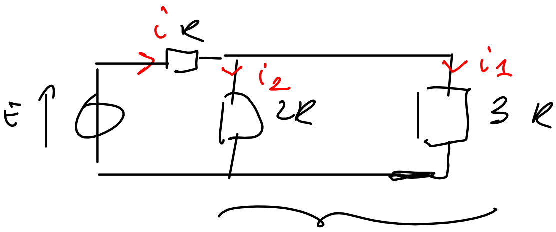


Loi d'ohm :

$$u_1 = R\,i$$
$$u_2 = 2R\,i_1$$
$$u_4 = 2R\,i'_2$$
$$u_3 = R\,i_1$$

$i,\ i_1,\ i_2$?

Pont diviseur de courant :



$$i_2 = \frac{1/2R}{1/2R + 1/3R} \times i$$

$$i_2 = \frac{1}{1+\frac{2}{3}} = \frac{3}{5}\,i$$

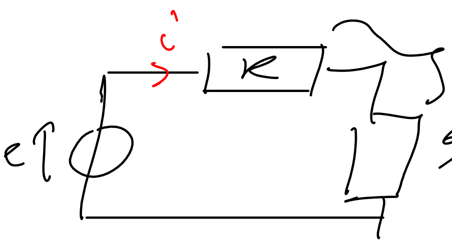
$$i_1 = \frac{1/3R}{1/2R + 1/3R}\,i = \frac{2}{5}\,i$$

2R // 3R

$$G_{eq} = \frac{1}{2R} + \frac{1}{3R}$$
$$\Rightarrow \quad = \frac{1}{R}\left(\frac{5}{6}\right)$$
$$\Leftrightarrow \quad R_{eq} = \frac{6}{5}R$$

Verif : $i_1 + i'_2 = i$ ✓

Reste à déterminer i



$$R + \frac{6}{5}R = \frac{11}{5}R$$

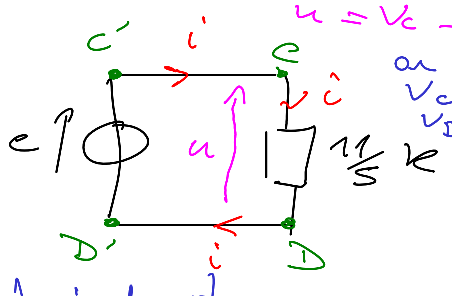
$\Longleftrightarrow$

$e = V_{C'} - V_{D'}$

$u = V_C - V_D$

or $V_{C'} = V_C$, $V_{D'} = V_D$

$\Rightarrow u = e$



Loi d'ohm :

$$e = +\frac{11}{5}R \times i$$

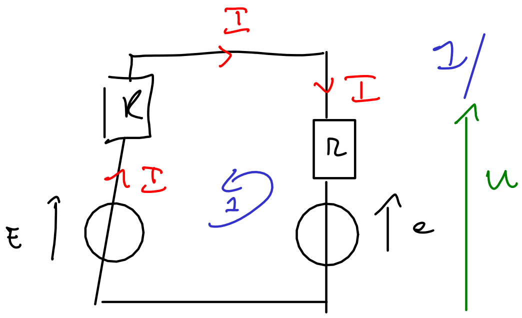
$$\Longleftrightarrow \boxed{i = \frac{5e}{11.R}}$$

D'où :

$$\underline{i_1} = \frac{3}{5}\,i = \underline{\frac{3e}{11R}}$$

$$\underline{i_2} = \frac{2}{5}\,i = \underline{\frac{2e}{11.R}}$$

53 - charge d'une batterie



1/ $I = \dfrac{E-e}{R+r}$

$U = e + rI$

$\;\;= e + \dfrac{r}{R+r} \times (E-e)$

2/ Bilan de puissance

$P_{fournie} = E \times I = \dfrac{E\,(E-e)}{R+r}$

$P_{reçue} = e \times I = \dfrac{e\,(E-e)}{R+r}$

$P_{dissipée} = RI^2 + rI^2 = (R+r)\,I^2$

$= (R+r) \times \left(\dfrac{E-e}{R+r}\right)^2 = \dfrac{(E-e)^2}{R+r}$

Rendement de la charge :

$$\eta = \frac{P_{reçue}}{P_{fournie}} = \boxed{\frac{e}{E} = \eta}$$

A.N. : $E = 13\,V$, $e = 12\,V$ $\Rightarrow$ $\eta = \dfrac{12}{13} \sim 95\,\%$?

$\longrightarrow$ pertes par effet Joule.

Rq : $P_{fournie} = P_{reçue} + P_{dissipée}$.

↳ conforme à la conservation de l'énergie

3/ Hyp : $e = 12\,V = cste$

3.1/ Capacité en A.h. | $Q_f = 50$ A.h.

$Q \longleftarrow I \;\; t$

charge électrique

3.2/ à $t = 0$ $Q = Q_0 = 10\,\%\, Q_f$

Temps de charge $= f(I)$

Or $i(t) = \frac{dq}{dt} \iff dq = i(t)\,dt$

$$\Rightarrow \int_{Q_0}^{Q_f} dq = \int_0^{\tau} i(t)\,dt \quad \text{avec} \quad i(t) = I = \frac{E-e}{R+r}$$

durée de charge

$$\Rightarrow Q_f - Q_0 = \int_0^{\tau} I\,dt = I\int_0^{\tau} dt = I \times \tau$$

$$\iff \boxed{\tau = \frac{Q_f - Q_0}{I}} \iff \boxed{\tau = \frac{(R+r)(Q_f - Q_0)}{E-e}}$$

A.N. $\tau \sim \frac{5\times 10^{-1} \times \frac{90}{100} \times 50 \times 3600}{13-12} = 25\,h\,!$ (3600 : 1h.)

Pas réaliste ...

3.3. E_J : énergie dissipée par la charge ?

$$P_J = (R+r)I^2 = \frac{dE_J}{dt}$$

$$\iff dE_J = P_J\,dt$$

$$\Rightarrow \int_0^{E_J} dE_J = \int_0^{\tau} P_J\,dt$$

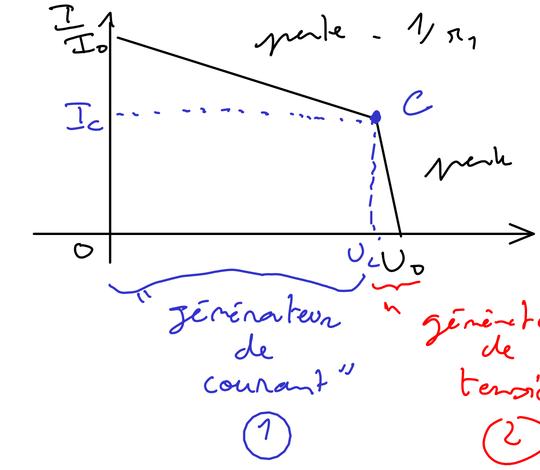
cste

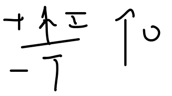
$$\left(\int_0^t f(u)\,du \qquad \int_0^t f(t)\,dt \right)$$

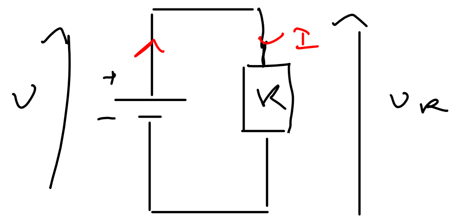
$$\Rightarrow E_J = (R+r)I^2 \times \tau = \frac{(R+r)^2(Q_f - Q_0)}{E-e}$$

A.N. : $E_J = \frac{(0{,}3+0{,}2)^2 \times \frac{90}{100} \times 50 \times 3600}{13-12} = 40{,}5\ kJ$

S 5 - Alimentation stabilisée.





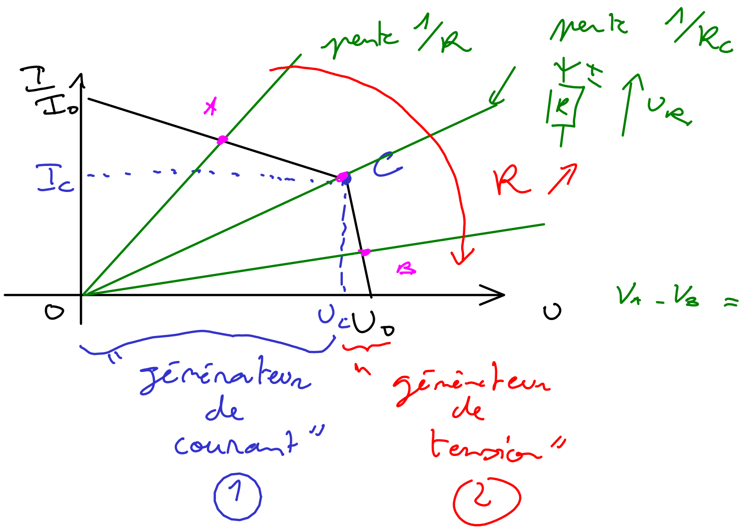


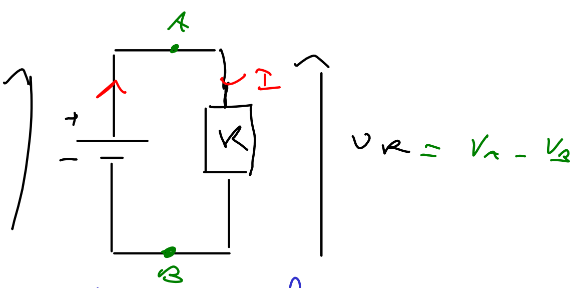
Mode ① : loi affine : $I = a_1 U_1 + b_1$
a_1 : pente $-1/r_1$; b_1 : I_0

$$I = -\frac{U_1}{r_1} + I_0 \quad \text{soit} \quad U_1 = \underbrace{r_1 I_0}_{\text{f.e.m.}} - r_1 I$$

Mode ② : loi affine : $U_2 = U_0 - r_2 I$ $\left(\begin{array}{l} y = ax \\ x = \frac{1}{a} y \end{array} \right)$

2/





point de fonctionnement
$U(I) = U_R(I)$
↳ graphiquement : intersection des caractéristiques.

→ le mode de fonctionnement de l'alimentation est imposé par la charge R.

3/ Si $R < R_c$: mode ①
Si $R > R_c$: mode ②

$R_c = ?$ $\quad R_c = \frac{U_c}{I_c}$. U_c et I_c ?

$C(I_c, U_c) \in$ au 2 portions de caractéristiques

Au point C $\quad U_1(I_c) = U_2(I_c) = U_c \quad (*)$

avec $\quad U_1(I_c) = r_1 I_0 - r_1 I_c$

$\quad\quad U_2(I_c) = U_0 - r_2 I_c$

$(*)$: $\quad r_1 I_0 - r_1 I_c = U_0 - r_2 I_c$

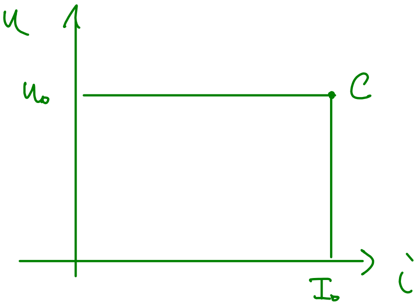
$$\Leftrightarrow \boxed{I_c = \frac{U_0 - r_1 I_0}{r_2 - r_1}}$$ homogène ✓

$$U_c = U_1(I_c) = r_1 I_0 - r_1 \times \frac{U_0 - r_1 I_0}{r_2 - r_1}$$

$$= \frac{r_2 r_1 I_0 - \cancel{r_1^2 I_0} - r_1 U_0 + \cancel{r_1^2 I_0}}{r_2 - r_1}$$

$$\boxed{U_c = \frac{r_1 (r_2 I_0 - U_0)}{r_2 - r_1}}$$ homogène ✓

Cas limite : $r_1 \to +\infty$ et $r_2 \to 0$. Alors la caractéristique devient :



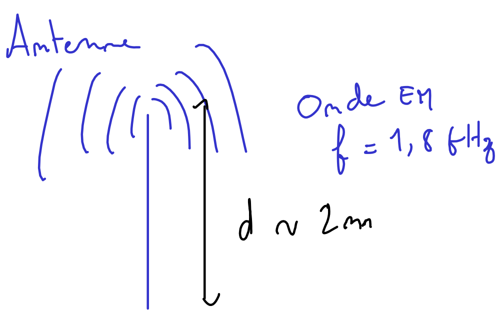
le point C a pour coordonnées (u_0, I_0)

$$\lim_{\substack{r_1 \to +\infty \\ r_2 \to 0}} I_c = -\frac{r_1 I_0}{-r_1} = I_0 \quad \text{ok ✓}$$

$$\lim_{\substack{r_1 \to +\infty \\ r_2 \to 0}} U_c = \frac{r_2 r_1 I_0 - r_1 U_0}{-r_1} = -r_2 I_0 + U_0 = U_0$$

OK ✓

S6 - Téléphonie mobile



A.R.Q.S valable si

$\lambda \gg d$

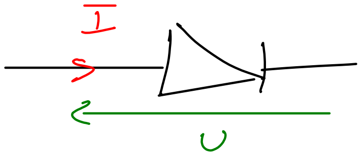
avec $\lambda = \frac{c}{f}$ avec $c = 3 \times 10^8$ m.s^{-1}

$f = 1,8 \times 10^9$ Hz

$\lambda \sim 0,1$ m

donc $\lambda < d$: l'ARQS n'est pas valable.

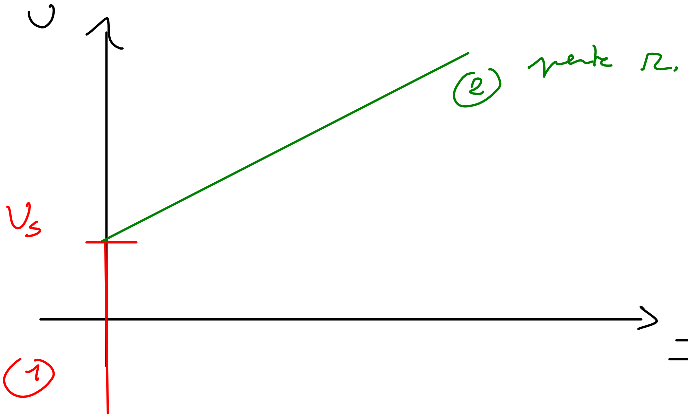
34 - Diode idéale



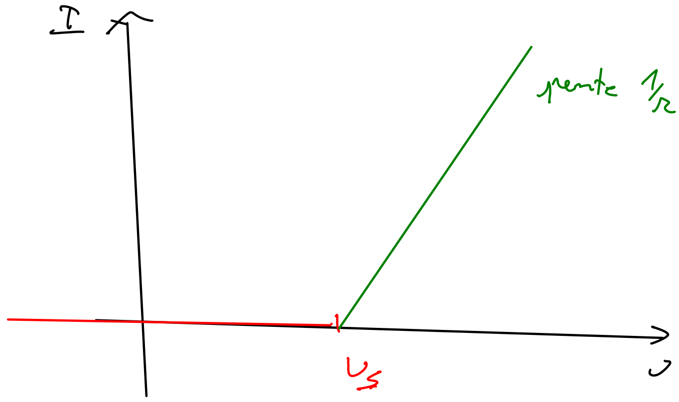
$$\begin{cases} I = 0 , & U \leqslant U_s \quad (1) \\ U = U_s + rI , & U \geqslant U_s \quad (2) \end{cases}$$

1. Convention récepteur.

2. Caractéristique Hyp : $U_s > 0$

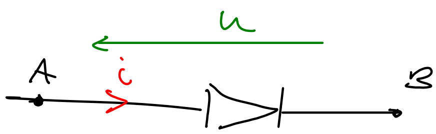


ou.

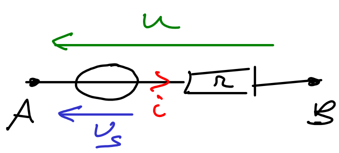


3. Dipôle non linéaire mais linéarisé par morceaux sur $]-\infty, U_s]$ et sur $[U_s, +\infty[$.

4. Modèle de diode pour $U > U_s$



$\Longleftrightarrow$



$U > U_s$:

$U = U_s + rI$

5. $U_s = 0$, $r = 0$