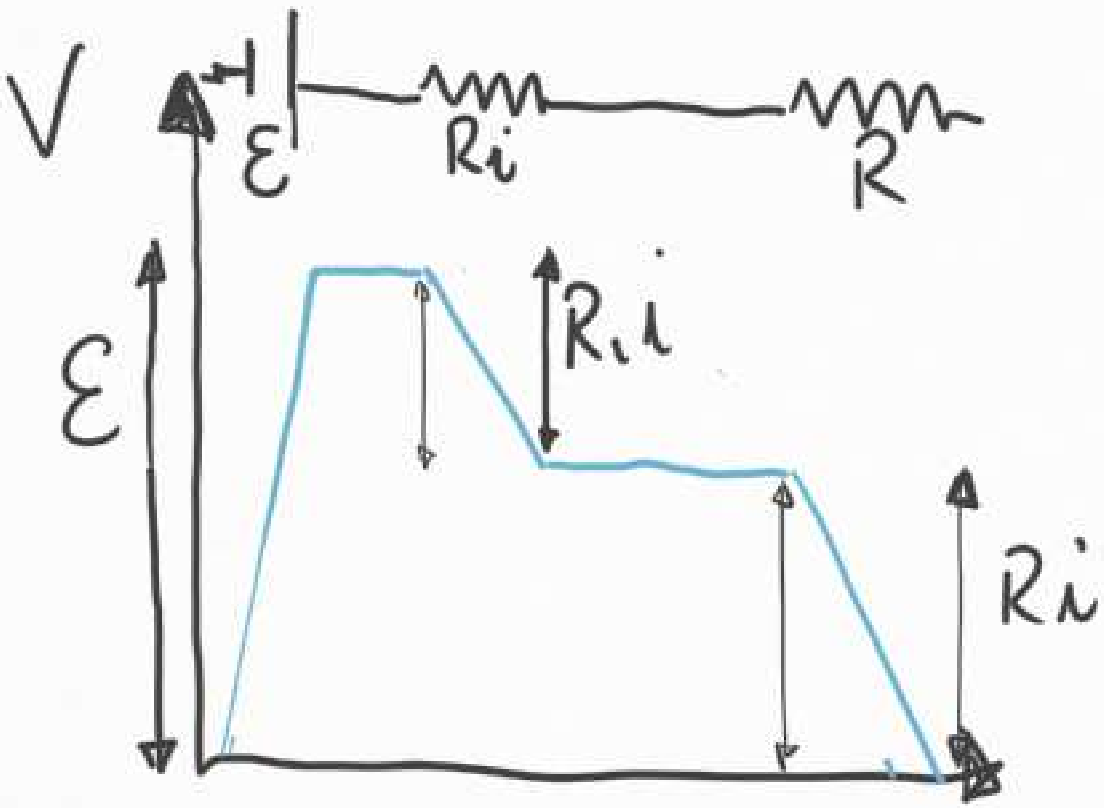
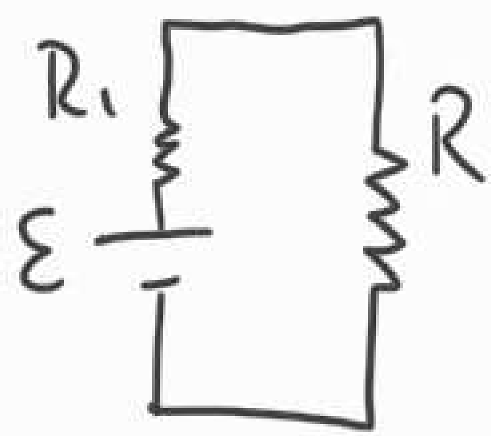
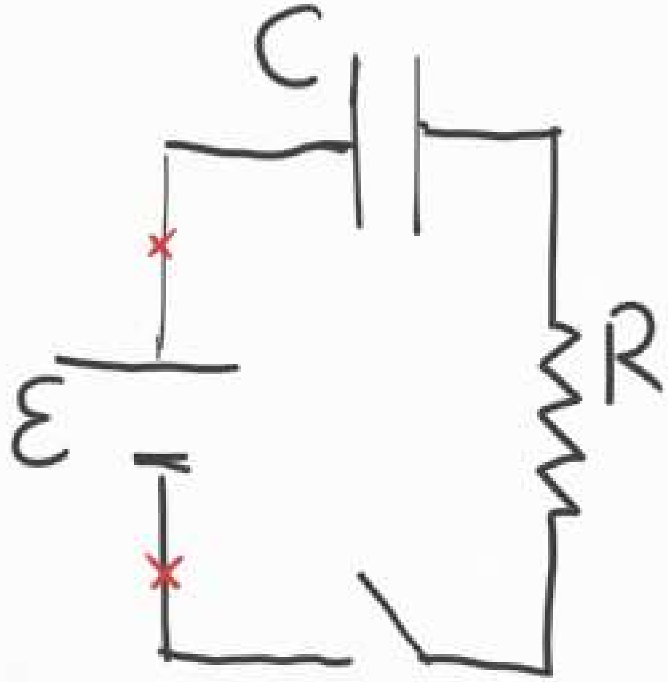

V
ε
Ri
R
ε
$R_i i$
Ri


R_i
R
ε



$$\mathcal{E}, \quad \Delta V_c = \frac{q(t)}{C}, \quad \Delta V_R = R\, i(t) = R\frac{dq}{dt} \implies$$

$$\mathcal{E} = \Delta V_c + \Delta V_R = \frac{q(t)}{C} + R\frac{dq}{dt} \implies$$

$$C\mathcal{E} - q(t) = RC\frac{dq}{dt} \implies$$

$$\frac{dt}{RC} = \frac{dq}{C\mathcal{E}-q} \implies$$

$$\int_0^t \frac{dt'}{RC} = \frac{t}{RC} = \int_0^{q(t)} \frac{dq'}{C\mathcal{E}-q'} = -\log\left(C\mathcal{E}-q'\right)\Big|_0^q = -\log\frac{C\mathcal{E}-q}{C\mathcal{E}} \implies$$

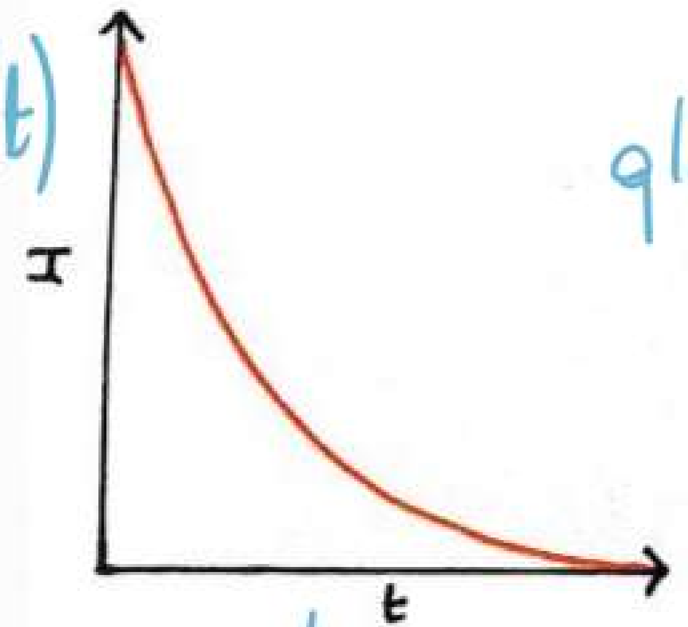
$$e^{-\frac{t}{RC}} = \frac{C\mathcal{E} - q(t)}{C\mathcal{E}} \Rightarrow \boxed{q(t) = C\mathcal{E}\left(1 - e^{-t/RC}\right)} \Rightarrow$$

$$i(t) = \frac{dq}{dt} = \frac{\cancel{C}\mathcal{E}}{R\cancel{C}}\, e^{-t/RC} = \boxed{\frac{\mathcal{E}}{R}\, e^{-t/RC}}$$

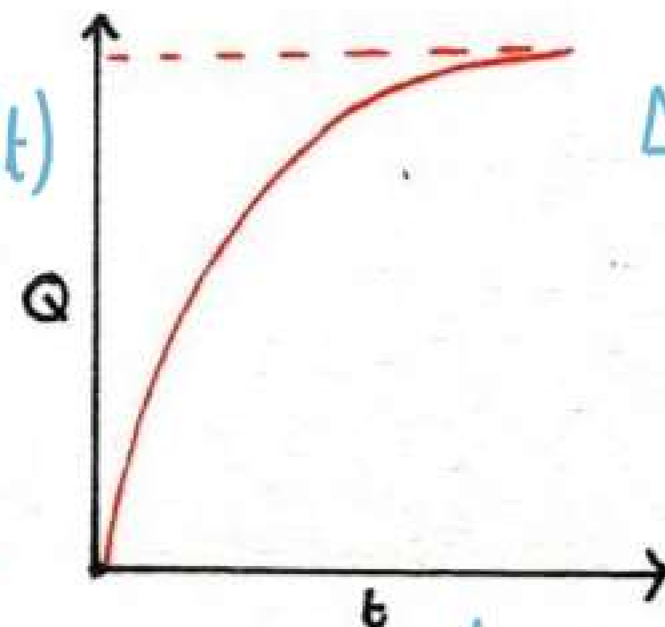
$$\Delta V_c(t) = \frac{q(t)}{C} = \boxed{\mathcal{E}\left(1 - e^{-t/RC}\right)}$$

$$RC \equiv \tau$$

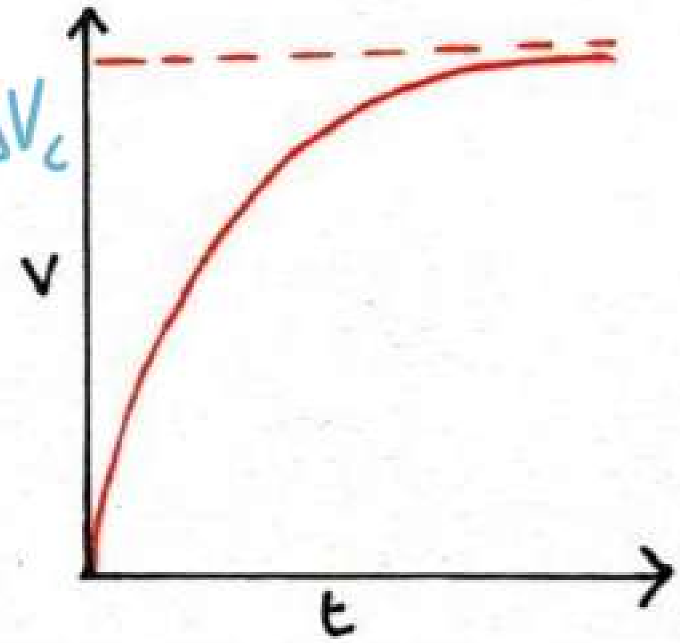
$i(t)$



$q(t)$



ΔV_c



$$\frac{\varepsilon}{R} e^{-t/RC}$$

$t \to 0$: $\frac{\varepsilon}{R}$ $\qquad$ $t \to \infty$: 0

$$C\varepsilon\left(1 - e^{-t/RC}\right)$$

$t \to 0$: 0 $\qquad$ $t \to \infty$: $C\varepsilon$

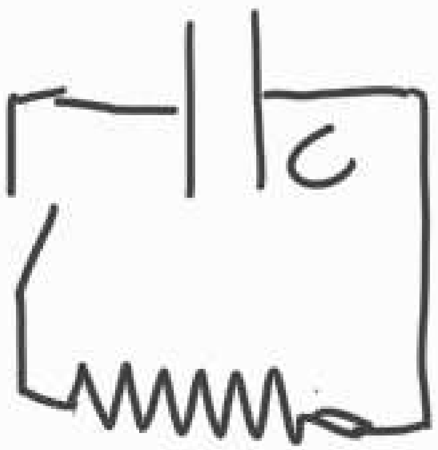
$t \to 0$: 0 $\qquad$ $t \to \infty$: ε

$$\boxed{q_f = \mathcal{E} C} \, , = \lim_{t \to \infty} q(t)$$

$$W_G = \int_0^{q_f} \mathcal{E} \, dq = \mathcal{E} q_f = \mathcal{E}^2 C$$

$$U_C^{(f)} = \frac{1}{2} q_f \mathcal{E} = \frac{1}{2} \mathcal{E}^2 C$$

$$P_R = R i^2 \, , \quad W = \int_0^t P_R \, dt' = \frac{1}{2} \mathcal{E}^2 C$$



R

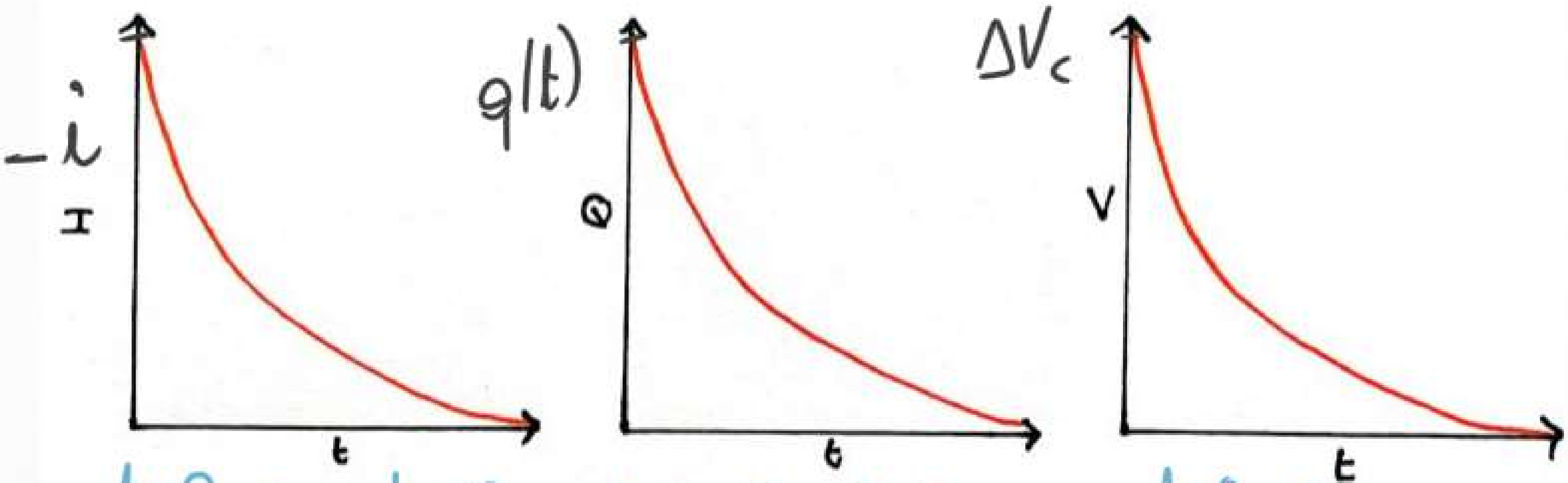
$$q(0) = q_0 \,, \quad \Delta V_c = \frac{q(t)}{C} \,, \quad \Delta V_R = R \frac{dq}{dt}$$

$$\Delta V_c + \Delta V_R = \frac{q(t)}{C} + R\frac{dq}{dt} = 0 \Rightarrow$$

$$\frac{dq}{q(t)} = -\frac{dt}{RC} \Rightarrow$$

$$\int_{q_0}^{q} \frac{dq'}{q'} = -\frac{t}{RC} \Rightarrow \log\frac{q}{q_0} = -\frac{t}{RC} \Rightarrow$$

$$q(t) = q_0 e^{-\frac{t}{RC}} \,, \quad i(t) = -\frac{q_0}{RC} e^{-t/RC} \,, \quad \Delta V_c = \frac{q_0}{C} e^{-t/\tau}$$



$$t \to 0 \longrightarrow \frac{q_0}{RC}, \qquad t \to \infty \longrightarrow 0$$

$$t \to 0 \longrightarrow q_0, \qquad t \to \infty \longrightarrow 0$$

$$t \to 0 \longrightarrow \frac{q_0}{C}, \qquad t \to \infty \longrightarrow 0$$

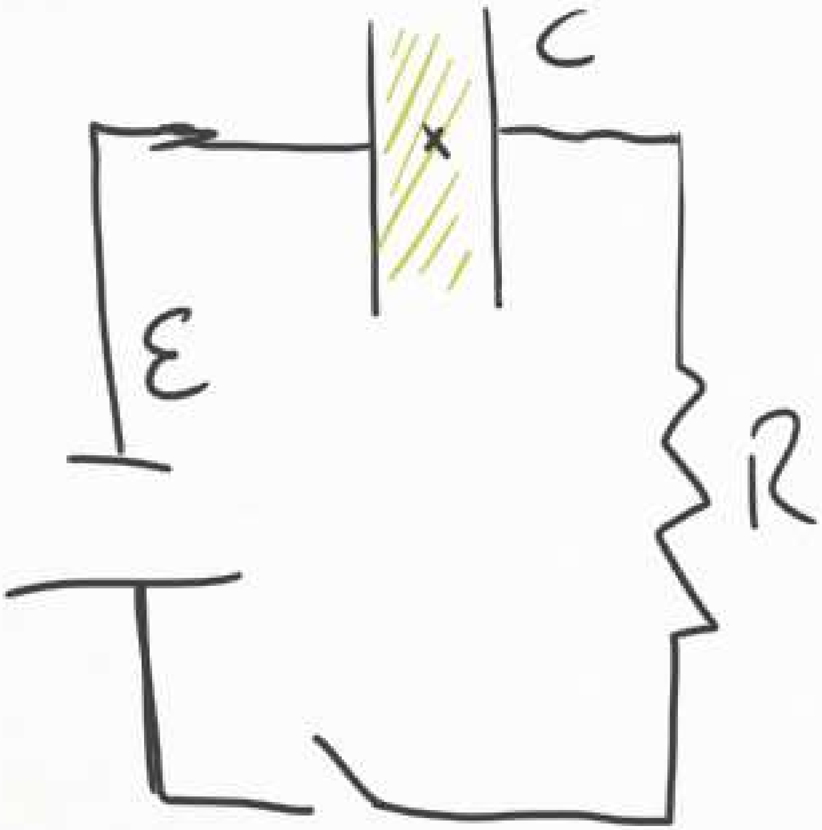
$$U_c^{(i)} = \frac{1}{2}\frac{q_0^2}{C}, \quad U_c^{(f)} = 0$$

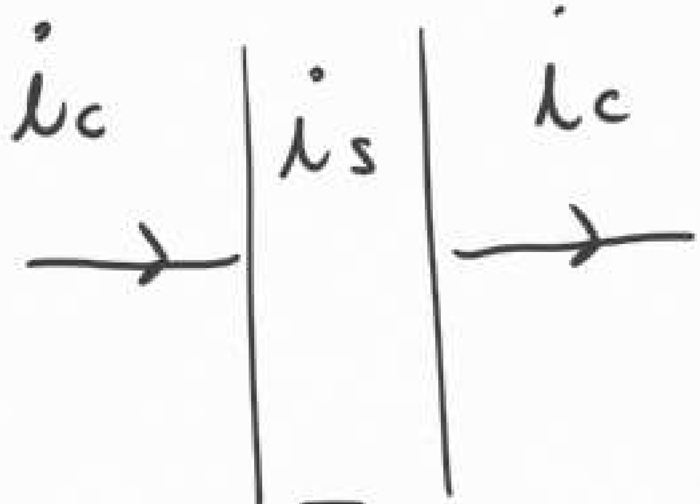
$$P_R(t) = Ri^2 = \frac{q_0^2}{RC^2} e^{-\frac{2t}{RC}} \Rightarrow$$

$$W_R \equiv \int_0^\infty \frac{q_0^2}{RC^2} e^{-\frac{2t}{RC}} dt = \frac{q_0^2}{\cancel{R}C^{\cancel{2}}}\left(-\frac{R\cancel{C}}{2}\right)\left(e^{-\frac{2t}{RC}}\right)_0^\infty =$$

$$= \frac{1}{2}\frac{q_0^2}{C} = U_c^{(i)}$$

$$\int e^{-\frac{x}{a}} dx = -a\, e^{-\frac{x}{a}}$$





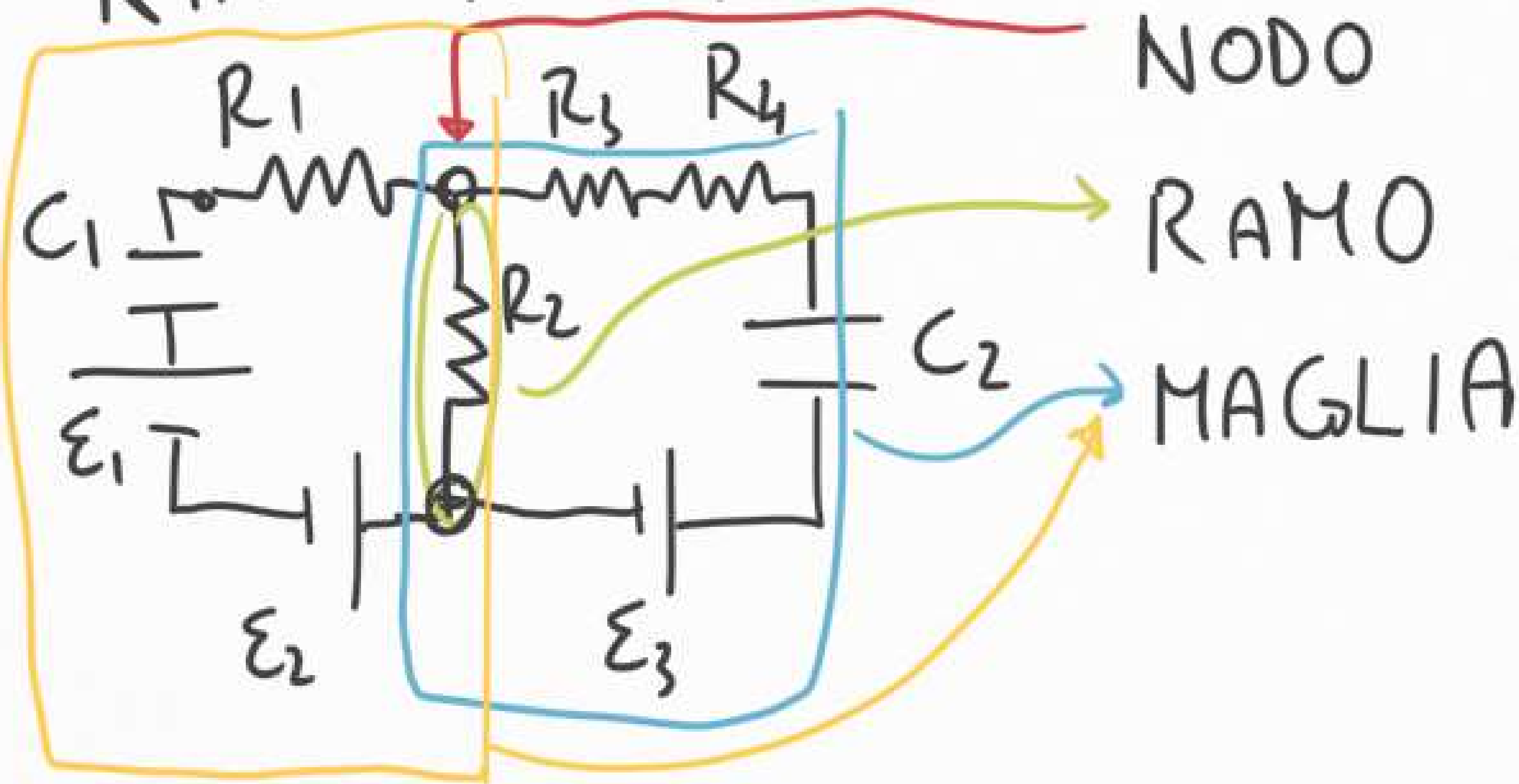
$$C = \frac{\varepsilon_0 \Sigma}{h}, \quad E = \frac{\Delta V}{h} \Rightarrow \Delta V = E h$$

$$q(t) = C \Delta V(t) = \varepsilon_0 \Sigma E(t) \Rightarrow$$

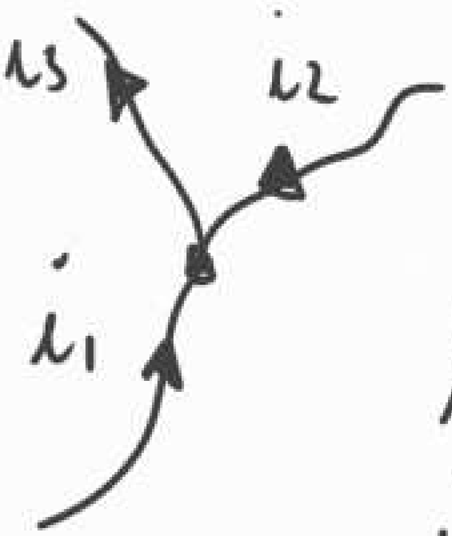
$$i_s = \frac{dq}{dt} = \varepsilon_0 \frac{d}{dt}\left(\Sigma E(t)\right) = \varepsilon_0 \frac{d\Phi(E)}{dt}$$

$$J_s = \frac{i_s}{\Sigma} = \varepsilon_0 \frac{dE}{dt} \longrightarrow \vec{J}_s = \varepsilon_0 \frac{d\vec{E}}{dt}$$

KIRCHHOFF


NODO
RAMO
MAGLIA
R_1
R_2
R_3
R_4
C_1
C_2
ε_1
ε_2
ε_3

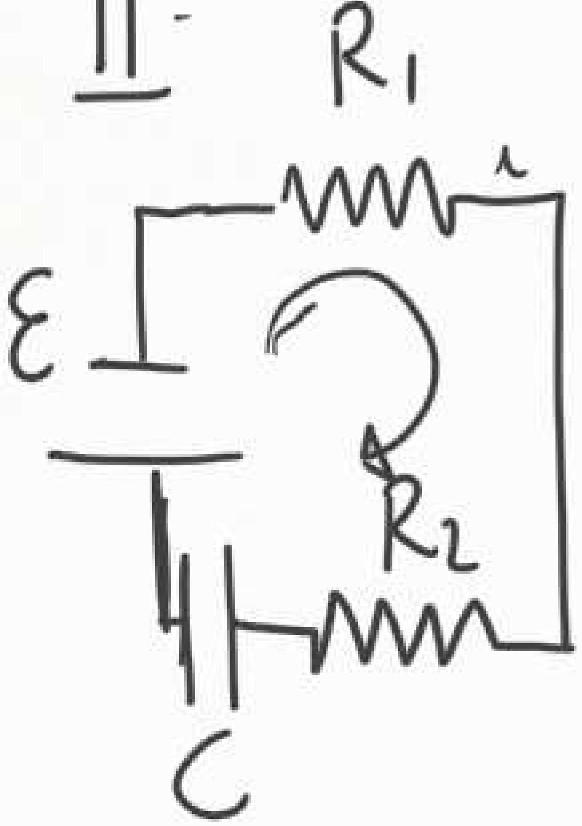
I



$$\sum_k i_k = 0$$

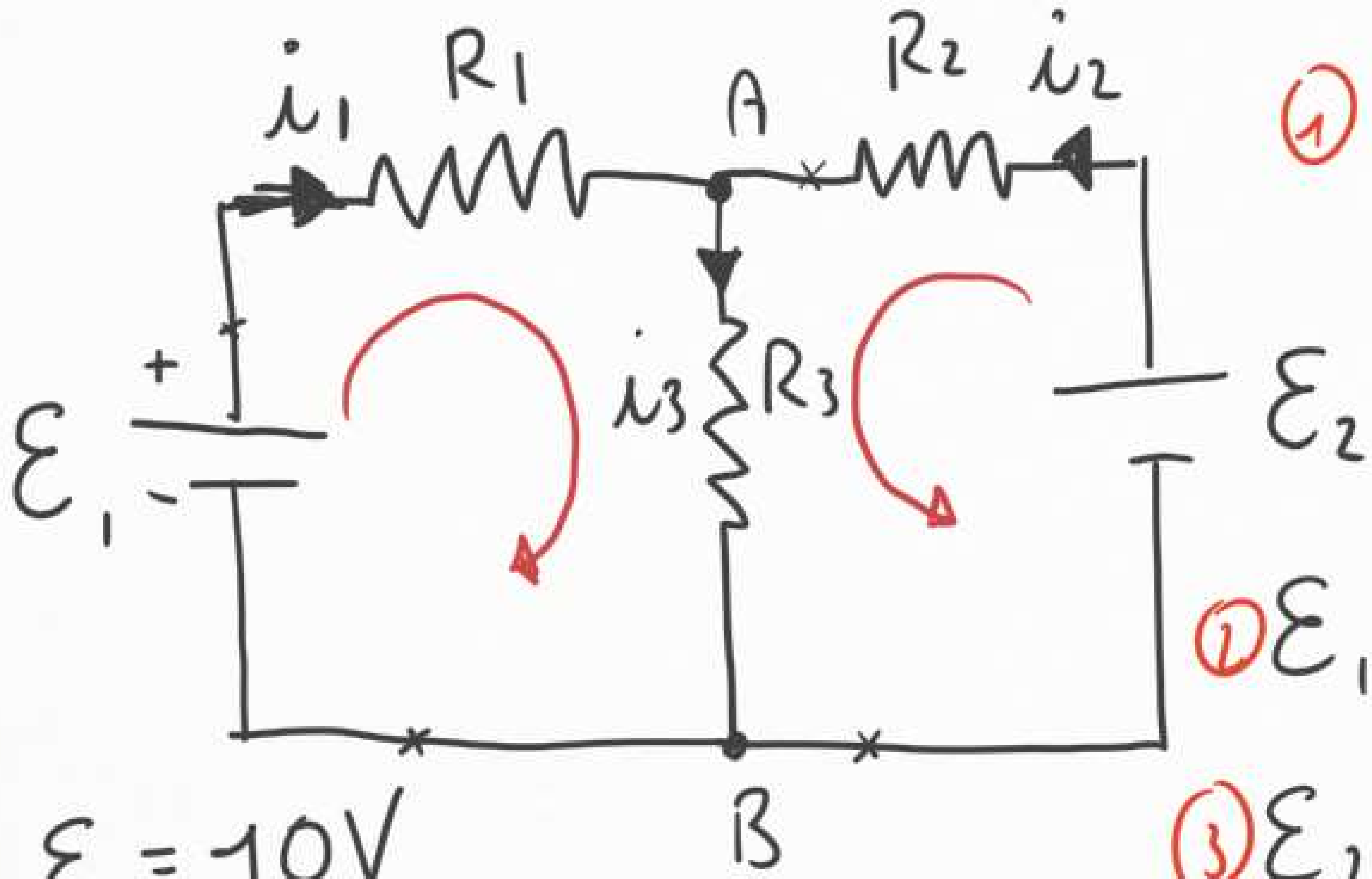
$$\left.\begin{aligned} i_1 + i_2 - i_3 &= 0 \\ i_3 - i_1 - i_2 &= 0 \end{aligned}\right\} \quad i_3 = i_1 + i_2$$

II



$$\underline{\sum_k \mathcal{E}_k = \sum_k \Delta V_k}$$

$$-\mathcal{E} = \Delta V_c + R_1 i + R_2 i$$



$\varepsilon_1 = 10V$

$\varepsilon_2 = 20V$

$R_1 = 10\,\Omega$

$R_2 = 20\,\Omega$

$R_3 = 40\,\Omega$

(1) $i_1 + i_2 = i_3$

(2) $\varepsilon_1 = i_1 R_1 + i_3 R_3$ $\Rightarrow$

(3) $\varepsilon_2 = i_2 R_2 + i_3 R_3$

$$i_1 = \frac{\varepsilon_1 - i_3 R_3}{R_1}, \quad i_2 = \frac{\varepsilon_2 - i_3 R_3}{R_2} \Rightarrow$$

$$\frac{\varepsilon_1 - i_3 R_3}{R_1} + \frac{\varepsilon_2 - i_3 R_3}{R_2} = i_3 \Rightarrow$$

$$\frac{\varepsilon_1}{R_1} + \frac{\varepsilon_2}{R_2} - i_3\left(\frac{R_3}{R_1} + \frac{R_3}{R_2}\right) = i_3 \Rightarrow$$

$$1 + 1 - i_3\left(4 + 2\right) = i_3 \Rightarrow$$

$$i_3 = \frac{2}{7}\,A, \quad i_1 = \frac{10 - \frac{2}{7}40}{10} = 1 - \frac{8}{7} = -\frac{1}{7}\,A$$

$$i_2 = \frac{3}{7}\,A$$