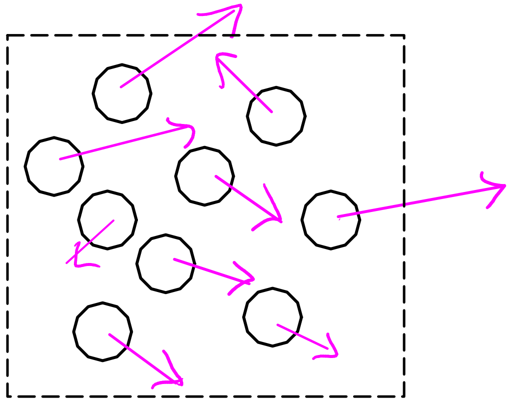
ELETTRICITÀ

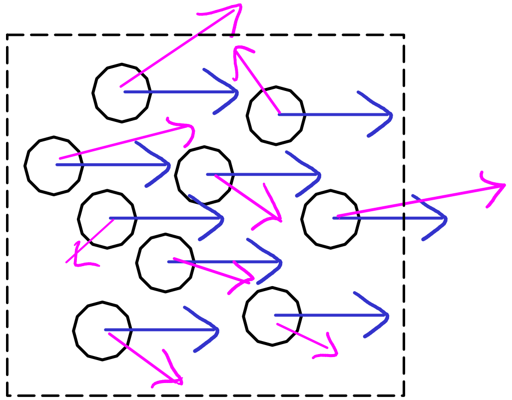
Cariche elettriche → interazioni, dinamica → corrente elettrica stazionaria

elettricità



equilibrio
elettrostatico

$\langle \vec{v} \rangle = \vec{0}$



conduzione
elettrica

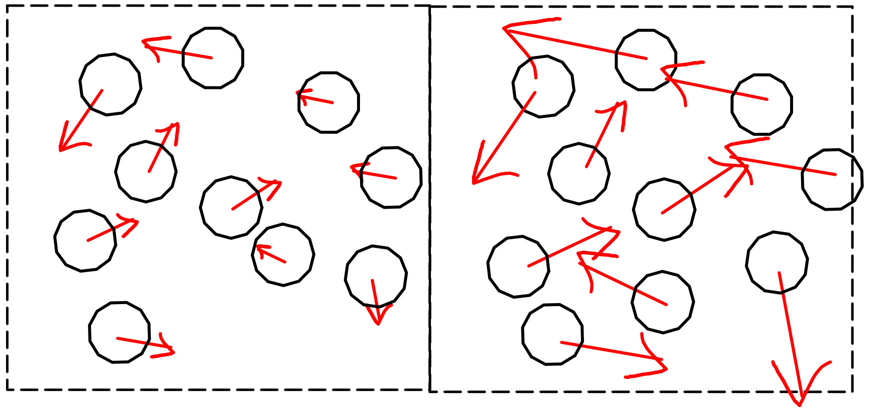
$\langle \vec{v} \rangle \neq \vec{0}$

stazionario

↓

elettromagnetismo

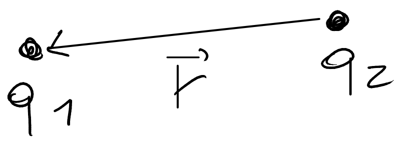
termodinamica



conduzione
termica

Richiami

- Forza elettrostatica



$$\vec F_e^{\,12} = k_e \frac{q_1 q_2}{|\vec r|^2} \frac{\vec r}{|\vec r|} = -\vec F_e^{\,21}$$

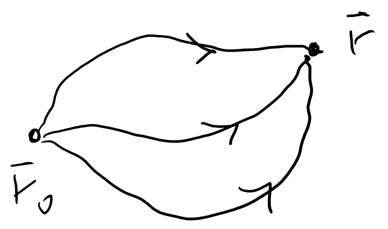
$$\vec r = \vec r_1 - \vec r_2$$

$$k_e \downarrow \frac{1}{4\pi\varepsilon_0}$$

ε_0 costante dielettrica del vuoto

- Energia potenziale

$$\Delta E_p = -\int_{\vec r_0}^{\vec r} \vec F_e \cdot d\vec r$$



$$\vec F_e = -\vec\nabla E_p$$

- Campo elettrico

$$\vec E \equiv \frac{\vec F_e}{q} \qquad [|\vec E|] = \frac{[|\vec F|]}{[q]} \Rightarrow SI: \frac{N}{C}$$

$$\vec{F}_e \longrightarrow \vec{E} \equiv \frac{\vec{F}_e}{q}$$

$$\Delta E_p \longrightarrow \Delta V \equiv \frac{\Delta E_p}{q} \quad (\to \phi_e)$$

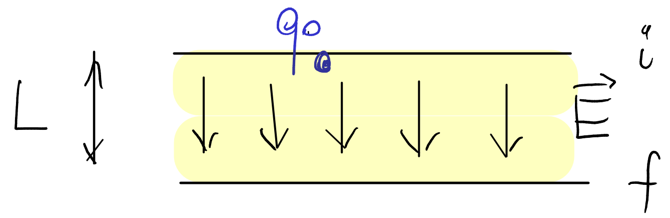
$$\Delta V = -\int_{\vec{r}_0}^{\vec{r}} \vec{E} \cdot d\vec{r}$$

differenza di potenziale elettrostatico

SI: $\frac{J}{C} = V$ (Volt)

Voltmetro

Es.: particella carica in campo elettrico costante



$q_0 =$ protone

$\Delta E_p = q_0 \Delta V = -q_0 E L$

$q_0 > 0 \quad \Delta E_p < 0 \quad \Rightarrow \quad \Delta E_c > 0$

$q_0 < 0 \quad \Delta E_p > 0$

elettronvolt : eV $\rightarrow$ energia!

$\Delta V = 12\ V$

$L = 0.3\ cm$

$q_0 = 1.6 \times 10^{-19}\ C$

$m = 1.67 \times 10^{-27}\ kg$

$v_f = \ ?$

Sistema: {carica, campo} isolato, $\vec{F}_e, \vec{E}$ conservativi

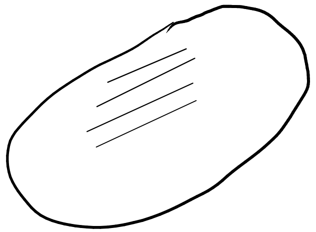
$$\Delta E_p + \Delta E_c = 0 \quad \Rightarrow \quad -q_0 E L + \left(\frac{1}{2} m v_f^2 - 0 \right) = 0$$

$$v_f = \sqrt{\frac{2 q_0 E L}{m}} = \sqrt{\frac{2 \times 1.6 \times 10^{-19}\ C \times 12 V}{1.67 \times 10^{-27}\ kg}} = 4.8 \times 10^4\ \frac{m}{s}$$

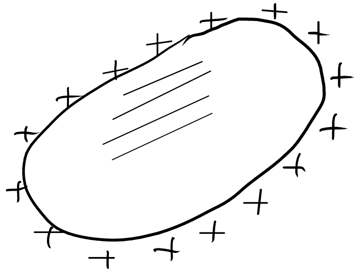
Conduttori elettrici

$\nearrow$ conduttori: una frazione delle cariche può spostarsi liberamente ($\to e^-$)

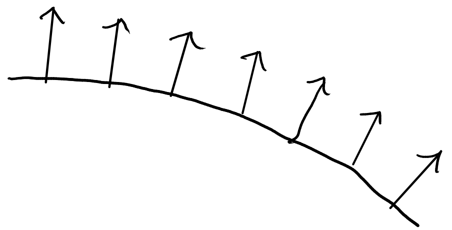
$\searrow$ isolanti: tutte le cariche sono legate $\to$ non possono spostarsi



1. chiuso
equilibrio elettrostatico
$\vec{E} = \vec{0}$



2. carica aggiuntiva si distribuisce sulla superficie



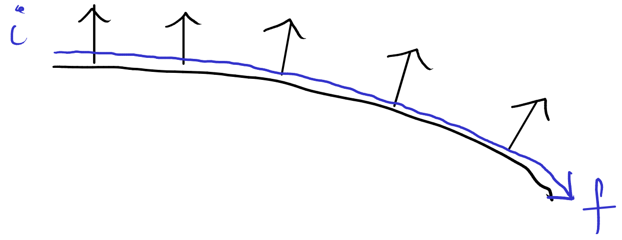
3. $\vec{E} \perp$ superficie

$|\vec{E}| = \frac{\sigma}{\varepsilon_0}$

$\nwarrow \quad \nearrow$

teor. Gauss

$\sigma \equiv$ densità di carica per unità di superficie

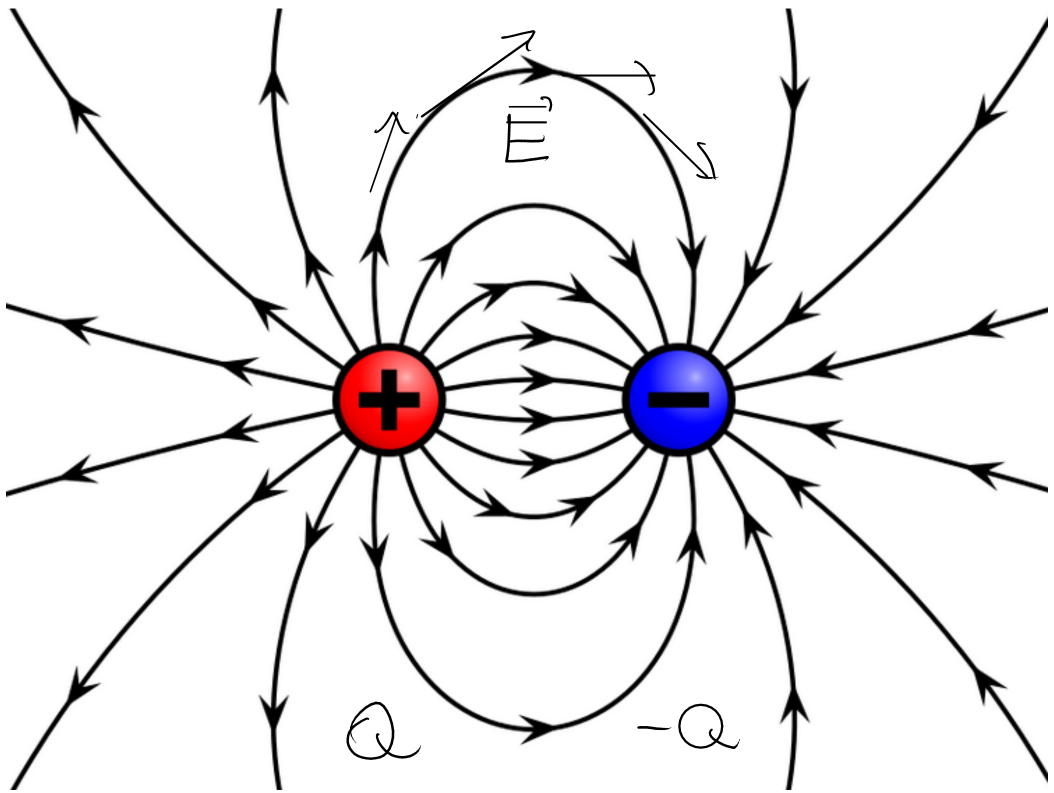


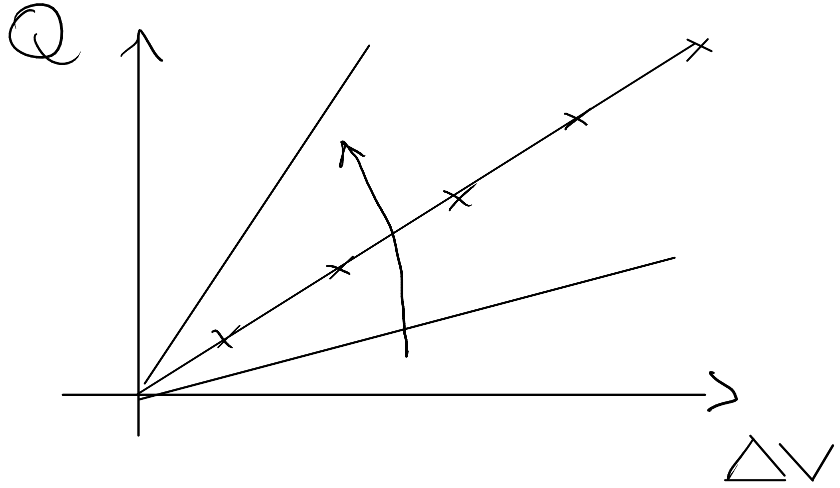
$\Delta V = -\int_i^f \vec{E} \cdot d\vec{r} = 0$

V è costante sulla superficie

$\Rightarrow$ V = cost in tutto il conduttore

Condensatore : dispositivo capace di accumulare cariche elettriche





$$Q \sim \Delta V$$

$$C \equiv \frac{Q}{\Delta V}$$

capacità elettrica

$$SI : \frac{C}{V} \equiv F$$

Farad

(pF ...)

$$C_V = \left.\frac{\partial U}{\partial T}\right|_V$$

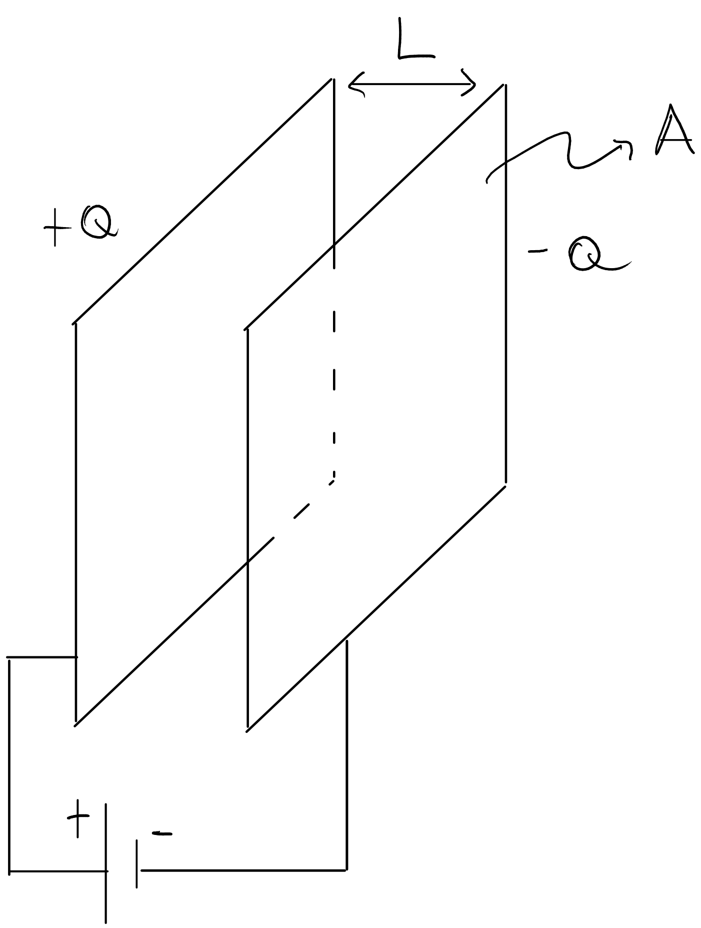
$$= \frac{\Delta U}{\Delta T}$$

$$U = C_V T$$

$$Q = C \,\Delta V$$

$$Q = \frac{1}{\tilde{C}} \Delta V \qquad \Delta V = \tilde{C} Q$$

Es.: condensatore a facce piane



$$\Delta V = \left| - \int_i^f \vec{E} \cdot d\vec{r} \right| = E \cdot L = \frac{\sigma}{\varepsilon_0} \cdot L = \frac{QL}{\varepsilon_0 A}$$

$$Q = C \Delta V$$

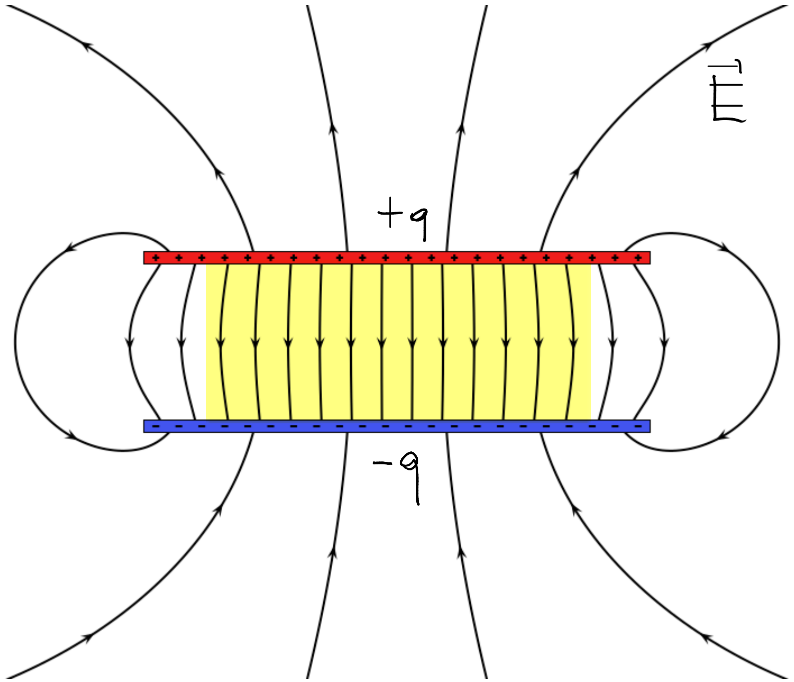
$$Q = \frac{\varepsilon_0 A}{L} \Delta V$$

$$\Rightarrow \quad C = \frac{\varepsilon_0 A}{L} \sim A \sim \frac{1}{L}$$

$$\tilde{C} = \frac{L}{\varepsilon_0 A}$$

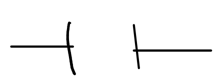
"incapacità elettrica"

$$\begin{cases} \vec{E} = \text{cost} & \text{all'interno} \\ \vec{E} = \vec{0} & \text{al di fuori} \end{cases}$$

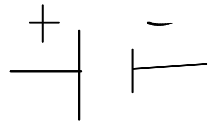


Associazione di condensatori

filo conduttore

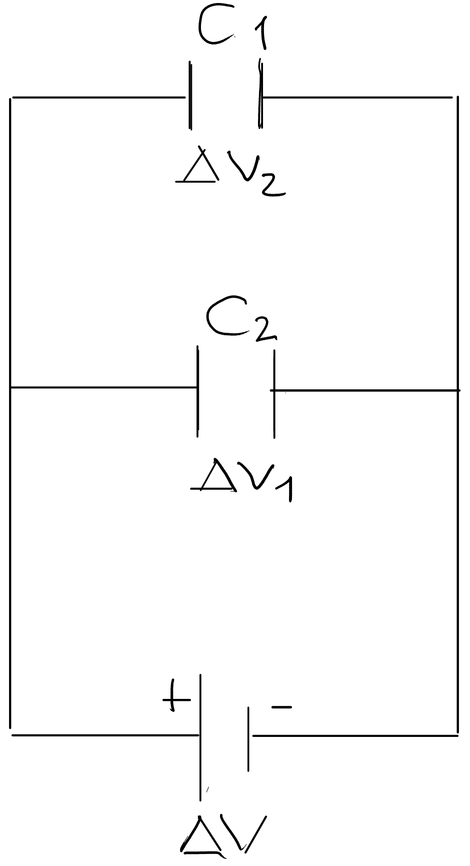


condensatore



batteria

Parallelo



$$\Delta V_1 = \Delta V_2 = \Delta V$$

$$Q_{tot} = Q_1 + Q_2$$

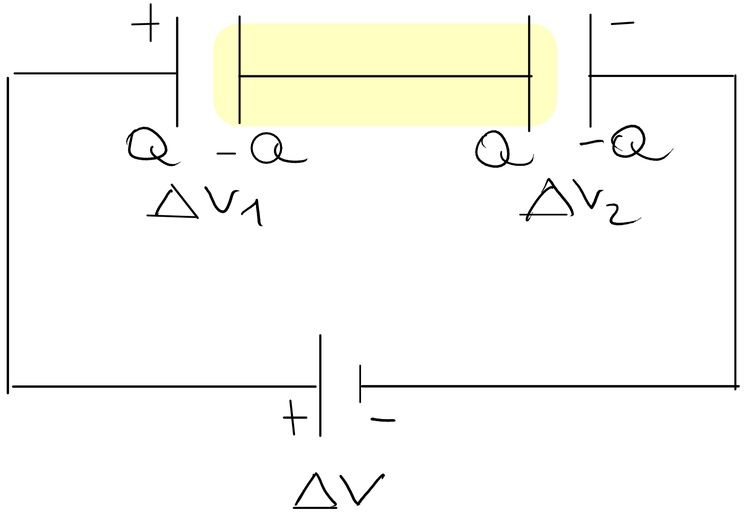
$$Q_{tot} = C_1 \Delta V + C_2 \Delta V = (C_1 + C_2)\,\Delta V$$

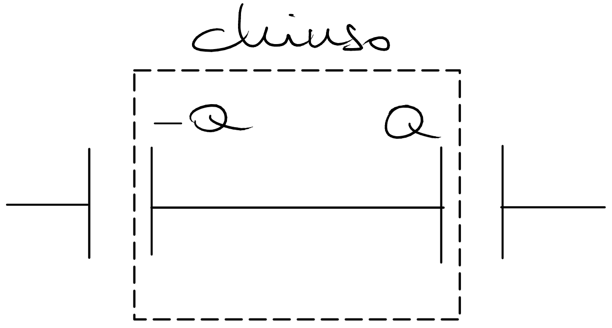
$$Q_{tot} = C_{tot}\,\Delta V$$

$$\Rightarrow C_{tot} = C_1 + C_2$$

$$C_{tot} = \sum_{i=1}^{n} C_i$$

Serie





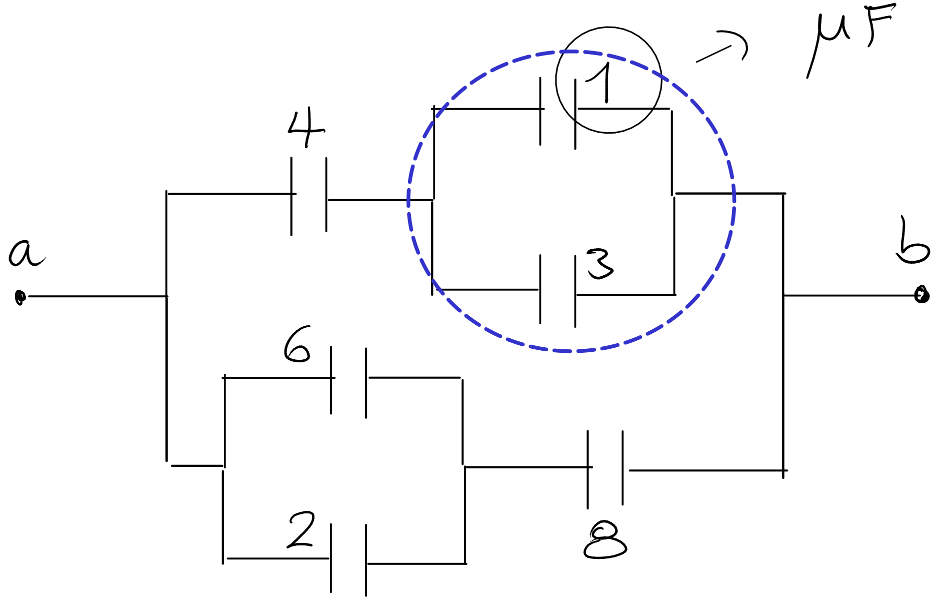
$$Q_1 = Q_2 = Q$$

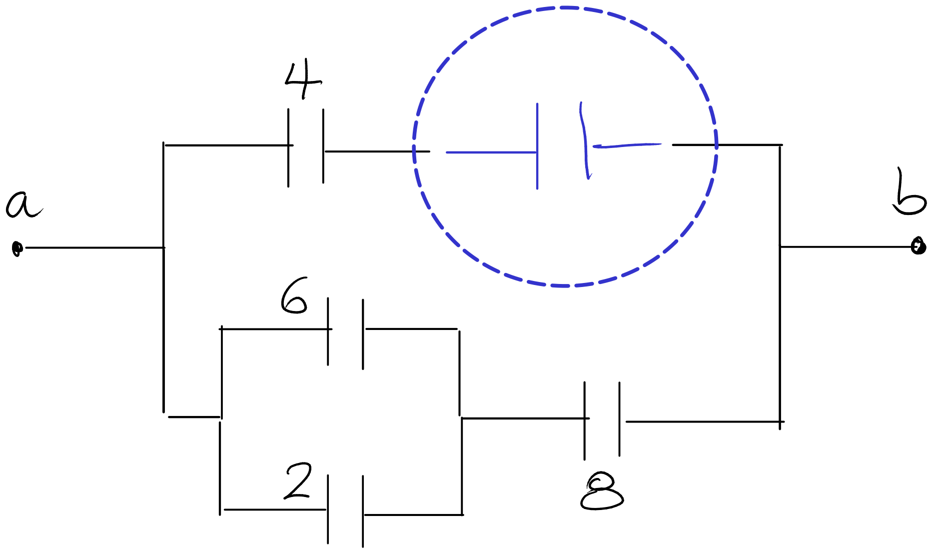
$$\Delta V = \Delta V_1 + \Delta V_2 = \frac{Q}{C_1} + \frac{Q}{C_2} = \frac{Q}{C_{tot}} \Rightarrow \frac{1}{C_{tot}} = \frac{1}{C_1} + \frac{1}{C_2}$$

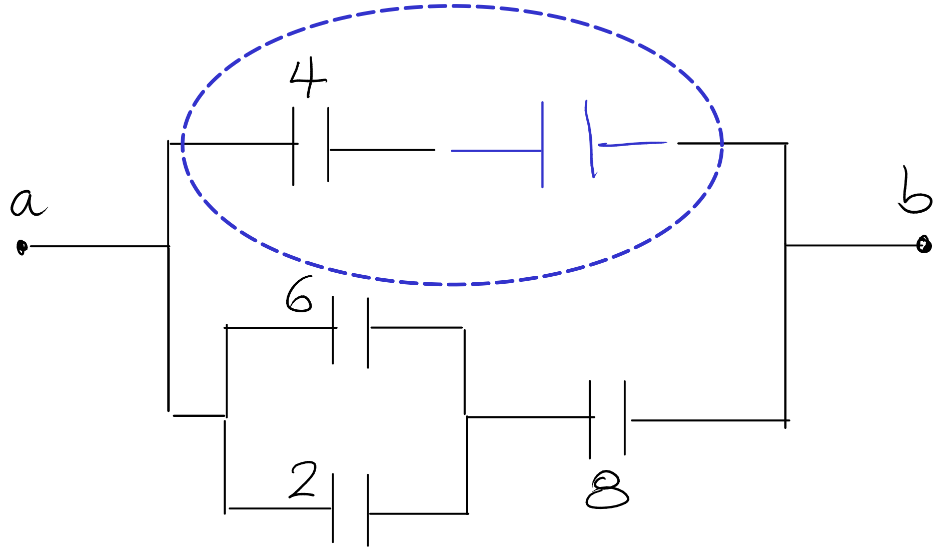
$$\frac{1}{C_{tot}} = \sum_{i=1}^{n} \frac{1}{C_i}$$

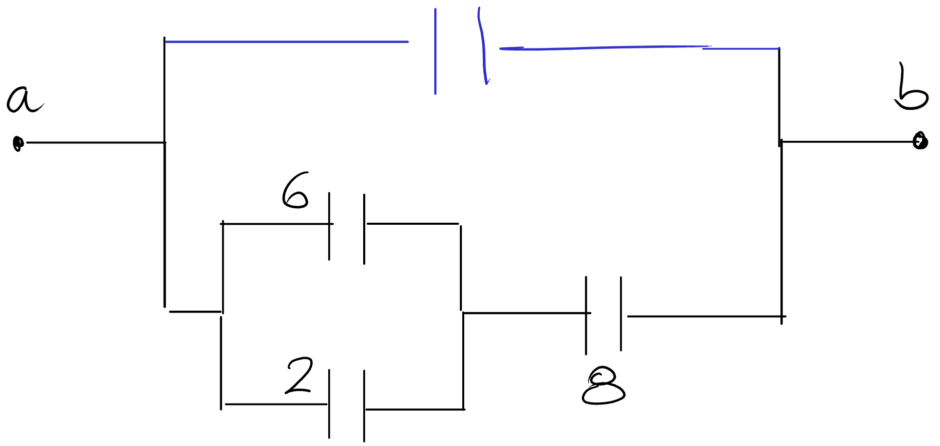
Es.: SJ esempio 20.8

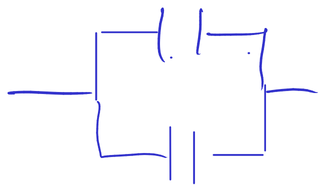
Capacità equivalente (totale) del dispositivo?











$\Rightarrow$ C_{tot}

$\Delta V = V_b - V_a$