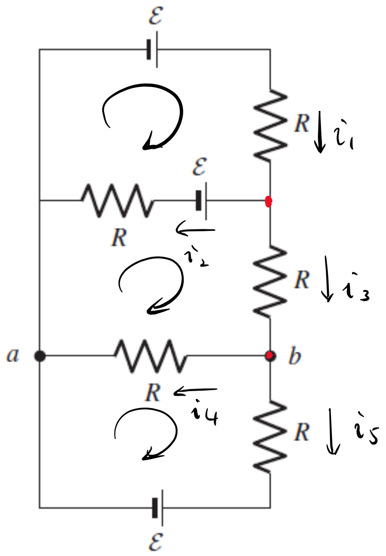


Potential Difference between a and b?

$$\begin{cases} i_1 = i_2 + i_3 \\ i_3 = i_4 + i_5 \checkmark \\ \cancel{-\varepsilon} - i_2R + \cancel{\varepsilon} - i_1R = 0 \\ -i_3R - i_4R + i_2R + \varepsilon = 0 \checkmark \\ -i_5R - \varepsilon + i_4R = 0 \checkmark \end{cases}$$

$i_1 = -i_1 + i_3$ $i_3 = 2i_1$

$i_1 + i_2 = 0$ $i_2 = -i_1$

$$\begin{cases} i_4 + i_5 = 2i_1 \\ -2i_1R - i_4R - i_1R + \varepsilon = 0 \\ -i_5R - \varepsilon + i_4R = 0 \end{cases}$$

$\frac{i_5R + \varepsilon}{R} + i_5 = 2i_1$ $2i_5 = 2i_1 - \frac{\varepsilon}{R}$

$i_5 = i_1 - \frac{\varepsilon}{2R}$

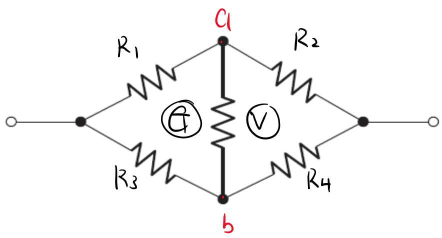
$i_4 = \frac{i_5R + \varepsilon}{R} = i_5 + \frac{\varepsilon}{R} = i_1 + \frac{\varepsilon}{2R}$

$-2i_1R - (i_1 + \frac{\varepsilon}{2R})R - i_1R + \varepsilon = 0$

$-4i_1R + \frac{\varepsilon}{2} = 0$ $i_1 = \frac{\varepsilon}{8R}$ $i_4 = \frac{\varepsilon}{8R} + \frac{\varepsilon}{2R} = \frac{5\varepsilon}{8R}$ $i_5 = \frac{\varepsilon}{8R} - \frac{\varepsilon}{2R} = -\frac{3\varepsilon}{8R}$

$i_2 = -\frac{\varepsilon}{8R}$ $i_3 = 2 \cdot \frac{\varepsilon}{8R} = \frac{\varepsilon}{4R}$

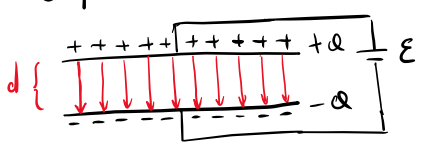
$V_{ba} = i_4R = \frac{5}{8}\varepsilon$.



Bridge 电桥

Balance: $R_1R_4 = R_2R_3$

Capacitance 电容



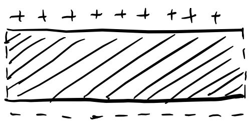
Capacitor 电容器.   (F)   Farady 法拉

$E = \frac{V}{d}$ V — potential difference

$C = \frac{Q}{V}$ Q — charge of a single plate

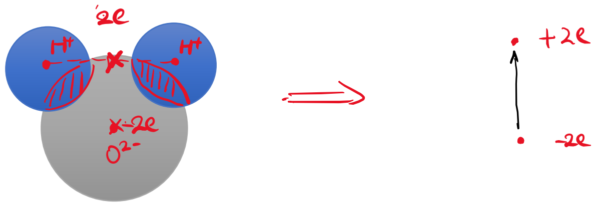
$C = \varepsilon_0 \cdot \frac{A}{d}$ A — Area of each plate

d — distance

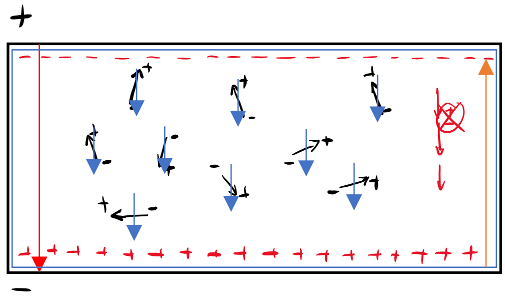


Dielectric

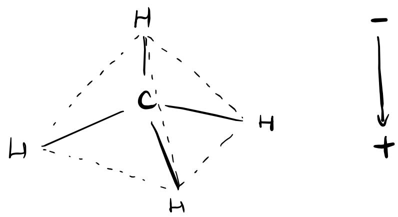
example: H_2O $\quad$ H–O–H $\quad$ H^+ O^{2-}



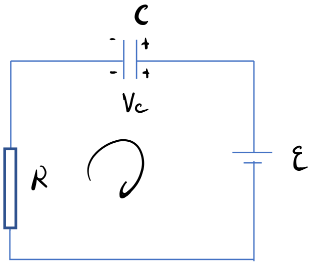
electric Dipole



Polarization



$$C = k\varepsilon_0 \cdot \frac{A}{d} \qquad k \text{ — material constant} \qquad c = \frac{Q}{V}$$



$$i = \frac{dq}{dt} \qquad V_c + V_R = \varepsilon$$

RC Circuit

$$V_c + R\cdot\frac{dq}{dt} = \varepsilon \qquad V_c = \frac{q}{C}$$

LC Circuit

$$\frac{q}{c} + R\cdot\frac{dq}{dt} = \varepsilon.$$

$$\frac{dq}{dt} + \frac{q}{RC} = \frac{\varepsilon}{R} \qquad \frac{dq}{dt} = \frac{\varepsilon}{R} - \frac{q}{RC} = -\frac{1}{RC}(q - \varepsilon C)$$

$$\frac{dq}{q-\varepsilon C} = -\frac{1}{RC}dt \qquad \int_0^q \frac{dq}{q-\varepsilon C} = \int_0^t -\frac{1}{RC}dt = -\frac{t}{RC}$$

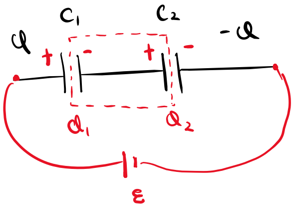
$$\ln|q-\varepsilon C|\Big|_0^t \qquad \ln|q-\varepsilon C| - \ln \varepsilon C = -\frac{t}{RC} \qquad \ln\frac{\varepsilon C - q}{\varepsilon C} = -\frac{t}{RC}$$

$$\frac{\varepsilon C - q}{\varepsilon C} = e^{-\frac{t}{RC}} \qquad q = \varepsilon C - \varepsilon C\cdot e^{-\frac{t}{RC}} = \varepsilon C\,(1-e^{-\frac{t}{RC}})$$

$$V_c = \frac{q}{C} = \varepsilon\,(1-e^{-\frac{t}{RC}}) \qquad i = \frac{dq}{dt} = \varepsilon C\cdot\frac{1}{RC}e^{-\frac{t}{RC}} = \frac{\varepsilon}{R}\cdot e^{-\frac{t}{RC}}$$

$$t=0 \quad V_c = 0 \quad i = \frac{\varepsilon}{R} \qquad t\to\infty \quad V_c = \varepsilon \quad i = 0$$

Capacitors connected in series



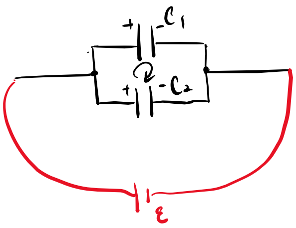
$C_{total} = \frac{Q}{V}$ $V = \varepsilon$

* $Q_1 = Q_2$ $V = V_{C_1} + V_{C_2} = \frac{Q_1}{C_1} + \frac{Q}{C_2}$

$V = \frac{\cancel{Q}}{C_1} + \frac{\cancel{Q}}{C_2} = \frac{\cancel{Q}}{C_{total}}$ $\frac{1}{C_{total}} = \frac{1}{C_1} + \frac{1}{C_2}$

$C_{total} = \frac{C_1 C_2}{C_1 + C_2}$

Capacitors connected in parallel

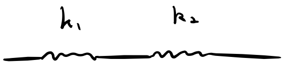


$V_1 = V_2$ $V_1 = \frac{Q_1}{C_1}$ $V_2 = \frac{Q_2}{C_2}$

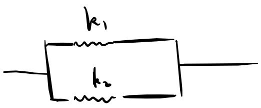
$\frac{Q_1}{C_1} = \frac{Q_2}{C_2} = \varepsilon$ $Q_1 = \varepsilon C_1$ $Q_2 = \varepsilon Q_2$

$Q = Q_1 + Q_2 = \varepsilon(C_1 + C_2)$

$C_{total} = \frac{Q}{\varepsilon} = C_1 + C_2$

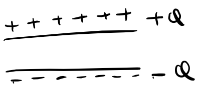


$k = \frac{k_1 k_2}{k_1 + k_2}$



$k = k_1 + k_2$

$\boxed{\text{Energy}}$ Stored in Capacitor

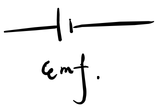


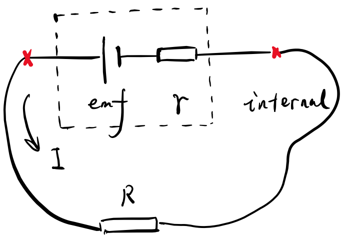
$dW = dq \cdot V = dq \cdot \frac{q}{C} = \frac{1}{C} \cdot q \cdot dq$

$W = \int_0^Q \frac{1}{C} q \, dq = \frac{1}{C} \cdot \frac{1}{2} q^2 \Big|_0^Q = \frac{1}{2} \cdot \frac{Q^2}{C}$

$C = \frac{Q}{V}$ $Q = CV$ $E = \frac{1}{2} \frac{Q^2}{C} = \frac{1}{2} CV^2 = \frac{1}{2} QV$

Cell





resistance.

$P = I^2 r$

$\varepsilon = I(R + r)$

$IR = \varepsilon - Ir$

$V = \varepsilon - Ir$