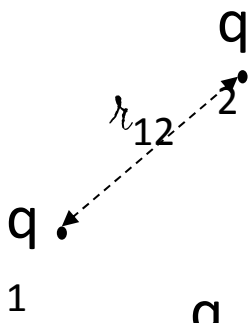
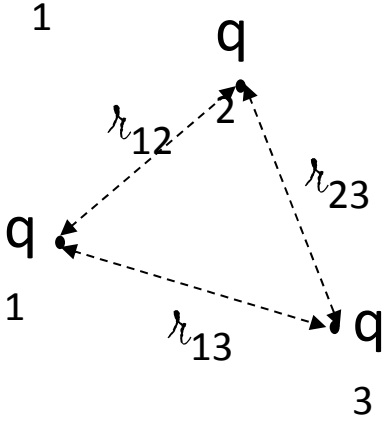
Energy stored in a capacitor

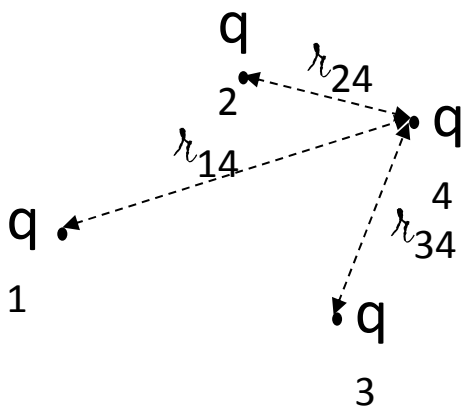
Energy to Assemble a Collection of Charges



$$W = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r_{12}}$$

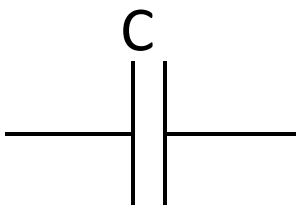


$$W = \left(\frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r_{12}}\right) + \left(\frac{1}{4\pi\varepsilon_0}\frac{q_1 q_3}{r_{13}} + \frac{1}{4\pi\varepsilon_0}\frac{q_2 q_3}{r_{23}}\right)$$



$$W = \left(\frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r_{12}}\right) + \left(\frac{1}{4\pi\varepsilon_0}\frac{q_1 q_3}{r_{13}} + \frac{1}{4\pi\varepsilon_0}\frac{q_2 q_3}{r_{23}}\right) + \left(\frac{1}{4\pi\varepsilon_0}\frac{q_1 q_3}{r_{14}} + \frac{1}{4\pi\varepsilon_0}\frac{q_2 q_4}{r_{24}} + \frac{1}{4\pi\varepsilon_0}\frac{q_3 q_4}{r_{34}}\right)$$

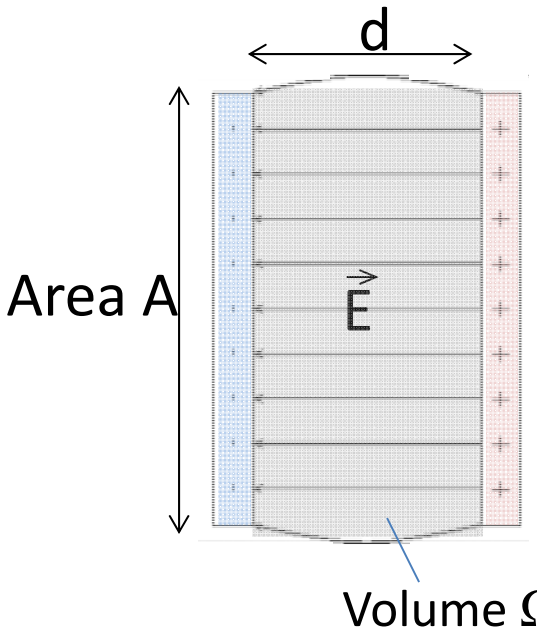
Energy Stored in a Capacitor



Energy stored in a charged capacitor:

$$U = \frac{1}{2} C V^2$$

(Do not forget $C = \frac{Q}{V}$.)

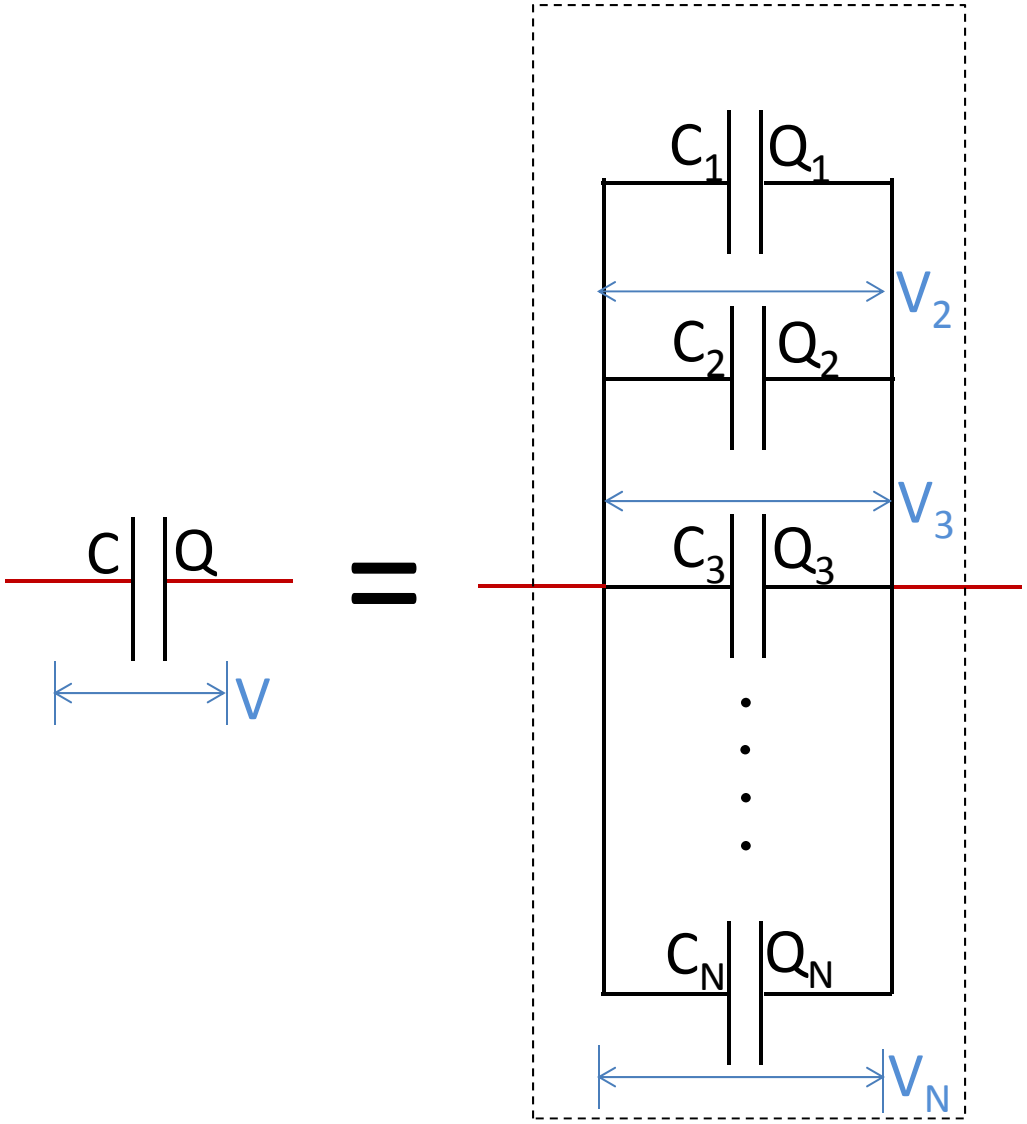


Energy density stored in an electric field:

$$u_E = \frac{U}{\Omega} = \frac{1}{2} \varepsilon_0 E^2$$

Class 17. Capacitors in parallel and in series I

Connecting Capacitors in Parallel



$$C = C_1 + C_2 + C_3 + \cdots C_N$$

$$Q = Q_1 + Q_2 + Q_3 + \cdots Q_N$$

$$V = V_1 = V_2 = V_3 = \cdots V_N$$

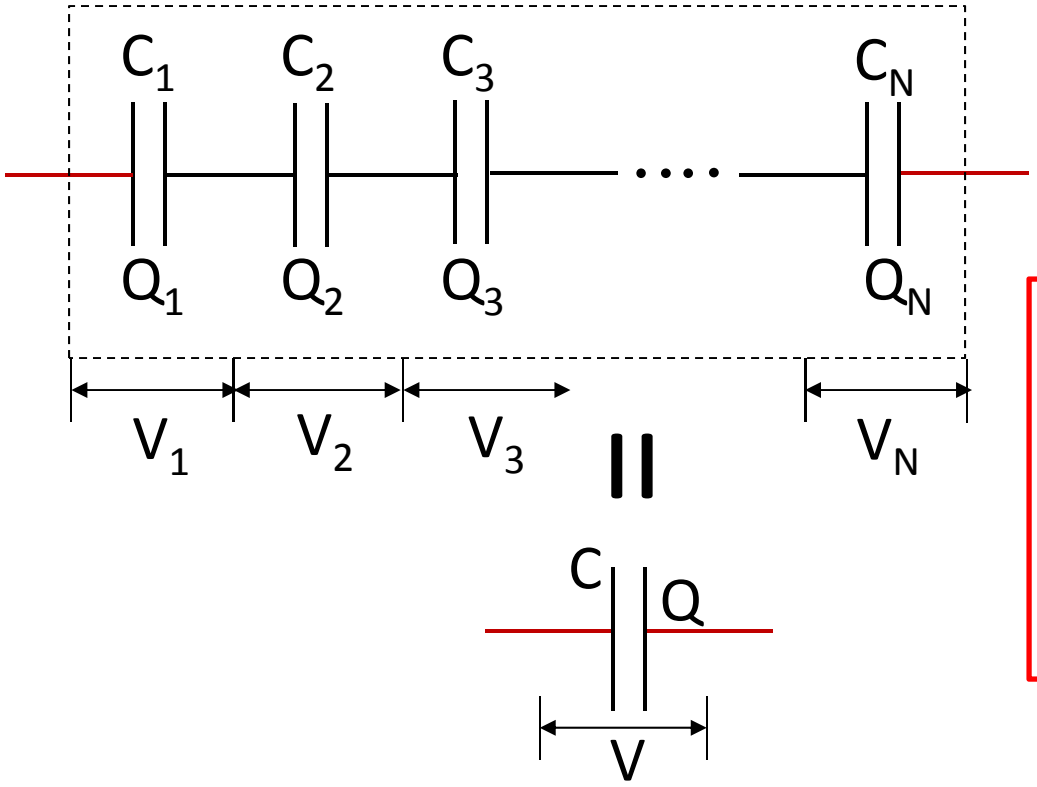
1. Potential difference across each individual capacitor is the same: (why?)

$$V = V_1 = V_2 = V_3 = \cdots V_N$$

$$\Rightarrow \frac{Q_1}{C_1} = \frac{Q_2}{C_2} = \frac{Q_3}{C_3} = \cdots \frac{Q_N}{C_N}$$

2. Charge stored in each individual capacitor should be different (unless they have the same capacitance).

Connecting Capacitors in Series



$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \cdots \frac{1}{C_N}$$

$$Q = Q_1 = Q_2 = Q_3 = \cdots = Q_N$$

$$V = V_1 + V_2 + V_3 + \cdots + V_N$$

1. Charge stored in each individual capacitor is the same: (why?)

$$Q = Q_1 = Q_2 = Q_3 = \cdots = Q_N$$

$$\Rightarrow CV = C_1V_1 = C_2V_2 = C_3V_3 = \cdots = C_NV_N$$

2. Potential difference across each individual capacitor should be different (unless they have the same capacitance).