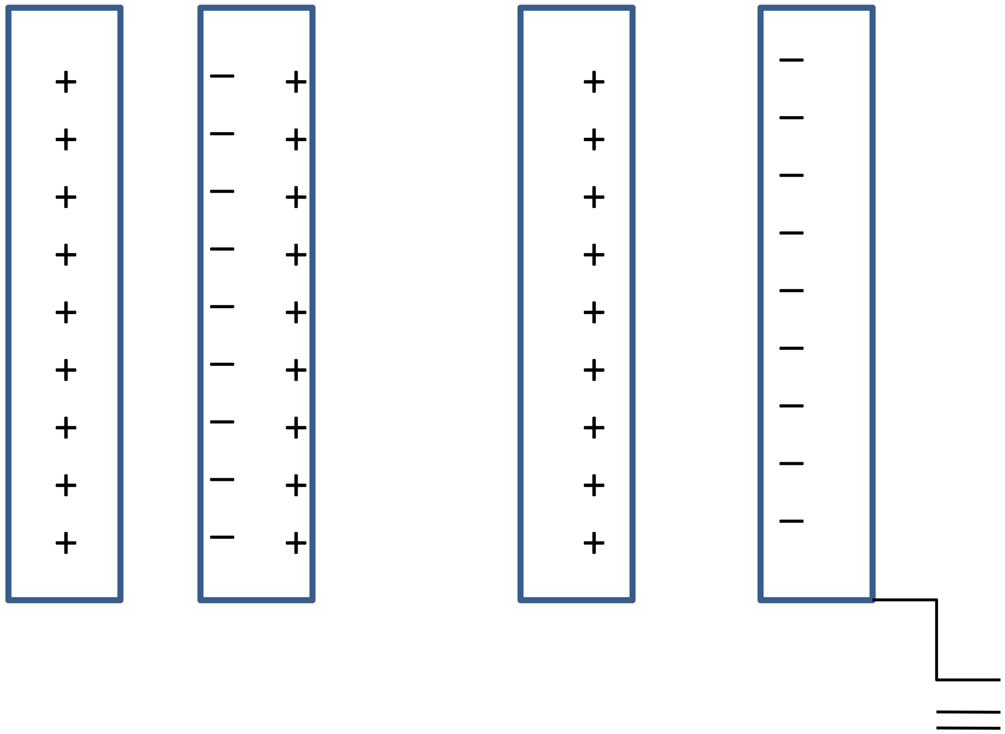
CAPACITOR

PRINCIPLE



Every Practical Capacitor as 2 plates carrying equal and opposite charges. Hence net Charge is ZERO

Whenever a neutral conductor is placed near a charged conductor its capacitance increase

CAPACITOR

TYPES

Based on Geometrical Shape

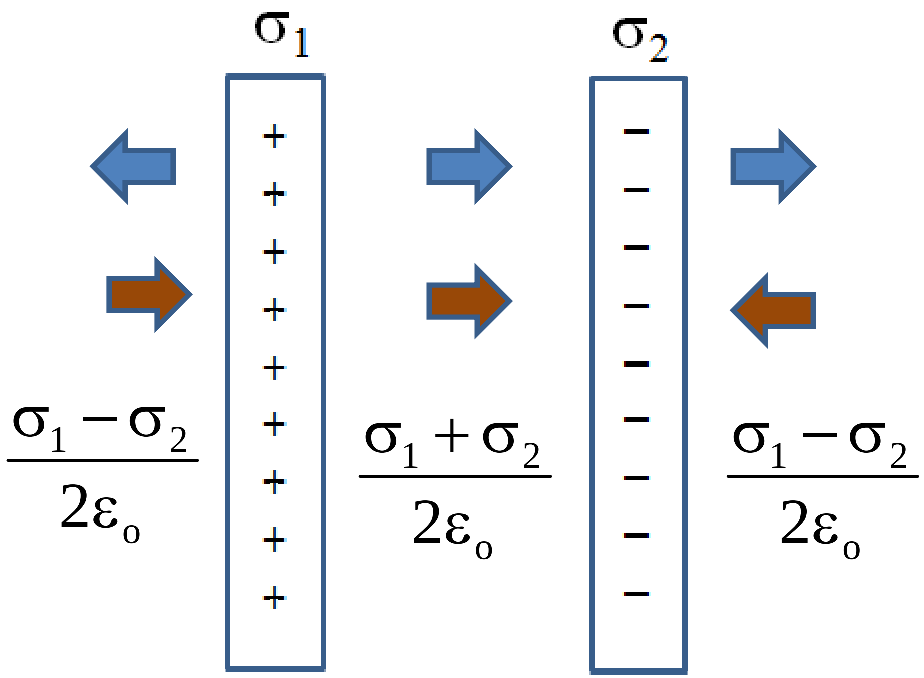
Parallel Plate Capacitor, Cylindrical Capacitor, Spherical Capacitor etc

Based on Material between Plates

Air Capacitor, Ceramic Capacitor, Mica Capacitor etc

Find the Potential due to a charge , Then Divide the Charge by potential. Whatever we get is the capacitance of capacitor.

CAPACITOR

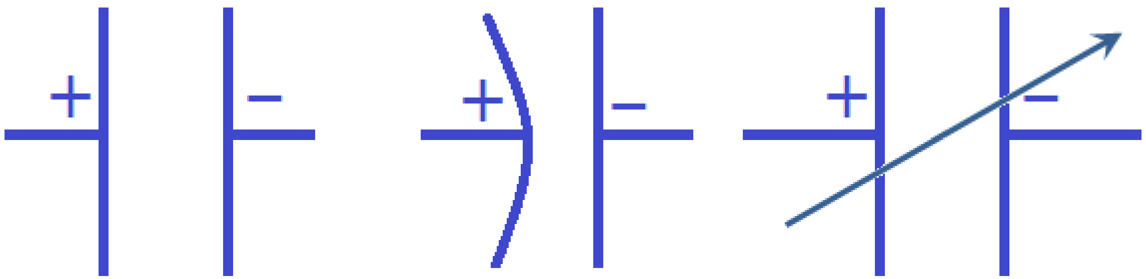


$$E \text{ in between 2 sheets} = \frac{\sigma}{\varepsilon_0}$$

$$E \text{ outside 2 sheets} = 0$$

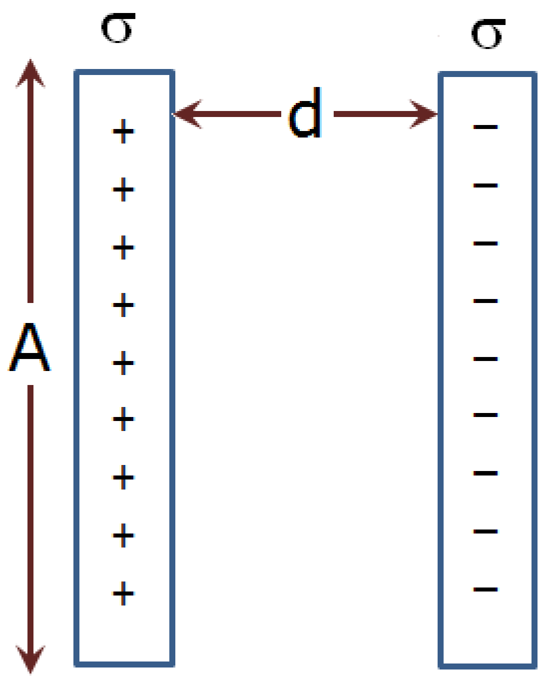
$$E = \frac{V}{d}$$

$$\sigma = \frac{Q}{A}$$



CAPACITOR

Parallel Plate Capacitor



$$E = \frac{V}{d} \qquad \sigma = \frac{Q}{A}$$

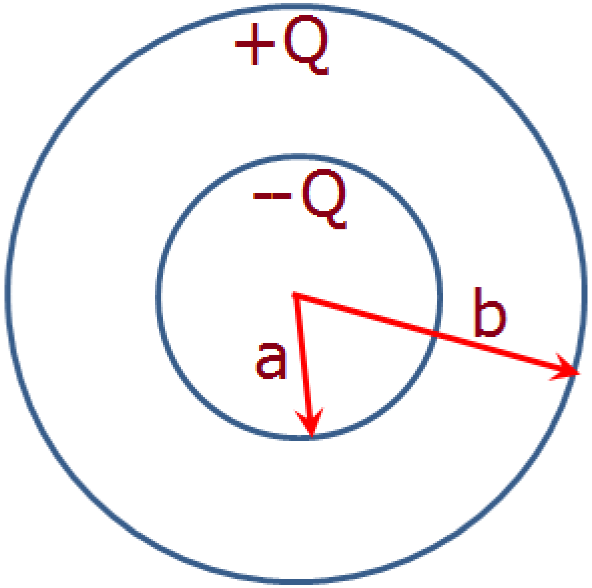
$$E = \frac{V}{d} \Rightarrow V = E.d$$

$$V = \frac{\sigma}{\varepsilon_0}.d \qquad V = \frac{Q}{A\varepsilon_0}.d$$

$$\frac{Q}{V} = \frac{\varepsilon_0 A}{d} = C$$

A and d have practical limitations

CAPACITOR



$$V \text{ at A due to} -Q = -\frac{kQ}{a}$$

$$V \text{ at A due to } +Q = \frac{kQ}{b}$$

$$V \text{ at A} = \frac{kQ}{b} - \frac{kQ}{a}$$

$$V \text{ at B due to} -Q = -\frac{kQ}{b}$$

$$V \text{ at B due to } +Q = \frac{kQ}{b}$$

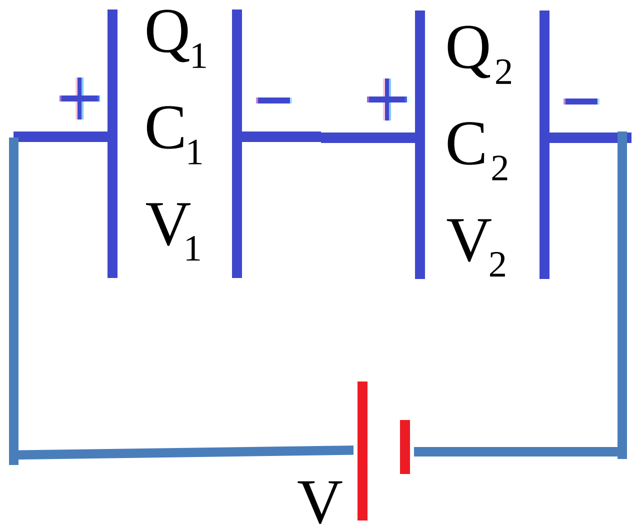
$$V \text{ at B} = \frac{kQ}{b} - \frac{kQ}{b} = 0$$

$$V_{AB} = \frac{kQ}{b} - \frac{kQ}{a} = kQ\left(\frac{1}{b} - \frac{1}{a}\right)$$

$$\frac{Q}{V_{AB}} = \frac{1}{k}\left(\frac{ab}{a-b}\right) = C$$

CAPACITOR

Grouping of Capacitor : SERIES



$$V = V_1 + V_2$$

$$Q_1 = Q_2 = Q$$

$$Q = C_1V_1 = C_2V_2 \Rightarrow V_1 = \frac{Q}{C_1}; V_2 = \frac{Q}{C_2}$$

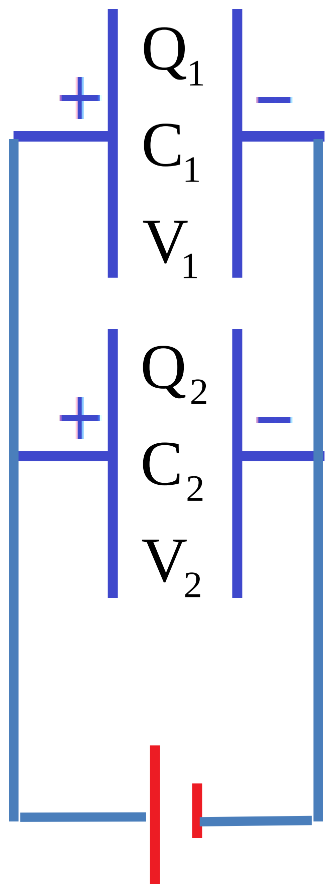
$$V = \frac{Q}{C_1} + \frac{Q}{C_2}$$

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

$$\frac{1}{C_{EQV}} = \frac{1}{C_1} + \frac{1}{C_2}$$

CAPACITOR

Grouping of Capacitor : PARALLEL



$$Q_1 = C_1V_1; \qquad Q_2 = C_2V_2$$

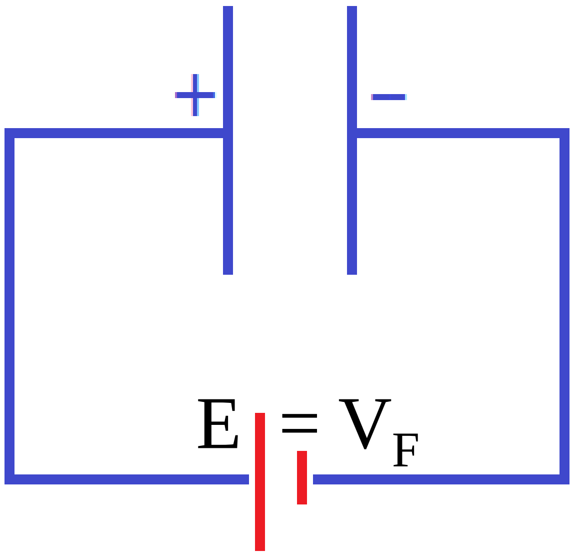
$$V_1 = V_2 = V(\text{say})$$

$$\text{Net charge stored} = Q = Q_1 + Q_2$$

$$Q = C_1V + C_2V$$
$$= (C_1 + C_2)V$$

$$\frac{Q}{V} = (C_1 + C_2) = C_{EQV}$$

CAPACITOR



$$Q = CV$$

$$\text{Initial } V = 0; Q = 0$$

$$\text{after some time } Q = q; V = V' \Rightarrow q = CV'$$

This instant charge dq is brought

$$dW = V'dq = \frac{q}{C}.dq$$

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

$$W = U = \frac{Q^2}{2C} = \frac{1}{2}CV^2 = \frac{1}{2}QV$$