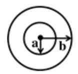
MIND MAP

Capacitor

Capacity of a Capacitor depends on
1) Shape and size of the plates
2) Distance between plates
3) Medium between the plates

Parallel Plate Capacitor $C = \frac{A\varepsilon_0}{d}$

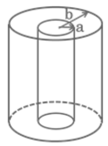
Spherical Capacitor



$C = \frac{4\pi\varepsilon_0 ab}{b-a}$

Cylindrical Capacitor

$C = \frac{2\pi\varepsilon_0 l}{\ln\left(\frac{b}{a}\right)}$



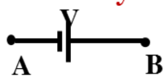
Series Combination (charge is same), $\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \cdots$

Parallel Combination (V is same), $C_{eq} = C_1 + C_2 + \cdots$

Mesh Analysis
- Assume charge using Junction Law.
- Apply KVL

Nodal Analysis
- Assume potential in a circuit.
- Apply Junction Law

Work Done By Battery

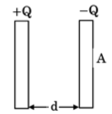


$W = QV$

Energy Stored in a Capacitor $= \frac{1}{2}CV^2 = \frac{Q^2}{2C} = \frac{1}{2}QV$

Electrostatic Force b/w the Plates of a Parallel Plate Capacitor

$F = \frac{Q^2}{2A\epsilon_0}$



Bound Charges (Induced Charges) on Dielectric $q = Q\left(1 - \frac{1}{K}\right)$

Heat Loss $= \frac{Q_0^2}{2C}$

Capacity of a Capacitor, $C = \frac{Q}{V}$

where C is a +ve constant for a conductor and is called capacity (capacitance) of capacitor.
SI unit of Capacity is Farad

Conductor	Capacitor
Q → Charge on conductor	Q → Charge on positive plate
V → Potential of conductor	V → Potential difference between plates

1 Farad is a very BIG unit. $\mu F(10^{-6}F)$, $nF(10^{-9}F)$, $pF(10^{-12}F)$

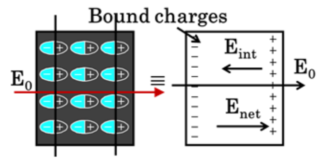
Heat Generated in Circuit $H = \sum W_b - \sum \Delta E$

$\Delta E = (E_f - E_i)$

$\sum W_b$ = Work done by all batteries

$\sum \Delta E$ = Energy change in all capacitors

Dielectric
- Polar (Eg. H_2O) have dipoles even in absence of external $\vec{E}$
- Non-Polar (Eg. Graphite) do not have dipoles in absence of external $\vec{E}$



$E_{net} = E_0 - E_{int}$

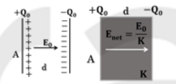
$E_{net} = \frac{E_0}{K}$ [K is dielectric constant]

$1 \le K \le \infty$
Vacuum — Conductors

Dielectric Inside Capacitor $E_{net} = \frac{E_0}{K}$ $C = KC_0$

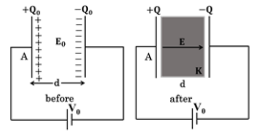
Effect on Parameters due to Introduction of Dielectric Slab (Completely Filled)

1. Battery is not connected



Before	After
Q_0	Q_0
C_0	KC_0
E_0	E_0/K
V_0	V_0/K
U_0	U_0/K

2. Battery is connected

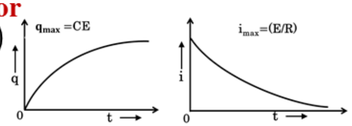


Before	After
Q_0	KQ_0
C_0	KC_0
E_0	E_0
V_0	V_0
U_0	U_0K

Charging of Capacitor

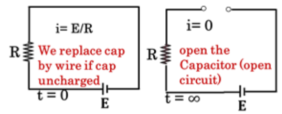
$q = CE\left(1 - e^{-t/RC}\right)$

$i = \frac{E}{R}\left(e^{-t/RC}\right)$

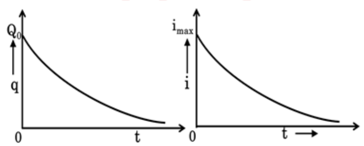


Time Constant (τ) $\tau = RC$
After 1τ time capacitor gets 63% charged

Calculation of current at $t = 0$ and $t = \infty$



Discharging of Capacitor



In 1τ approx capacitor 63% discharged

$q = Q_0 e^{-t/RC}$

$i = i_{max}\, e^{-t/RC}$