Capacitors

01) $C = Q/V$

02) For parallel-plate capacitor

$E = \frac{\sigma}{\epsilon_0}$ $V = Ed = \frac{Q}{A\epsilon_0}$

$C = Q/V$

$$\boxed{C = \frac{\epsilon_0 A}{d}}$$

03) For cylinderical capacitor

$$C = \frac{l}{2k\ln(\frac{b}{a})}$$

04) For spherical Capacitorr

$$C = \frac{ab}{k(b-a)}$$

05) Capacitors in parallel

$C = C_1 + C_2 + C_3$

05) Capacitors in series

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

04) Energy stored in a capacitor

$$U = \frac{1}{2}CV^2 \quad \text{or} \quad U = \frac{1}{2C}Q^2$$

~~Energy density~~

Energy in a parallel capacitor

$$U = \frac{1}{2}CV^2 = \frac{1}{2}\frac{A\epsilon_0}{d}(E^2d^2)$$

$$\boxed{U = \frac{1}{2}A\epsilon_0 d(E^2)}$$

Energy density =

$$\frac{U}{V} = \frac{1}{2}\cancel{A}\epsilon_0\cancel{d}(E^2) \times \frac{1}{\cancel{V}}$$

$$\boxed{U_E = \frac{1}{2}\epsilon_0 E^2}$$

07) Capacitors with dielectrics:-

$$\Delta V = \frac{\Delta V_0}{K}$$

$$E = \frac{E_0}{K}$$ electric field in presence of dipole

$$C = KC_0$$

$$\boxed{C = \frac{K\epsilon_0 A}{d}}$$

when an external field is induced in a dipole

$$E = E_0 - E_{ind}.$$

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Electric Current & Resistance

01) $I = q/t$

02) $Q = \boxed{nA\Delta x q} = \boxed{nA\Delta t \times V_{drift} \times q}$

$$\boxed{I = nAV_d q = \frac{nA\Delta x q}{\Delta t}}$$

03)
current density $\curvearrowleft$ $J = I/A = nqV_d = \sigma E$
$\hookrightarrow$ conductivi

04) Resistance:-

$\rightarrow \Delta V = El$

$\rightarrow J = \sigma E = \frac{\sigma V}{l}$; $\boxed{J = \frac{\sigma V}{l}}$

$$\Delta V = \frac{l}{\sigma} J = \frac{l}{\sigma} \times \frac{I}{A}$$

$$\rightarrow \boxed{\Delta V = \left(\frac{l}{\sigma A}\right) I}$$

$\hookrightarrow$ resistance

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$$\boxed{R = \frac{l}{\sigma A} = \frac{\Delta V}{I}}$$

$$\rho = \frac{1}{\sigma}$$

resistivity (ρ), $\sigma \to$ conductivity

$$\boxed{R = \frac{\rho l}{A} = \frac{l}{\sigma A} = \frac{V}{I}}$$

Resistance & temperature:-

Resistivity

$$\rho = \rho_0 (1 + \alpha \Delta T)$$

$$\rho = \rho_0 + \rho_0 \Delta T \alpha$$

$$\Delta \rho = \rho_0 \alpha \Delta T$$

$$\boxed{\alpha = \frac{\Delta \rho}{\rho_0 \Delta T}}$$

Resistance

$$R = R_0 (1 + \alpha \Delta T)$$

$$\alpha = \frac{\Delta R}{\Delta T R_0}$$

$$P = VI = I^2 R = \frac{V^2}{R}$$