$[\vec{E}] = \frac{[F]}{[q]} = \frac{N}{C} = \frac{V}{m}$

$\vec{F}_E = q\vec{E}$

$$\vec{F}_E = \frac{1}{4\pi\varepsilon_0} \sum_i \frac{q\, q_i}{r_i^2} \hat{r}_i$$

(전기력) $[F_E = N]$

$$\vec{E} = \frac{1}{4\pi\varepsilon_0} \sum_i \frac{q_i}{r_i^2} \hat{r}_i$$

(전기장)

$V = V(A) - V(B)$

$= \int_A^B \vec{E} \circ d\vec{l}$

$\vec{E} = -\vec{\nabla} V$

$\vec{\nabla} = \frac{\partial}{\partial x}\hat{x} + \frac{\partial}{\partial y}\hat{y} + \frac{\partial}{\partial z}\hat{z}$

$$E_p = \frac{1}{4\pi\varepsilon_0} \sum_i \frac{q\, q_i}{r_i}$$

$[E_p] = J$ (줄)

(전기 위치에너지)

$E_p = qV$

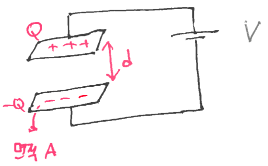
$$V = \frac{1}{4\pi\varepsilon_0} \sum_i \frac{q_i}{r_i}$$

$[V] = J/C = V$ (볼트)

(전위)

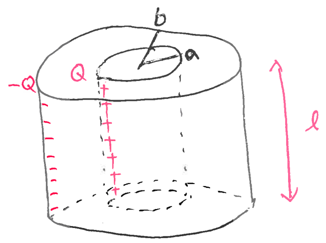
* 전기용량 : $C = \frac{Q}{V}$, $[C] = \frac{C}{V} = F$ (페럿)

① 평행판 축전기 : $E = \frac{\sigma}{\varepsilon_0}$, $C = \varepsilon_0 \frac{A}{d}$

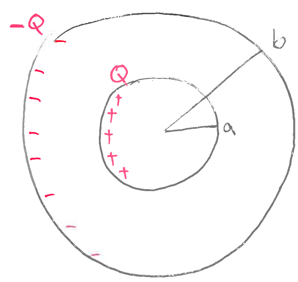


$W = \frac{Q^2}{2C} = \frac{QV}{2} = \frac{CV^2}{2}$: 축전기에 저장된 전기에너지

② 원통형 축전기 : $E = \frac{Q}{2\pi\varepsilon_0 l r}$, $C = \frac{2\pi\varepsilon_0 l}{\ln\left(\frac{b}{a}\right)}$



③ 구형 축전기 : $E = \frac{1}{4\pi\varepsilon_0} \frac{Q}{r^2}$, $C = \frac{4\pi\varepsilon_0 ab}{b-a}$



※ 전기 용량을 구하는 법

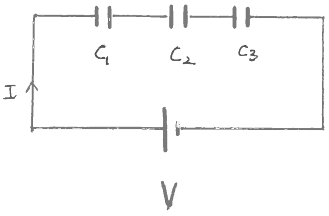
⇒ Gauss 법칙을 사용하여 E를 구한다 : $\Phi_E = \oint \vec{E} \cdot \hat{u}_n\, ds = \frac{Q_{in}}{\varepsilon_0}$

⇒ $V = V(A) - V(B) = \int_A^B \vec{E} \cdot d\vec{l}$: E를 대입하여 V를 구한다

⇒ $C = \frac{Q}{V}$: V를 대입하여 C를 구한다.

※ 등가 전기용량 (C)

① 직렬연결



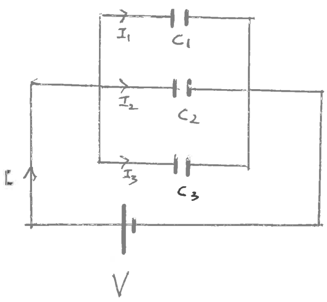
$$V = V_1 + V_2 + V_3 = \left(\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}\right) q$$

$$q = C_1 V_1 = C_2 V_2 = C_3 V_3$$

$$I = I_1 = I_2 = I_3$$

∴ 등가 전기용량 $= C = \dfrac{q}{V} = \dfrac{1}{\dfrac{1}{C_1} + \dfrac{1}{C_2} + \dfrac{1}{C_3}}$

② 병렬 연결



$$V = V_1 = V_2 = V_3$$

$$I = I_1 + I_2 + I_3$$

$$q = (C_1 + C_2 + C_3) V$$

$$q_1 = C_1 V_1 , \quad q_2 = C_2 V_2 , \quad q_3 = C_3 V_3$$

∴ 등가 전기용량 : $C = \dfrac{q}{V} = C_1 + C_2 + C_3$

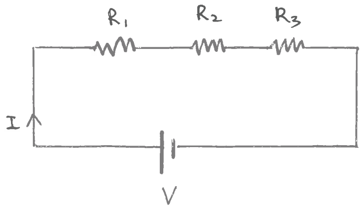
※ 전기용량 : $C = \dfrac{Q}{V}$

※ 축전기에 저장된 전기에너지 : $W = \dfrac{Q^2}{2C} = \dfrac{QV}{2} = \dfrac{CV^2}{2}$

※ 전기 에너지 밀도 : $u_E = \dfrac{\text{전체 전기에너지}}{\text{축전기의 부피}} = \dfrac{1}{2} \varepsilon_0 E^2$

* 등가 저항 (R)

① 직렬연결



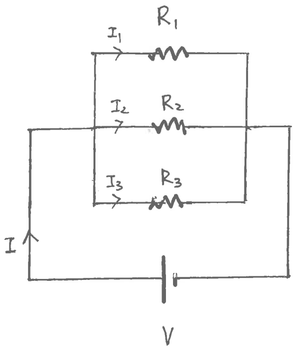
$$I = I_1 = I_2 = I_3$$

$$V = V_1 + V_2 + V_3$$

$$I = \frac{V}{R_{tot}}$$

$\therefore R_{tot} = R_1 + R_2 + R_3$: 등가저항

② 병렬연결



$$V = V_1 = V_2 = V_3$$

$$I = I_1 + I_2 + I_3$$

$$I = \frac{V}{R_{tot}}$$

$$\therefore R_{tot} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

* 옴의 법칙

◎ $\boxed{V = IR}$, $R \equiv \rho \frac{l}{A} = (\text{비저항}) \times \frac{\text{도선의 길이}}{\text{단면적}}$: 저항.

◎ $\boxed{\vec{J} = \sigma \vec{E}}$, $[\sigma] = \frac{[\vec{J}]}{[\vec{E}]} = \frac{A/m^2}{V/m} = \frac{A}{Vm} = \frac{1}{(\frac{V}{A})m} = \frac{1}{\Omega m}$

$J = \frac{I}{A} = \frac{\text{전류}}{\text{단면적}}$: 전류밀도 , $[\rho] = \frac{1}{[\sigma]} = \Omega m$

σ : 전기 전도도 (conductivity)

$\rho = \frac{1}{\sigma} = \frac{1}{\text{전기전도도}}$: 비저항 (resistivity)

※ 전력 : 단위 시간당 공급하는 에너지

$$P = VI = I^2R = \frac{V^2}{R}$$: 전력 (power

$$[P] = J/Sec = W \text{ (와트)}$$

$$P = \frac{dW}{dt} = \frac{V\,dq}{dt} = V\left(\frac{dq}{dt}\right) = VI$$

* 키르히호프법칙

① 전압법칙 or 폐회로법칙 : $\sum_i \Delta V_i = 0$

② 전류법칙 or 분기점법칙 : $\sum_i I_i = 0$