§9-1

1. 法拉第电磁感应定律

$$\mathcal{E}_1 = -N\frac{d\Phi}{dt} \longrightarrow I = \frac{\mathcal{E}_i}{R} = -\frac{1}{R}\frac{d\Phi}{dt}$$

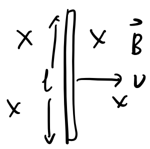
$$dq = I\,dt \longrightarrow q = \int_{t_1}^{t_2} I\,dt = -\frac{1}{R}\int_{\Phi_1}^{\Phi_2} d\Phi = \frac{1}{R}(\Phi_1-\Phi_2)$$

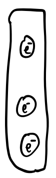
用 E_k 表示非静电场强:

$$\mathcal{E}_i = \oint_L \vec{E}_k\cdot d\vec{l} \rightarrow \oint_L \vec{E}_k\cdot d\vec{l} = -\frac{d}{dt}\int_S \vec{B}\cdot d\vec{s}$$

§9-2.

1. 动生电动势: $\mathcal{E}_i = -\frac{d\Phi}{dt} = -Blv$





对 e^- 而言, $F_{洛} = -e\vec{v}\times\vec{B}$

而 E_k (非静电场强) 实为 $F_{洛}$提供

$$\rightarrow \vec{E}_k = \vec{v}\times\vec{B}$$

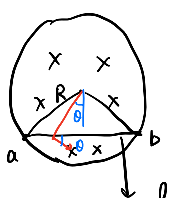
$$\therefore \mathcal{E}_i = \oint_L \vec{E}_k\cdot d\vec{l} = \boxed{\oint_L \vec{v}\times\vec{B}\cdot d\vec{l}} = vBl$$ (均强情况)

§9-3

1. 变化磁场产生电场 → "感生电场"

法拉第 ⇒ $\oint_L \vec{E}\cdot d\vec{l} = -\frac{d}{dt}\int \vec{B}\cdot d\vec{s} = -\int_S \frac{\partial\vec{B}}{\partial t}\,d\vec{s}$.

例:



$$\mathcal{E}_i = \int_a^b \vec{E}_k\cdot d\vec{l}$$

☆ $E_k \perp R$

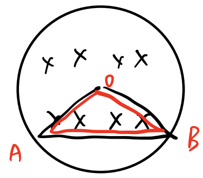
$l_{ab}=l$

$$= \int_a^b E\,dl\cdot\cos\theta$$

$$= \int_a^b \frac{r}{2}\frac{dB}{dt}\cos\theta\,dl$$

又 $\cos\theta = \frac{\sqrt{R-(\frac{l}{2})^2}}{r}$ → 代入上式 ✓.

另解:



对 △AOB 回路应用法...定律:

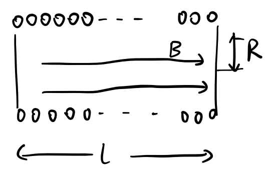
$$\oint_{AOB} \vec{E}_k\cdot d\vec{l} = S_{\triangle AOB}\cdot\frac{dB}{dt}$$

又 OA、OB 均于电场垂直 ⇒ $\mathcal{E}_{OA} = \mathcal{E}_{OB} = 0$

✓.

§9-4.

1. 自感: 考虑一通电螺线管, $B = \mu_0 nI = \mu_0\frac{N}{L}I$.



$$\Phi_N = NBS = \mu_0\frac{N^2}{L}I\cdot\pi R^2$$

在自己管内产生感应电动势:

$$\mathcal{E}_L = -\frac{d\Phi_N}{dt} = -\underbrace{\frac{\mu_0 N^2\pi R^2}{L}}_{L\ (const)}\frac{dI}{dt}$$

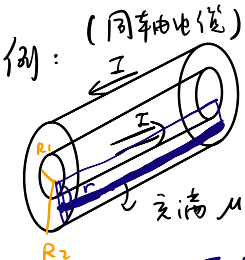
$$= -L\frac{dI}{dt}$$

L 称为自感系数. 一般地, 定义

$$L = \frac{d\Phi_N}{dI}$$

当回路几何形状保持不变时, $\Phi_N \propto I$, 则 $L = \frac{\Phi_N}{I}$.

例: (同轴电缆)



充满 μ 的磁介质, 求其 L.

由于高频电流趋肤, 认为电流仅分布在表面

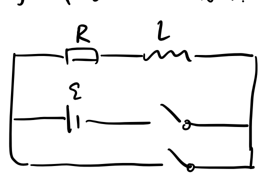
取出一小片计算其 Φ.

$$B = \frac{\mu_0 I}{2\pi r},\quad S = l\cdot dr.\quad d\Phi = \frac{\mu_0 I l}{2\pi r}dr$$

$$L = \frac{\Phi}{I} = \frac{\int_{R_1}^{R_2}\frac{\mu_0 I l}{2\pi r}dr}{I} = \frac{\mu_0 l}{2\pi}\ln\frac{R_2}{R_1}$$

单位长 $L = \frac{\mu_0}{2\pi}\ln\frac{R_2}{R_1}$

例: (电容 + 电感)



充电: $\mathcal{E} = IR + L\cdot\frac{dI}{dt}$

→ 求微分方程

→ $I = \frac{\mathcal{E}}{R}(1-e^{-\frac{R}{L}t})$

dI ε $-\underline{R}\,t$