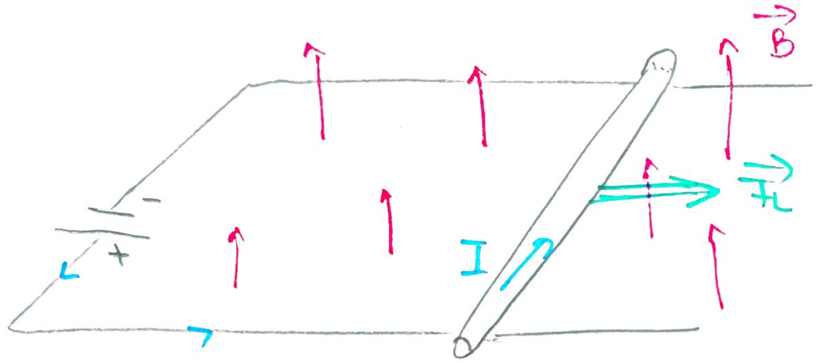
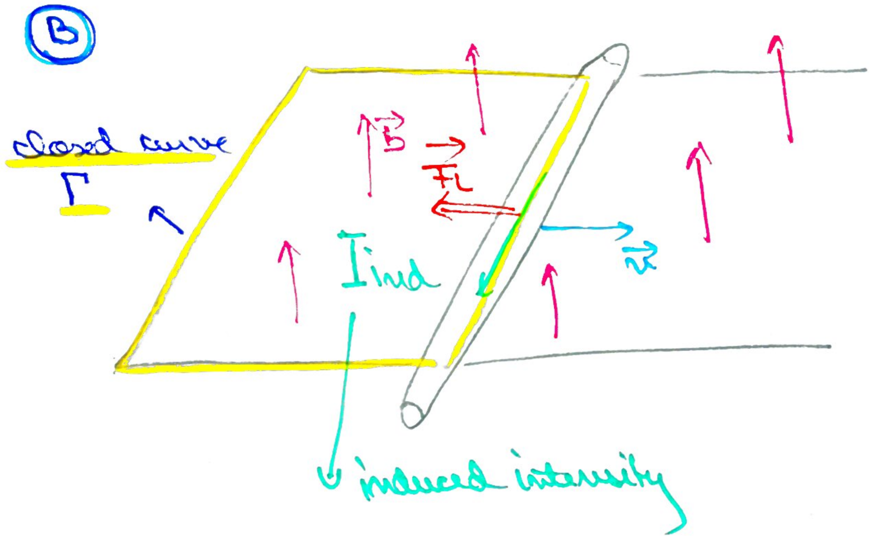
IX The electromagnetic field

1. The electromagnetic induction
The Faraday's law

(A)



(B)



$$\boxed{\mathcal{E} = -\frac{d\Phi_m}{dt}}$$

the Faraday's law

EXAM

$\mathcal{E}$: the electromotive tension

$-$: Lentz's law

$\Phi_m = \vec{B} \cdot \vec{S}$

$\Phi_m = \int_S \vec{B} \cdot \vec{ds}$

$$U = -\Delta V = \int_{\vec{r}_1}^{\vec{r}_2} \vec{E} \cdot d\vec{r}$$

(tension)

electric field

$$\mathcal{E} = U = \oint_\Gamma \vec{E} \cdot d\vec{l}$$

$$\oint_\Gamma \vec{E} \cdot d\vec{l} = -\frac{d}{dt}\left(\int_S \vec{B} \cdot d\vec{s}\right) \Rightarrow$$

$$\boxed{\oint_\Gamma \vec{E}\, d\vec{l} = \int_S -\frac{\partial \vec{B}}{\partial t}\, d\vec{s}}$$

Faraday's law

2. The Maxwell's equations

EXAM !

2.1. Integral form

integral form

$$\boxed{\oint_\Sigma \vec{E} \cdot d\vec{s} = \frac{Q_i}{\varepsilon_0}}$$

Gauss' law for $\vec{E}$

$$\boxed{\oint_\Sigma \vec{B} \cdot d\vec{s} = 0}$$

Gauss law for $\vec{B}$

$$\boxed{\oint_\Gamma \vec{E}\, d\vec{l} = \int_S -\frac{\partial \vec{B}}{\partial t}\, d\vec{s}}$$

Faraday's law

$$\boxed{\oint_\Gamma \vec{B}\, d\vec{l} = \int_S \left(\mu_0 \vec{j}_i + \mu_0 \varepsilon_0 \frac{\partial \vec{E}}{\partial E}\right) d\vec{s}}$$

Ampère's law

electric current intensity (inside)

2.2

(A) Note $\boxed{\rho = \frac{dQ}{dV}}$ - electric charge density

$dQ = \rho \cdot dV \quad \Big| \int$

$Q = \int_V \rho \, dV$

(B) The Gauss' theorem

$$\boxed{\oint_\Sigma \vec{A}\, d\vec{s} = \int_V \nabla \vec{A}\, dV}$$

(C) The Stocke's theorem

$$\boxed{\oint_\Gamma \vec{A}\, d\vec{l} = \int_S (\nabla \times \vec{A})\, d\vec{s}}$$

(D) $\nabla V =$ grad V

$\nabla \vec{A}$ - divergence of $\vec{A}$

$\nabla \times \vec{A}$ - rot of A

2.3

$$\int_V \nabla \vec{E}\, dV = \int \frac{\rho_i}{\varepsilon_0}\, dV$$

$$\boxed{\nabla \vec{E} = \frac{\rho_i}{\varepsilon_0}}$$

$$\int_V \nabla \vec{B}\, dV = \int_V 0\, dV$$

Differential form of Maxwell equations

$\boxed{\nabla \cdot \vec{B} = 0}$ (divergence of a magnetic field)

$$\int (\nabla \times \vec{E})\, d\vec{s} = \int_S -\frac{\partial \vec{B}}{\partial t}\, d\vec{s}$$

$$\boxed{\nabla \times \vec{E} = -\frac{\partial B}{\partial t}}$$

(relation between the magnetic field and the electric field)

$$\int_S (\nabla \times \vec{B})\, d\vec{s} = \int_S \left(\mu_0 j_i + \mu_0 \varepsilon_0 \cdot \frac{\partial \vec{E}}{\partial t}\right) \cdot d\vec{S}$$

$$\boxed{\nabla \times \vec{B} = \mu_0 \cdot \vec{j_i} + \mu_0 \varepsilon_0 \cdot \frac{\partial \vec{E}}{\partial t}}$$