



1. Revise 1B26, especially electrically polarised media and displacement, leading to $\mathbf{D}(\mathbf{r}) \equiv (\varepsilon_0 \mathbf{E}(\mathbf{r}) + \mathbf{P}(\mathbf{r}))$
2. Study magnetic materials, based on magnetic effects of dipole loop currents; leading to $\mathbf{H}(\mathbf{r}) \equiv \left(\frac{\mathbf{B}(\mathbf{r})}{\mu_0} - \mathbf{M}(\mathbf{r}) \right)$; para- dia- and ferromagnetism.
3. Understand simple electromagnets, stored energy in fields, forces generated by magnets.
4. Find inadequacy of Ampere Law. Add displacement current



$$\oint_P \mathbf{H} \cdot d\mathbf{l} = \int_{S_P} \left(\mathbf{J}_f + \frac{\partial \mathbf{D}}{\partial t} \right) \cdot d\mathbf{S} \quad \text{Ampere Law (+Maxwell)}$$

$$\nabla \times \mathbf{H} = \mathbf{J}_f + \frac{\partial \mathbf{D}}{\partial t}$$

$$\oint_S \mathbf{B} \cdot d\mathbf{S} = 0 \quad \text{No Monopoles}$$

$$\nabla \cdot \mathbf{B} = 0$$

$$\oint_C \mathbf{E} \cdot d\mathbf{l} = - \int_{S_C} \frac{\partial \mathbf{B}}{\partial t} \cdot d\mathbf{S} = - \frac{d\Phi_C}{dt} \quad \text{Faraday Law (+Lenz)}$$

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

$$\oint_S \mathbf{D} \cdot d\mathbf{S} = \int_{\tau} \rho_f d\tau = \sum_{\tau} q_i$$

$$\nabla \cdot \mathbf{D} = \rho_f \quad \text{Gauss Law}$$

Integral and Differential forms linked by

$$\int_{S_C} (\nabla \times \mathbf{A}) \cdot d\mathbf{S} = \oint_C \mathbf{A} \cdot d\mathbf{l}$$

Stokes Theorem

$$\int_V \nabla \cdot \mathbf{A} d\tau = \oint_S \mathbf{A} \cdot \hat{\mathbf{n}} dS = \oint_S \mathbf{A} \cdot d\mathbf{S}$$

Gauss Theorem

