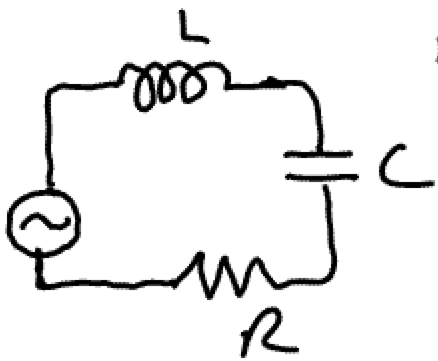
Physics 142 – November 11, 2008

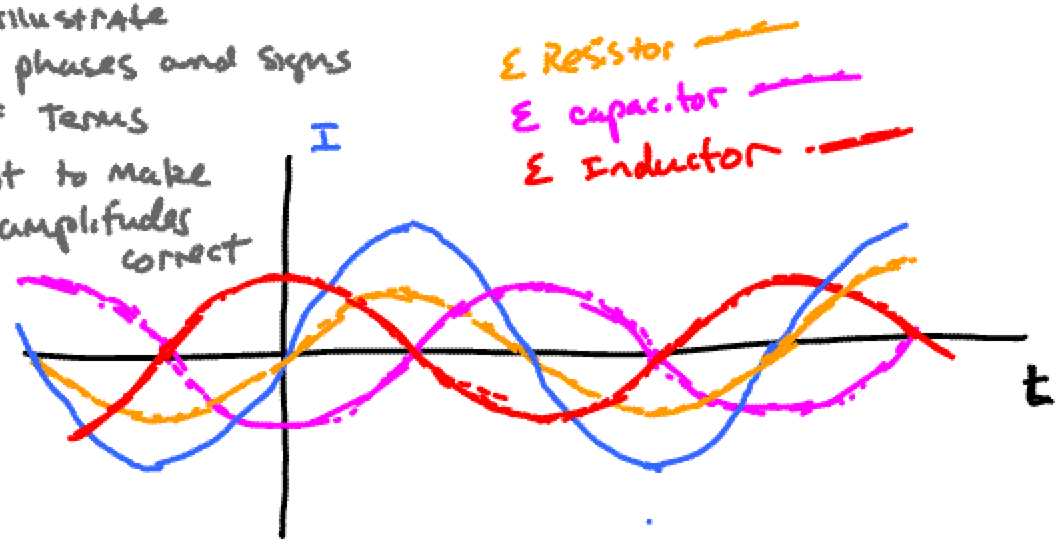
- Exam 2 – Thursday … Hoyt … 11:05–12:20
- Presentation groups

Last Time –



Graph to illustrate relative phases and signs of EMF Terms

No attempt to make relative amplitudes correct



$$\mathcal{E} = \underbrace{\Delta V_R}_{R I_{max} \sin(\omega t+\phi)} + \underbrace{\Delta V_C}_{-X_C I_{max} \cos(\omega t+\phi)} + \underbrace{\Delta V_L}_{X_L I_{max} \cos(\omega t+\phi)}$$

$$\mathcal{E} = \mathcal{E}_{max} \sin \omega t$$

general Expression $I = I_{max} \sin(\omega t + \phi)$

unknown

$$\mathcal{E} = \Delta V_R + \Delta V_C + \Delta V_L$$

$$\mathcal{E}_{max} \sin \omega t = R I_{max} \sin(\omega t + \phi) - \chi_C I_{max} \cos(\omega t + \phi) + \chi_L I_{max} \cos(\omega t + \phi)$$

Acts as "Resistance" of capacitor

Acts as "Resistance" of Inductor

$$\tan \phi = \frac{\chi_L - \chi_C}{R}$$

$$I_{max} = \frac{\mathcal{E}_{max}}{\sqrt{R^2 + (\chi_L + \chi_C)^2}}$$

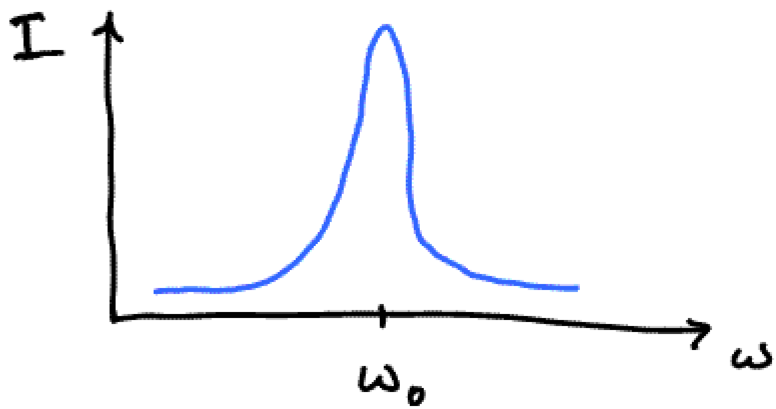
$$Z \equiv \sqrt{R^2 + (\chi_L + \chi_C)^2}$$

Impedance

Acts as total resistance of LRC circuit

when $\omega \rightarrow \omega_0 = \frac{1}{\sqrt{LC}}$ (Natural frequency of the LC circuit)

I gets Maximized $\rightarrow$ Resonance

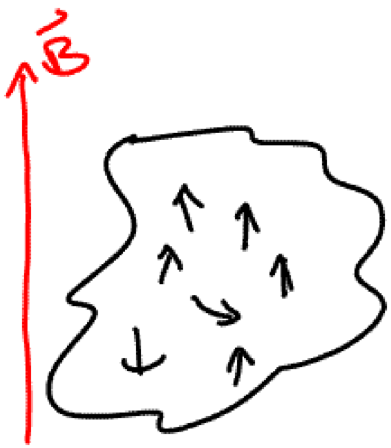


circuits have natural frequency + Bandwidth

Magnetism in Materials

Paramagnetic

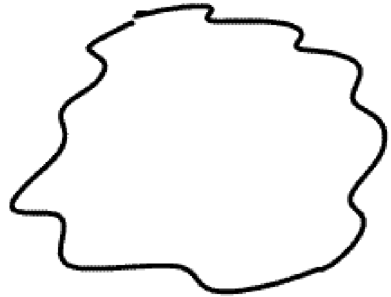
Natural Dipoles



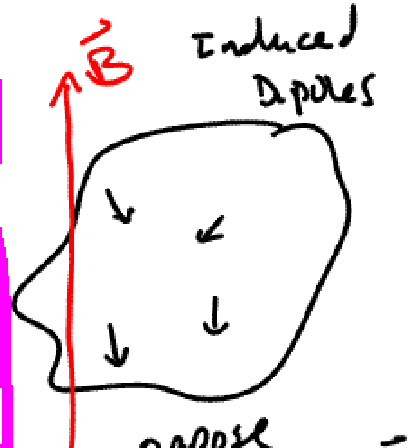
Torque from $\vec{B}$ Aligns more Dipoles along $\vec{B}$

$\Rightarrow$ $\vec{B}$ increased

Diamagnetic



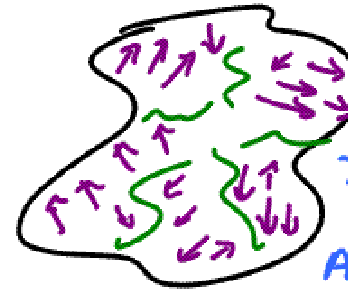
No Dipole



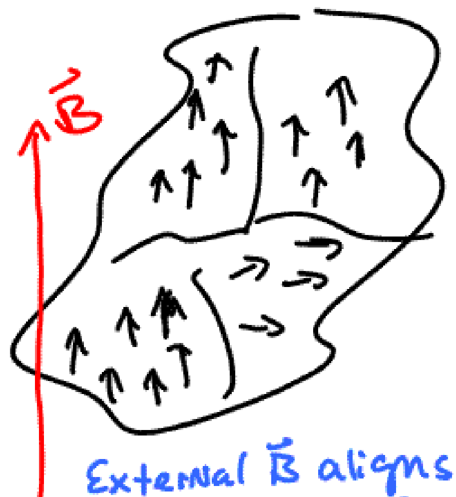
Oppose External $\vec{B}$

$\Rightarrow$ $\vec{B}$ weakened

Ferromagnetic



Strong Dipoles in Domains of local Alignment



External $\vec{B}$ aligns more Domains along $\vec{B}$

$\Rightarrow$ $\vec{B}$ increased

$$B = \mu_0 (1 + \chi_m) B_{free}$$

Magnetic Susceptibility

External B field

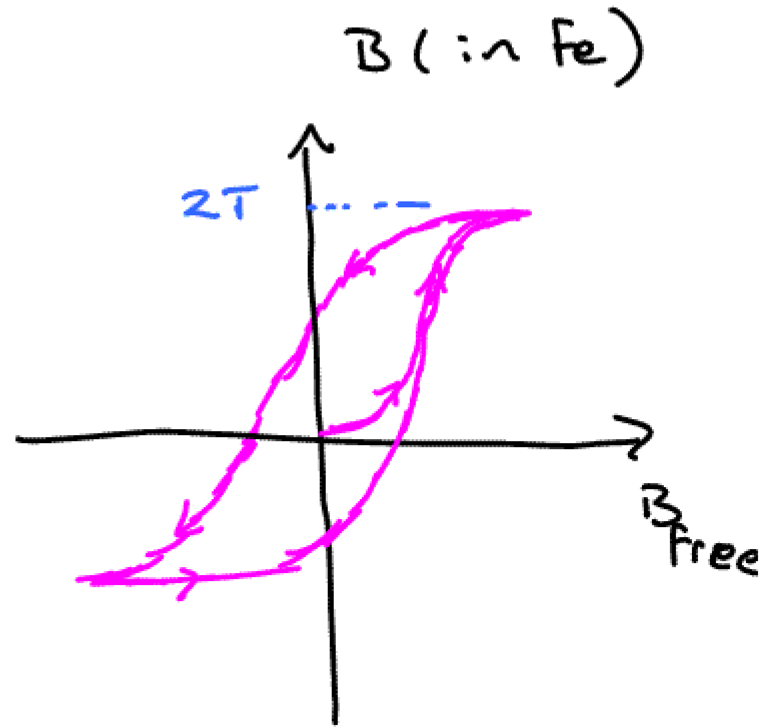
relative permeability

$\mu_0 K_m \sim$ permeability $\rightarrow \mu$

$K_m \gtrsim 1$ Paramagnetism

$\gg 1$ Ferromagnetism

< 1 Diamagnetism



Hysteresis loop

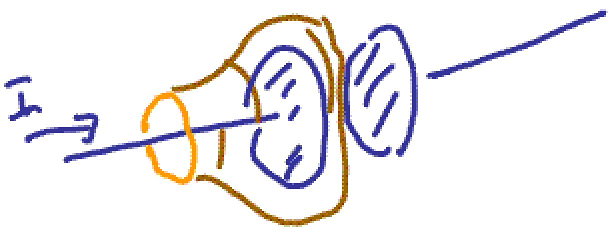
where are we?

$$\oint_S \vec{E} \cdot d\vec{A} = \frac{Q_{encl}}{\epsilon_0}$$ Gauss' law

$$\oint_S \vec{B} \cdot d\vec{A} = 0$$ Nature has No Magnetic Monopole

$$\oint_C \vec{B} \cdot d\vec{l} = \mu_0 I_{encl}$$ Ampere's law.

$$\oint_C \vec{E} \cdot d\vec{l} = -\frac{d\Phi_M}{dt} = -\frac{d}{dt}\oint_S \vec{B} \cdot d\vec{A}$$ Faraday's law



$$\oint_c \vec{B} \cdot d\vec{l} = \mu_0 I + \underbrace{\mu_0 \epsilon_0 \frac{d}{dt} \oint_s \vec{E} \cdot d\vec{A}}_{\text{Maxwell's Displacement current}}$$

$$\oint_S \vec{E}\cdot d\vec{A} = \frac{Q_{encl}}{\epsilon_0}$$

$$\oint_S \vec{B}\cdot d\vec{A} = 0$$

$$\oint_C \vec{B}\cdot d\vec{l} = \mu_0 \int_S \vec{j}\cdot d\vec{A} + \mu_0\epsilon_0 \frac{d}{dt}\int \vec{E}\cdot d\vec{A}$$

$$\oint_C \vec{E}\cdot d\vec{l} = -\frac{d}{dt}\int \vec{B}\cdot d\vec{a}$$

integral form of Maxwell's equations

often the differential form of Maxwell's equations are more useful ... will derive these next

Gauss' Law $\qquad \oint \vec{E}\cdot d\vec{A} = \frac{Q_{encl}}{\epsilon_0}$

vector calculus

Gauss' Theorem
Green's theorem
divergence theorem

$$\int_{Vol} (\vec{\nabla}\cdot\vec{V})\,dv = \int_{Surf} \vec{V}\cdot d\vec{A}$$

for vector field $\vec{V}$

$$\text{del} \equiv \vec{\nabla} \equiv \frac{\partial}{\partial x}\hat{i} + \frac{\partial}{\partial y}\hat{j} + \frac{\partial}{\partial z}\hat{k}$$

$\vec{\nabla}\cdot\vec{V} \equiv$ divergence of $\vec{V}$

$$\vec{\nabla}\cdot\vec{V} = \frac{\partial V_x}{\partial x} + \frac{\partial V_y}{\partial y} + \frac{\partial V_z}{\partial z}$$

scaler

$$\oint \vec{E}\cdot d\vec{A} = \frac{Q_{encl}}{\epsilon_0}$$

$\int \rho \, dv$

by Gauss' Thm

$$\oint \vec{E}\cdot d\vec{A} = \int_{vol} (\vec{\nabla}\cdot\vec{E})\, dv = \frac{Q_{encl}}{\epsilon_0}$$

$$\int_V (\vec{\nabla}\cdot\vec{E})\, dv = \frac{1}{\epsilon_0}\int_V \rho \, dv$$

$$\boxed{\vec{\nabla}\cdot\vec{E} = \frac{\rho}{\epsilon_0}}$$

$$\boxed{\vec{\nabla}\cdot\vec{B} = 0}$$