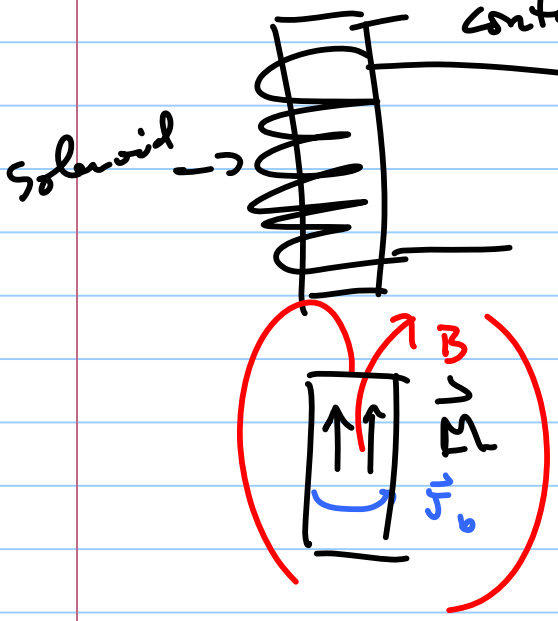
Note Title 4/28/2008

find mag dipole mom of an atom.

Use large sample & measure $\vec{M}$ dipole mom / vol
might be average

$= \frac{\text{atoms}}{\text{vol}} \frac{\text{mag dipole mom}}{\text{atom}}$



$C = \frac{Q}{V}$ $V_{cap} \propto Q$ $V = \frac{Q}{C}$

change induced

$\Phi_m = L I$

$BA = \mu H A = L I$

$\mu H = \mu_0 (1 + \chi_m) H$

$H = n I_0$

n = #turns / length, I_0 = current in wire

$\mu n I_0 A = L I_0$ $\quad L = \mu_0 (1 + \chi_m) n A$

want $\vec{M}$ say measure L, n, A, μ_0 find χ_m

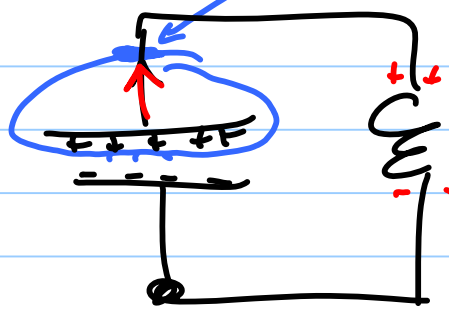
$\vec{M} = \chi_m \vec{H}$ linear material

$= \chi_m n I_0$

know $\vec{M}$

to measure L or C

$\int \vec{J} \cdot d\vec{a} = I = -\frac{dQ}{dt}$



$\mathcal{E}mf = -\frac{d\Phi_m}{dt} = -L\frac{dI}{dt}$

$\frac{Q}{C} + L\frac{d^2Q}{dt} = \phi$

$V_C - V_L = 0 \qquad \frac{Q}{C} - L\frac{dI}{dt} = 0$

Cons. charge

$\vec{\nabla} \cdot \vec{J} = -\frac{\partial \rho}{\partial t} \xrightarrow{\text{integral form}} \oint \vec{J} \cdot d\vec{a} = -\frac{\partial}{\partial t} Q_{enc}$

$\int \vec{\nabla} \cdot \vec{J}\, d\tau = \oint \vec{J} \cdot d\vec{a} = -\frac{\partial}{\partial t} \int \rho\, d\tau$

$Q = Q_{max} \sin \omega t \qquad L\frac{d^2Q}{dt} = -\omega^2 L Q = -\frac{Q}{C}$

$\omega = \frac{1}{\sqrt{LC}}$

measure ω for LC circuit $\Rightarrow$ get L

find atomic electric dipole moment of atom

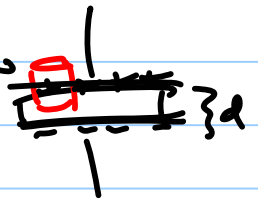
$\vec{P} = \epsilon_0 \chi_e \vec{E}$ (linear)

Prime $\vec{D} = \epsilon_0 \vec{E} + \vec{P}$

Maxwell's eqn: $\nabla \cdot \vec{E} = \rho/\epsilon_0 \rightarrow \nabla \cdot \vec{D} = \rho_f$

$$\oint \vec{D} \cdot d\vec{a} = Q_{encl,f}$$

Know C find $\vec{P} = \epsilon_0 \chi_e \vec{E}$



defn $C = \dfrac{Q_f}{V} = \dfrac{\sigma_f A}{E d}$

↖ find

$$\oint \vec{D} \cdot d\vec{a} = DA = \sigma_f A = \epsilon E = \epsilon_0 (1+\chi_e) E$$

$$E = \frac{\sigma_f}{\epsilon}$$

$$C = \frac{\sigma_f A}{\frac{\sigma_f}{\epsilon} d} = \frac{A\epsilon}{d} = \frac{A}{d} \epsilon_0 (1+\chi_e)$$

In biology macroscopic property might be the color of your eyes. Microscopic reason in DNA like macroscopic prop "the capacitance of some device" is due to the atomic dipole moment.