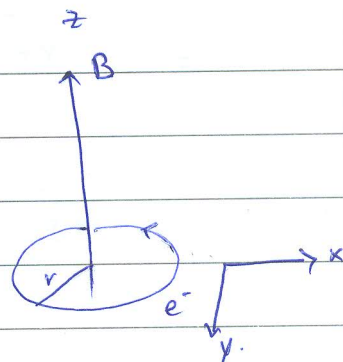


HW-3

Q.2

Consider an electron moving in an orbit of radius \vec{r} . At time t , the mag. field is turned on slowly from zero, the change in flux through the current loop induces an emf. Induced emf is given by



$$\epsilon = \oint \vec{E} \cdot d\vec{l} = -d\phi/dt$$

$$E \cdot 2\pi r = -d\phi/dt$$

Torque on electron by induced E is $= -eEr$

$$\text{Also } \vec{\tau} = |d\vec{L}/dt| = -eEr = \frac{e}{2\pi} \frac{d\phi}{dt}$$

$$= \frac{er^2 \mu_0}{2} \frac{dH}{dt}$$

$$\begin{aligned} \phi &= BA \\ &= \mu_0 H \pi r^2 \end{aligned}$$

Integrating w.r.t time from zero field, change in angular momentum

$$\Delta L = \frac{er^2 \mu_0}{2} H.$$

magnetic moment

$$\mu = \frac{-e}{2m_e} L$$

change in ang. mom. changes magnetic moment by an amount

$$\Delta \mu = \frac{-e}{2m_e} \Delta L$$

$$\Delta\mu = -\frac{e^2 r^2 \mu_0 H}{4m_e}$$

For all the electrons in the solid,

$$\Delta\mu = -\frac{Z e^2 \mu_0 H}{4m_e} \langle r_{xy}^2 \rangle$$

Multiply with n no. of electrons.

$$\Delta\mu = -\frac{Z n e^2 \mu_0 H}{6m_e} \langle r_{xy}^2 \rangle$$

average value of the square of projection onto the field direction reduces μ by a factor $2/3$.

$$\chi = \mu/H$$

$$\langle x^2 \rangle = \langle y^2 \rangle = \frac{2}{3} \langle r^2 \rangle$$

$$\chi = -\frac{n \mu_0 Z e^2}{6m_e} \langle r^2 \rangle_{\text{avg}}$$

$$x^2 + y^2 + z^2 = r^2$$

$$3\langle x^2 \rangle = \langle r^2 \rangle$$

$$\langle x^2 \rangle = \frac{1}{3} \langle r^2 \rangle$$

~~etc~~

