CL47_Q1. Obtain the expression for orbital magnetic moment of the electron and Explain Bohr magneton.

Ans:

The basic atomic model of orbiting electrons around the nucleus constitutes tiny current loops at atomic levels. If the electrons are assumed to move in an orbit of radius r with a constant speed v, the period of rotation T, then the current

$I = \frac{e}{T} = \frac{e\omega}{2\pi}$

The magnetic moment associated with the electron's moment in the orbit

$\mu_m = I.A$

$= -\frac{e\omega}{2\pi} * \pi r^2 = -\frac{em\omega r^2}{2m}$

$\mu_m = -\frac{e}{2m}L$, where L is called orbital angular momentum

Thus the magnetic moment of the electron is proportional to it's angular momentum. The ratio of the magnetic moment to the angular momentum $\gamma = \frac{\mu_{orb}}{L} = \left(\frac{e}{2m_e}\right)$ is known as the gyro magnetic ratio. Due to the negative charge of the electron, the vectors $\vec{\mu}$ and $\vec{L}$ point in opposite directions and perpendicular to the plane of the orbit.

The smallest non zero value of the spin magnetic moment due to electrons) is obtained as $\mu_s = \frac{e\hbar}{m}$. The magnetic moment being quantized; the smallest unit of magnetic moment $\mu_B = \frac{e\hbar}{2m} = 9.27 \times 10^{-24}$ J/T is called the Bohr magneton

CL47_Q2. Estimate the magnetic moment of an electron that revolves around a nucleus in an orbit of 0.53A^0 radius. If the frequency of revolution 6.6 x10^{15} Hz.

Ans:

The magnetic moment associated with the electron's moment in the orbit $\mu e = I.A$

$\frac{e\omega}{2\pi} * \pi r^2 = \frac{e\omega r^2}{2}$

$\mu e = ef.\pi r^2$

=9.314x10^{-24} Am

CL47_Q3. Why does a magnetic dipole due to orbital motion of the electron precess in a magnetic field?

Ans:

When a magnetic moment is μ is placed in a magnetic field B, it experiences a torque which is given by $\tau = \mu \times B$. The torque then produces a change in angular momentum which is perpendicular to that angular momentum , causing the magnetic moment to precess around the direction of the magnetic field.