Magnetic Field due to a Current Carrying Conductor

1. **Biot-Savart Law**:
    - This law helps to calculate the magnetic field produced at a point due to a small element of current-carrying conductor.
    - The formula is: $d\mathbf{B} = \frac{\mu_0}{4\pi} \frac{I d\mathbf{l} \times \hat{\mathbf{r}}}{r^2}$
    - Here, $d\mathbf{B}$ is the infinitesimal magnetic field, μ_0 is the permeability of free space, I is the current, $d\mathbf{l}$ is the length element, and $\hat{\mathbf{r}}$ is the unit vector from the element to the point where the field is calculated.
2. **Magnetic Field Due to a Long Straight Conductor**:
    - Using the Biot-Savart Law, the magnetic field at a distance r from a long straight conductor is: $B = \frac{\mu_0 I}{2\pi r}$
3. **Magnetic Field on the Axis of a Circular Loop**:
    - For a loop of radius R and current I, the magnetic field at the center is: $B = \frac{\mu_0 I}{2R}$

Force on a Current Carrying Conductor in a Magnetic Field

1. **Lorentz Force Law**:
    - A conductor carrying current I in a magnetic field $\mathbf{B}$ experiences a force given by: $\mathbf{F} = I(\mathbf{l} \times \mathbf{B})$
    - Here, $\mathbf{l}$ is the length vector of the conductor.
2. **Force Between Two Parallel Current-Carrying Conductors**:
    - Two parallel conductors carrying currents I_1 and I_2 separated by a distance d exert a force on each other: $F = \frac{\mu_0 I_1 I_2 l}{2\pi d}$
    - If currents are in the same direction, the force is attractive; if opposite, the force is repulsive.

Force on a Charge in an Electric and Magnetic Field

1. **Lorentz Force**:
    - The total force on a charge q moving with velocity $\mathbf{v}$ in an electric field $\mathbf{E}$ and magnetic field $\mathbf{B}$ is: $\mathbf{F} = q(\mathbf{E} + \mathbf{v} \times \mathbf{B})$
2. **Motion of Charged Particle in a Uniform Magnetic Field**:
    - A charged particle moving perpendicular to a uniform magnetic field follows a circular path with radius r: $r = \frac{mv}{qB}$
    - The angular frequency (cyclotron frequency) is: $\omega = \frac{qB}{m}$

Ampere’s Circuital Law

1. **Statement**:

- Ampere’s Law relates the integrated magnetic field around a closed loop to the electric current passing through the loop: $\oint \mathbf{B} \cdot d\mathbf{l} = \mu_0 I_{\text{enc}}$
- Here, I_{enc} is the current enclosed by the loop.

2. **Applications**:
   - **Solenoid**: The magnetic field inside a long solenoid is uniform and given by: $B = \mu_0 n I$
     - Here, n is the number of turns per unit length.
   - **Toroid**: The magnetic field inside a toroid is: $B = \frac{\mu_0 N I}{2\pi r}$
     - Here, N is the total number of turns and r is the radius of the toroid.

Magnetic Dipole Moment of Revolving Electron

1. **Magnetic Dipole Moment (μ)**:
   - The magnetic dipole moment of a current loop is given by: $\mu = IA$
   - For an electron orbiting a nucleus, the magnetic dipole moment is: $\mu = \frac{e}{2m} L$
   - Here, e is the electron charge, m is the electron mass, and L is the orbital angular momentum.
2. **Bohr Magneton**:
   - The Bohr magneton is the quantum of the magnetic dipole moment: $\mu_B = \frac{e\hbar}{2m_e}$

Additional Resources

- **Video Lectures**:
  - Force on current carrying conductor in a magnetic field
  - Lorentz force
- **Quizzes**:
  - Ampere's circuital law