

# Moving Charges Formulas

## Important Formulas, Symbols, Expressions, and Units in "Moving Charges and Magnetism" (Class 12 NCERT Physics)

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### 1. Magnetic Force (Lorentz Force)

$$\vec{F} = q(\vec{v} \times \vec{B})$$

- **Symbols:**  
 $q$  = charge,  $v$  = velocity of the charge,  $\vec{B}$  = magnetic field
  - **SI Unit:** Newton ( $N$ )
  - **Constant Values:** None
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### 2. Magnetic Force on a Current-Carrying Conductor

$$\vec{F} = I(\vec{L} \times \vec{B})$$

- **Symbols:**  
 $I$  = current,  $\vec{L}$  = length vector,  $\vec{B}$  = magnetic field
  - **SI Unit:** Newton ( $N$ )
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### 3. Torque on a Current Loop in a Magnetic Field

$$\vec{\tau} = \vec{m} \times \vec{B}$$

- $\vec{m} = I \cdot \vec{A}$ , where  $\vec{A}$  = area vector
  - **Symbols:**  
 $\tau$  = torque,  $I$  = current,  $A$  = area,  $\vec{B}$  = magnetic field
  - **SI Unit:** Newton-meter ( $Nm$ )
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### 4. Biot-Savart Law

$$d\vec{B} = \frac{\mu_0}{4\pi} \frac{I d\vec{l} \times \hat{r}}{r^2}$$

- **Symbols:**  
 $d\vec{B}$  = infinitesimal magnetic field,  $I$  = current,  $d\vec{l}$  = infinitesimal length vector,  $\hat{r}$  = unit vector,  $r$  = distance
  - **SI Unit:** Tesla ( $T$ )
  - **Constant Values:**  $\mu_0 = 4\pi \times 10^{-7} T \cdot m/A$
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## 5. Magnetic Field Due to a Straight Current-Carrying Wire

$$B = \frac{\mu_0 I}{2\pi r}$$

- **Symbols:**  
 $B$  = magnetic field,  $I$  = current,  $r$  = perpendicular distance
  - **SI Unit:** Tesla ( $T$ )
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## 6. Magnetic Field at the Center of a Circular Loop

$$B = \frac{\mu_0 I}{2R}$$

- **Symbols:**  
 $B$  = magnetic field,  $I$  = current,  $R$  = radius of the loop
  - **SI Unit:** Tesla ( $T$ )
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## 7. Ampere's Circuital Law

$$\oint \vec{B} \cdot d\vec{l} = \mu_0 I_{\text{enc}}$$

- **Symbols:**  
 $I_{\text{enc}}$  = current enclosed,  $d\vec{l}$  = infinitesimal length element
  - **SI Unit:** Tesla-meter ( $T \cdot m$ )
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## 8. Magnetic Field Due to a Solenoid

$$B = \mu_0 n I$$

- **Symbols:**  
 $n$  = number of turns per unit length,  $I$  = current
  - **SI Unit:** Tesla ( $T$ )
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## 9. Magnetic Field Due to a Toroid

$$B = \frac{\mu_0 N I}{2\pi r}$$

- **Symbols:**  
 $N$  = total number of turns,  $I$  = current,  $r$  = radius of the toroid
  - **SI Unit:** Tesla ( $T$ )
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## 10. Cyclotron Frequency

$$f = \frac{qB}{2\pi m}$$

- **Symbols:**

$f$  = frequency,  $q$  = charge,  $B$  = magnetic field,  $m$  = mass of the particle

- **SI Unit:** Hertz ( $Hz$ )

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### 11. Radius of Charged Particle in a Magnetic Field (Cyclotron Motion)

$$r = \frac{mv}{qB}$$

- **Symbols:**

$r$  = radius,  $m$  = mass,  $v$  = velocity,  $q$  = charge,  $B$  = magnetic field

- **SI Unit:** Meter ( $m$ )

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### 12. Magnetic Dipole Moment of a Current Loop

$$m = I \cdot A$$

- **Symbols:**

$m$  = magnetic dipole moment,  $I$  = current,  $A$  = area

- **SI Unit:** Ampere-meter<sup>2</sup> ( $A \cdot m^2$ )

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### 13. Energy of a Magnetic Dipole in a Magnetic Field

$$U = -\vec{m} \cdot \vec{B}$$

- **Symbols:**

$U$  = energy,  $\vec{m}$  = magnetic dipole moment,  $\vec{B}$  = magnetic field

- **SI Unit:** Joules ( $J$ )

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### Constants and Conversions

- **Permeability of free space ( $\mu_0$ ):**  $4\pi \times 10^{-7} T \cdot m/A$

- **Tesla (T):**  $1T = 10^4 Gauss$