Charge in a Magnetic Field
Review the textbook on the Motion of a Charged Particle in a Magnetic Field

- **Phys 2426**: Serway/Jewett: Section 29.2, Active Figures 29.8 and 29.9, Example 29.3.

\[ m_e = 9.1 \times 10^{-31} \text{ kg}, \quad m_p = 1.7 \times 10^{-27} \text{ kg}, \quad e = |q_e| = |q_p| = 1.6 \times 10^{-19} \text{ C} \]

1. A proton enters a region of a uniform magnetic field with velocity \( v = 3.0 \times 10^6 \text{ m/s} \) in \(+X\) direction. The magnitude of the field is 2.0 T and is in \(-Y\) direction. What is the magnetic force (magnitude and direction) exerted on the proton from the field? (9.6e−13 N in \(-Z\) direction or into the page)

2. An electron enters a region of a uniform magnetic field with velocity \( v = 3.0 \times 10^6 \text{ m/s} \) in \(+X\) direction. The magnitude of the field is 2.0 T and is in \(-Y\) direction. What is the magnetic force (magnitude and direction) exerted on the proton from the field? (9.6e−13 N in \(+Z\) direction or out of the page)

3. An electron enters a region of a uniform magnetic field with velocity \( v = 3.0 \times 10^6 \text{ m/s} \) in \(+X\) direction. The magnitude of the field is 2.0 T and is in \(-X\) direction. What is the nature of electron’s trajectory in this field (a line, a circle, or a helix)? (A line, because the velocity is parallel to the magnetic field)

4. A proton enters a region of a uniform magnetic field with velocity that has x- and y-components, \( v = (3.0 \times 10^6 \text{ m/s}) x + (−2.0 \times 10^6 \text{ m/s}) y \). The magnitude of the field is 2.0 T and is in \(-X\) direction. What is the nature of proton’s trajectory in this field (a line, a circle, of a helix)? (A helix, because the velocity has both parallel and perpendicular components relative to the magnetic field)

5. A proton enters a region of a uniform magnetic field with velocity that has x- and y-components, \( v = (3.0 \times 10^6 \text{ m/s}) x + (−2.0 \times 10^6 \text{ m/s}) y \). The magnitude of the field is 2.0 T and is in \(-Z\) direction. What is the nature of proton’s trajectory in this field (a line, a circle, of a helix)? (A circle, because both components of the velocity are perpendicular relative to the magnetic field)

6. An electron enters a region of a uniform magnetic field with velocity \( v = 3.0 \times 10^6 \text{ m/s} \) in \(+X\) direction. The magnitude of the field is 2.0 T and is in \(-Y\) direction. What are the radius and direction of electron’s circular orbit? (8.5 \(\mu\)m clockwise as viewed toward \(-Y\) direction)

7. A proton enters a region of a uniform magnetic field with velocity \( v = 3.0 \times 10^6 \text{ m/s} \) in \(+X\) direction. The magnitude of the field is 2.0 T and is in \(-Y\) direction. What are the radius and direction of proton’s circular orbit? (1.6 cm counter clockwise as viewed toward \(-Y\) direction)

8. What would be the change in the trajectory of the electron from the question #6 with the gradual increase of the magnitude of magnetic field? (The electron will continue to rotate clockwise as viewed toward \(-Y\) direction but the radius of the trajectory will get gradually smaller)