Charge in a Magnetic Field

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

- **Phys 1402:** Serway/Vuille: Section. 19.6, Active Figures 19.19 and 19.20, Example 19.6.
- **Phys 2426:** Serway/Jewett: Section 29.2, Active Figures 29.8 and 29.9, Example 29.3.

$$m_e = 9.1\times10^{-31}\ \text{kg}, \quad m_p = 1.7\times10^{-27}\ \text{kg}, \quad e = |q_e| = |q_p| = 1.6\times10^{-19}\ \text{C}$$

1. A proton enters a region of a uniform magnetic field with velocity v = 3.0×10^6 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* = 3.0×10^6 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* = 3.0×10^6 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* = (3.0×10^6 m/s) **x** + (−2.0×10^6 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* = (3.0×10^6 m/s) **x** + (−2.0×10^6 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 = 3.0×10^6 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 μm clockwise as viewed toward −**Y** direction)

7. A proton enters a region of a uniform magnetic field with velocity v = 3.0×10^6m/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)