

Charged Particle in a Magnetic Field

Classroom worksheet · Interactive simulation: <https://lkforge.com/tools/physics/charged-particle/>

Name: _____ Date: _____

Learning objectives

- Describe the magnetic force on a moving charge.
- Relate the circular path radius to speed, mass, charge, and field.
- Predict the direction of the force.

Variables to change

- Charge sign
- Speed
- Magnetic field strength
- Entry angle

Procedure

1. Send a charge into the field perpendicular to it and observe the circular path.
2. Increase the speed and observe the radius.
3. Increase the field strength and observe the radius.
4. Flip the charge's sign and note the direction of curving.

Observations

Record how the path radius changes with speed and field strength, and how sign affects direction.

Questions

1. Write the magnetic force on a moving charge.
2. Why does the charge move in a circle (v perpendicular to B)?
3. Write the radius of the circular path.
4. What happens to the radius if you double the field?
5. What path results if the charge enters at an angle to the field?

Answer key (instructors)

- **1.** $F = qv \times B$ — magnitude qvB when v is perpendicular to B .
- **2.** The force is always perpendicular to the velocity, so it changes direction but not speed — centripetal motion.
- **3.** $r = mv/(qB)$.
- **4.** It halves — radius is inversely proportional to B .
- **5.** A helix — circular motion perpendicular to B plus constant drift along B .

A magnetic field exerts $F = qv \times B$, always perpendicular to the velocity, so a charge moving across the field circles with radius $r = mv/(qB)$. Faster charges circle wider, stronger fields tighten the circle, and an angled entry gives a helix.