Paths Through Fields

Predict particle motion in a uniform magnetic field

HS-PSII-6.3 "Describe the motion of a charged or uncharged particle through a uniform magnetic field."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB As you read, underline each rule that helps you predict a particle's path. Circle the words that tell you whether the field changes its speed.

Inside a Particle Detector

1. Inside a particle detector, a beam enters a chamber where the magnetic field has the same strength and direction everywhere. Scientists call this a uniform magnetic field. Imagine testing particles in a vacuum so that air resistance and electric forces do not complicate their motion. A particle with no electric charge, such as a neutron, feels no force from the uniform magnetic field that would change its path. It continues in a straight line at constant speed if no other force acts on it. The field cannot identify a neutral particle by bending its path because there is no bend to measure.

2. A moving charged particle behaves differently when its motion has a component across the field. The magnetic force acts at right angles to both that component of motion and the field. If the particle enters exactly across the field, this sideways force continually turns its velocity, making a circular path. The force changes the direction of motion but does not change the particle's speed. Reversing the sign of the charge reverses the direction of the turn. For the same particle and entry speed, a stronger field produces a tighter circle. A faster entry speed produces a wider circle.

3. If a charged particle moves exactly along the field direction, the magnetic force on it is zero, so it travels straight at constant speed. When its motion is partly along and partly across the field, the two parts combine: it circles while advancing along the field, tracing a helix like a stretched spring. The across-field motion bends, but the along-field motion remains steady. A uniform magnetic field cannot speed up or slow down any of these particles on its own. To predict a path, first check charge, then compare the entry direction with the field direction.

2 ANSWER WITH EVIDENCE

Use the passage

1. An electron enters across a uniform magnetic field. Describe its path and what happens to its speed.

2. A positive ion enters a uniform magnetic field moving exactly along the field direction. Describe its motion.

3. A neutral atom enters a uniform magnetic field at an angle to the field direction. What path does it follow if no other force acts?

4. The same charged particle enters across the same field twice, at a higher speed the second time. Compare its two paths and its speed during each run.

3 YOUR TURN

Your own words

Design a test with two charged particles entering a uniform magnetic field at different angles and one neutral particle entering at an angle you choose. In four or five sentences, describe all three paths, predict how a stronger field would affect the charged paths, and state what happens to each particle's speed.

ANSWER KEY

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HIGH SCHOOL · HS-PSII-6.3

PART 1 · READ AND MARK

As you read, underline each rule that helps you predict a particle's path. Circle the words that tell you whether the field changes its speed. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	An electron enters across a uniform magnetic field. Describe its path and what happens to its speed.	**It follows a circular path at constant speed.**
2	A positive ion enters a uniform magnetic field moving exactly along the field direction. Describe its motion.	**It continues straight at constant speed because the magnetic force is zero.**
3	A neutral atom enters a uniform magnetic field at an angle to the field direction. What path does it follow if no other force acts?	**It continues in a straight line at constant speed.**
4	The same charged particle enters across the same field twice, at a higher speed the second time. Compare its two paths and its speed during each run.	**Both paths are circles, but the faster entry produces a wider circle. The field does not change the particle's speed during either run.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

In my test, a positive ion enters across the field and follows a circle. Another positive ion enters at an angle and follows a helix. A neutral atom enters along the field and continues straight. A stronger field would make the circle tighter and the helix wind more tightly. The magnetic field does not change any of their speeds.

Accept any two different entry angles for the charged particles, with paths that match those angles. A stronger field bends across-field motion more tightly but does not change any particle's speed.