Detector Decisions

Calculate magnetic force and use its direction to track charged particles.

HS-PSII-6.4 "Determine the magnitude of the magnetic force acting on a charged particle moving through a uniform magnetic field and apply the right hand rule to determine the direction of either the magnetic force or the magnetic field."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the force equation, circle the angle facts, and number the right-hand-rule actions in order so you can use them with the detector log.

Inside a Particle Detector

1. In a particle detector, a charged particle crosses a region with a uniform magnetic field. The magnetic force has magnitude $F = |q|vB \sin \theta$, where q is charge, v is speed, B is field strength, and θ is the angle between motion and field. Use coulombs, meters per second, and teslas to obtain newtons.

2. For direction, point your right-hand fingers along a positive particle's velocity, then curl them toward the magnetic field. Your thumb points along the magnetic force. For a negative particle, reverse the thumb's direction. On this page, "into the page" means away from you, and "out of the page" means toward you.

3. The detector log below records four particles moving to the right across the page. Each row gives a charge, a speed, and a uniform field. The field's direction determines the angle in the formula. Parallel motion has $\sin 0° = 0$; perpendicular motion has $\sin 90° = 1$. A zero force has no direction.

DETECTOR LOG

Particle and charge (C)	Speed (m/s)	Field strength (T)	Field direction
A: $+2.0 \times 10^{-6}$	3.0×10^{4}	0.50	Into the page
B: -2.0×10^{-6}	3.0×10^{4}	0.50	Into the page
C: $+1.0 \times 10^{-6}$	4.0×10^{4}	0.25	Up the page
D: $+2.0 \times 10^{-6}$	5.0×10^{4}	0.40	Right

2 ANSWER WITH EVIDENCE

Use the passage

1. What is the magnetic force on particle A? Show your calculation.

2. Which way is the magnetic force on particle B? Explain how its charge affects your answer.

3. Find both the magnitude and direction of the magnetic force on particle C. Show your calculation.

4. What is the magnetic force on particle D? State whether it has a direction and explain why.

3 YOUR TURN

Your own words

Invent a new case with a negative particle moving up the page through a uniform field pointing out of the page. Choose a charge magnitude, speed, and field strength unlike the values in the log, then calculate the force magnitude and use the right-hand rule to give its direction.

ANSWER KEY

Detector Decisions

PART 1 · READ AND MARK

Underline the force equation, circle the angle facts, and number the right-hand-rule actions in order so you can use them with the detector log. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	What is the magnitude of the magnetic force on particle A? Show your calculation.	**$(2.0 \times 10^{-6}\ \text{C})(3.0 \times 10^{4}\ \text{m/s})(0.50\ \text{T})(1) = 0.030\ \text{N}$.**
2	Which way is the magnetic force on particle B? Explain how its charge affects your answer.	**Down the page. The right-hand rule gives an upward force for a positive charge moving right through a field into the page; B is negative, so its force is opposite.**
3	Find both the magnitude and direction of the magnetic force on particle C. Show your calculation.	**$(1.0 \times 10^{-6}\ \text{C})(4.0 \times 10^{4}\ \text{m/s})(0.25\ \text{T})(1) = 0.010\ \text{N}$, out of the page.**
4	What is the magnetic force on particle D? State whether it has a direction and explain why.	**0 N, with no force direction. Its motion is parallel to the field, so sin 0° = 0.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Let $q = -3.0 \times 10^{-6}$ C, $v = 2.0 \times 10^{4}$ m/s, and B = 0.20 T. The motion and field are perpendicular, so $F = (3.0 \times 10^{-6})(2.0 \times 10^{4})(0.20)(1) = 0.012$ N. The right-hand rule points right for a positive charge, so this negative particle feels a force to the left.

Accept equivalent units and notation. For Part 3, each chosen numerical value must differ from the values in its corresponding log column, and the force must point left.