

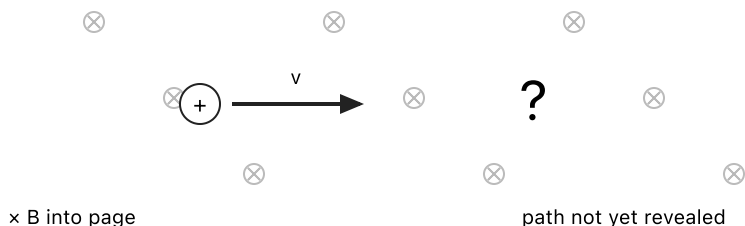
MAGNETISM DAY 4: CIRCULAR MOTION IN B & CROSSED FIELDS

CED 12.2 · Skill 2.B · FRQ: MR

PREDICT THE PATH

A positive charge enters a uniform magnetic field with $\vec{v} \perp \vec{B}$. Predict its path: **straight / circular / parabolic / spiraling inward**. Commit before the trajectory is revealed.

UNIFORM FIELD INTO THE PAGE — PATH NOT YET REVEALED



MAGNETIC FORCE AS THE INWARD FORCE

When $\vec{v} \perp \vec{B}$, the magnetic force has constant magnitude and remains perpendicular to the velocity. It can supply the inward force for uniform circular motion.

$$|q|vB = \frac{mv^2}{r} \quad r = \frac{mv}{|q|B}$$

NOTES / REASONING

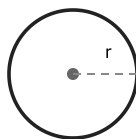
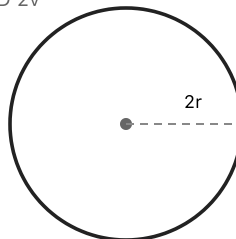
RADIUS AND PERIOD

WE DO A proton has $m_p = 1.67 \times 10^{-27} \text{ kg}$, $|q| = 1.60 \times 10^{-19} \text{ C}$, and $v = 3.0 \times 10^6 \text{ m/s}$. It enters $B = 0.50 \text{ T}$ perpendicularly. Find the orbit radius.

One lap has distance $2\pi r$, so

$$T = \frac{2\pi r}{v} = \frac{2\pi m}{|q|B}$$

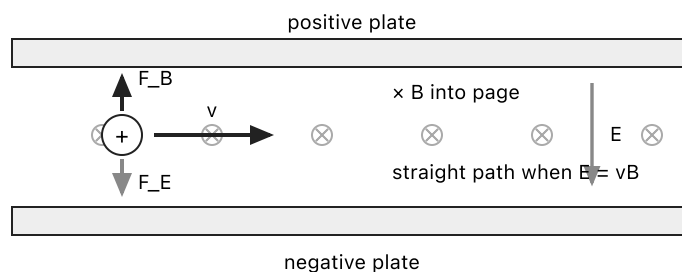
The period does not contain v . At fixed m , $|q|$, B , a faster particle follows a proportionally larger circle.

DOUBLE SPEED: DOUBLE RADIUS, SAME PERIODSPEED v SPEED $2v$ 

CALCULATE Find the proton's period for the stated field.

VELOCITY SELECTOR

OPPOSING FORCES SELECT ONE SPEED



The drawn positive charge moves right. Electric and magnetic forces cancel only when their magnitudes match.

Crossed electric and magnetic fields can transmit particles of one speed without deflection.

$$|q|E = |q|vB \quad v = \frac{E}{B}$$

The charge magnitude cancels. Reversing the charge reverses both forces, so the selected speed is unchanged.

WE DO A selector has $E = 2.4 \times 10^5 \text{ N/C}$ and $B = 0.30 \text{ T}$. Find the undeflected speed.

REASON State what happens to a particle moving slower than the selected speed in the pictured geometry.

PRACTICE

1. A proton moves at $2.5 \times 10^6 \text{ m/s}$ perpendicular to 0.55 T . Find its radius.

2. At fixed m , $|q|$, B , the speed doubles. State the factors by which radius and period change.

3. A negative charge replaces a positive charge with the same m , $|q|$, v , B . Compare radius, period, and direction of curvature.

4. Find the selected speed for $E = 1.8 \times 10^5 \text{ N/C}$ and $B = 0.45 \text{ T}$.

5. On a circular-path sketch, label the instantaneous velocity and magnetic force at one point.

