

MAGNETISM DAY 5: FORCE ON CURRENT-CARRYING WIRES

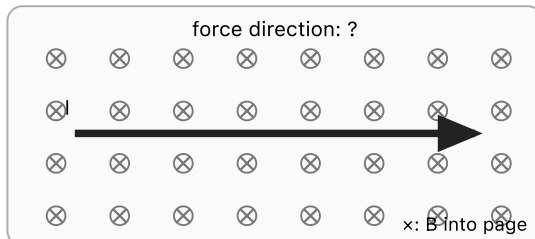
CED 12.3 · Skill 2.B · FRQ: MR

PREDICT BEFORE SWITCHING ON

A horizontal wire carries conventional current to the right through a magnetic field directed into the page. Predict the wire's force: **up / down / right / no force**. Commit before the switch closes.

Observation source: a wire in a magnet gap; projected PhabPhysics Wire-Force Bench; or the printed geometry below.

CURRENT RIGHT; MAGNETIC FIELD INTO THE PAGE



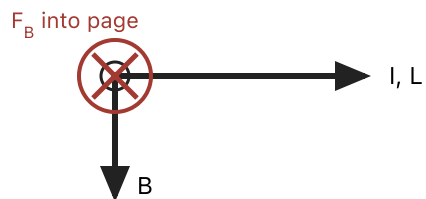
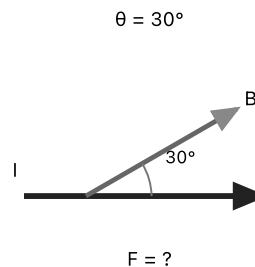
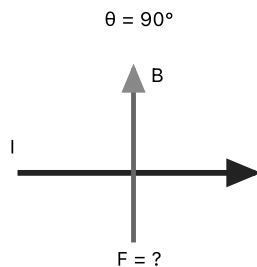
FROM MOVING CHARGES TO A WIRE FORCE

Each moving charge in the wire can experience $q\vec{v} \times \vec{B}$. Adding those forces over a straight active length gives

$$\vec{F}_B = I\vec{L} \times \vec{B} \quad F_B = BIL \sin \theta$$

$\vec{L}$ points with conventional current. The angle θ is between $\vec{L}$ and $\vec{B}$.

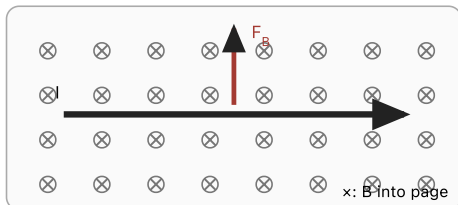
NOTES / REASONING

DIRECTION AND ANGLE**MUTUALLY PERPENDICULAR CURRENT, FIELD, AND FORCE**Use conventional current in $\mathbf{I} \times \mathbf{L}$ **ONLY THE PERPENDICULAR FIELD COMPONENT CONTRIBUTES**

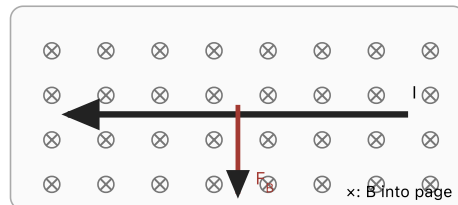
WE DO A 6.0 A current passes through 0.30 m of wire in a 0.40 T field. Find the magnetic force at 90° , then at 30° .

REVERSALS

ORIGINAL CURRENT



CURRENT REVERSED



- Reverse I alone: $\vec{F}_B$ reverses.
- Reverse $\vec{B}$ alone: $\vec{F}_B$ reverses.
- Reverse both: the force returns to its original direction.
- Make $I \parallel B$: $F_B = 0$.

1. Find F_B for $I = 7.0 \text{ A}$, $L = 0.25 \text{ m}$, $B = 0.30 \text{ T}$, and $\theta = 90^\circ$.

2. In the warmup geometry, reverse only the field. State the new force direction.

PRACTICE

3. A 9.0 A current passes through 0.18 m of wire in a 0.30 T field at 90° . Find the force magnitude.

4. A wire experiences 0.336 N when $I = 7.0\text{ A}$, $L = 0.20\text{ m}$, and $I \perp B$. Find B .

5. The current is parallel to the magnetic field. Find the magnetic force and explain why increasing the current does not change that result while the vectors remain parallel.