MAGNETISM DAY 3: FORCES ON CURRENTS

WARMUP Two Predictions

Day 1's twitching wire, two predictions before any formula. The teacher turns the supply up, so more current flows: does the wire kick **harder / softer / the same**? A longer stretch of wire hangs in the field: **harder / softer / the same**? Circle both and jot your gut reason — today's law grades them.

FORCE ON A CURRENT

$F = IL \times B$, magnitude **$F = BIL \sin\theta$**.

Direction: Day 1's right-hand rule with I in place of v — fingers along the current (the direction positive charge moves), curl to B, thumb gives F.

Parallel wires: each sits in the other's field; $F/L = \mu_0 I_1 I_2/(2\pi d) = (2\times10^{-7})I_1 I_2/d$. Same-direction currents ATTRACT.

WE DO Exercise 1: Motor Segment

A 1.5 m wire carries 8.0 A $\perp$ to a 0.5 T field. **(a)** F = BIL = _____. **(b)** The current direction reverses — what happens to the force?

WIRES ON WIRES

WE DO Exercise 2: The Double Right-Hand Rule

Two long parallel wires lie flat on the bench, both carrying current NORTH; wire 2 sits EAST of wire 1. **(a)** Sketch wire 1's circular field at wire 2's location — which way does it point there (grip rule)? **(b)** Cross wire 2's IL with that field: attract or repel? **(c)** Repeat for opposite currents.

YOU DO Exercise 3: Size the Pair

Two parallel wires 0.10 m apart carry 100 A each (same direction). Find the force per meter between them: $F/L = (2\times10^{-7})I_1I_2/d$.

CALC Exercise 4: Why BIL Follows From qvB

In time t, the charge passing a point is Q = It, moving at drift speed v with L = vt. Start from F = QvB and substitute to reach F = BIL. Show every replacement.

PAPER PRACTICE

PRACTICE PROBLEMS

P1 BIL

A 2.0 m wire carries 5.0 A $\perp$ to 0.4 T. Find F.

P2 At an Angle

The same wire, current at 30° to B: find F.

P3 Solve for I

A 0.8 m wire $\perp$ to 0.5 T must feel exactly 2.0 N (a rail-gun spec). What current does it need?

P4 Levitate the Wire

A horizontal wire (mass per length 0.01 kg/m) carries current $\perp$ to a horizontal 0.25 T field. What current makes the magnetic force balance gravity? Work with ONE meter of wire: its weight is (0.01 kg)(g), and the magnetic force on it is BI(1 m) — set them equal. Use g = 9.8 m/s².