

MAGNETISM DAY 7: PARALLEL WIRES & COMBINED CONFIGURATIONS

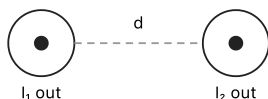
CED 12.3 · Skill 2.C · FRQ: QQT

PREDICT BEFORE REVEALING FORCES

Two parallel wires carry currents in the same direction. Predict: **attract / repel / no force**. Commit before the wires are released or the force arrows are shown.

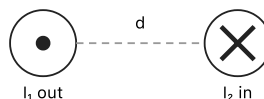
CROSS SECTIONS OF TWO CURRENT PAIRS

SAME DIRECTION



force: ?

OPPOSITE DIRECTIONS



force: ?

EACH WIRE SITS IN THE OTHER WIRE'S FIELD

Wire 1 makes a magnetic field at wire 2. That field exerts a force on the current in wire 2. Reversing either current reverses one step of this direction chain.

NOTES / REASONING

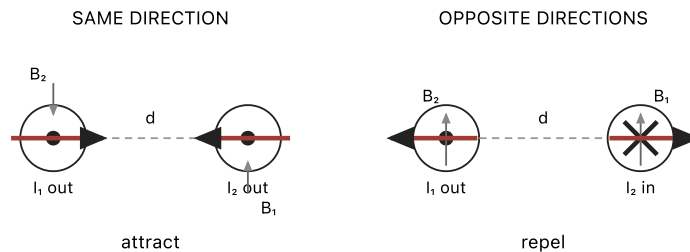
FORCE PER UNIT LENGTH

At separation d , wire 1 produces $B_1 = \mu_0 I_1 / (2\pi d)$. The perpendicular force on length L of wire 2 is $F_2 = I_2 L B_1$.

$$\frac{F}{L} = \frac{\mu_0 I_1 I_2}{2\pi d}$$

The formula gives the positive magnitude. Current directions determine attraction or repulsion.

WE DO Parallel wires carry $I_1 = 8.0 \text{ A}$ and $I_2 = 12 \text{ A}$, separated by $d = 0.040 \text{ m}$. Find F/L . State the interaction for same-direction currents.

DIRECTION CHAIN AND SUPERPOSITION**COMPLETE FIELD AND FORCE ARROWS**

At a point between two same-direction currents, the two magnetic fields point oppositely. At the midpoint they cancel only if the current magnitudes are equal. For opposite-direction currents, the two fields between the wires point in the same direction and add.

1. Two equal same-direction currents are separated by 0.050 m . Find the net field at the midpoint.

2. Repeat the midpoint direction comparison after one current reverses. Explain whether the fields add or cancel.

PRACTICE

3. Two wires carry 6.0 A and 10.0 A in opposite directions, separated by 0.050 m. Find F/L and state attract or repel.

4. The current in each of two wires doubles while separation stays fixed. By what factor does F/L change?

5. The two currents stay fixed while separation triples. By what factor does F/L change? Connect the result to the field of a straight wire.