LESSON MAKER PRO

Current and Distance

Model the magnetic field around a straight wire.

HIGH SCHOOL · HS-PSII-6.2

HS-PSII-6.2 "Develop and apply a mathematical representation that describes the relationship between the magnetic field created by a long straight wire carrying an electric current, the magnitude of the current, and the distance to the wire."

NAME _____ DATE _____

THE FIELD RULE

For a long, straight wire in air, the magnetic field strength B increases with current I and decreases with distance r from the wire. Use B = 20I/r when I is in amperes (A), r is in centimeters (cm), and B is in microteslas (μT).

WORKED EXAMPLE

A long, straight wire carries 7 A. Find the magnetic field strength 14 cm from the wire.

1. Write the rule: B = 20I/r.
2. Substitute: B = 20(7)/14.
3. Divide: B = 10 μT.

Answer: 10 μT

PRACTICE 6 problems

1 Find the magnetic field strength 4 cm from a long, straight wire carrying 2 A.

ANSWER _____

2 Find the magnetic field strength 8 cm from a long, straight wire carrying 6 A.

ANSWER _____

3 Find the magnetic field strength 20 cm from a long, straight wire carrying 5 A.

ANSWER _____

4 The magnetic field strength is 8 μT at a distance of 10 cm from a long, straight wire. What current flows in the wire?

ANSWER _____

5 A long, straight wire carries 9 A. At what distance is its magnetic field strength 30 μT?

ANSWER _____

6 Use the table to find the field strength at each point. Is either field stronger?

POINTS NEAR LONG, STRAIGHT WIRES

Point	Current I (A)	Distance r (cm)
A	2	5
B	4	10

ANSWER _____

APPLY IT Show your work

1 A robotics club tests a long, straight wire carrying 8 A in air. A magnetic sensor is 16 cm from the wire. What field strength does the model predict there? What does it predict if the club moves the sensor to 8 cm?

WORK SPACE

ANSWER _____

2 A student building a magnetic switch for a model train measures the wire's magnetic field contribution as 24 μT at a distance of 10 cm. Treat the wire as long and straight. What current flows in it?

WORK SPACE

ANSWER _____

CHALLENGE One step up

A robotics team needs a magnetic sensor to detect at least 15 μT from a long, straight wire carrying 6 A. What is the greatest whole-number distance, in centimeters, that the sensor can be from the wire? Explain why a greater distance will not work.

WORK SPACE AND ANSWER

Current and Distance

PART 1 · PRACTICE

#	PROBLEM	ANSWER
1	Find the magnetic field strength 4 cm from a long, straight wire carrying 2 A.	**10 μT**
2	Find the magnetic field strength 8 cm from a long, straight wire carrying 6 A.	**15 μT**
3	Find the magnetic field strength 20 cm from a long, straight wire carrying 5 A.	**5 μT**
4	The magnetic field strength is 8 μT at a distance of 10 cm from a long, straight wire. What current flows in the wire?	**4 A**
5	A long, straight wire carries 9 A. At what distance is its magnetic field strength 30 μT?	**6 cm**
6	Use the table to find the field strength at each point. Is either field stronger?	**A: 8 μT; B: 8 μT. The fields are equal.**

PART 2 · APPLY IT

1. **10 μT at 16 cm; 20 μT at 8 cm** Use B = 20I/r at each distance: 20(8)/16 = 10 μT and 20(8)/8 = 20 μT.
2. **12 A** Substitute into B = 20I/r: 24 = 20I/10 = 2I, so I = 12 A.

CHALLENGE

8 cm. At 8 cm, B = 20(6)/8 = 15 μT. At any greater distance, the field is less than 15 μT.

All field strengths use the long, straight wire model in air. Accept equivalent calculations with correct units.