Magnetism

PH11-11

ORIENTATION

Lesson goal: describe magnetic fields and field patterns around magnets, straight wires, coils, solenoids, and electromagnets.

Direction rules matter. A correct answer should state both the rule used and the resulting field direction.

CORE CONTENT

Magnetic fields exert forces on magnetic materials and moving charges. Around a current-carrying wire, the magnetic field forms circular loops. Around a solenoid, the field resembles a bar magnet and is strengthened by more turns, greater current, and a suitable core.

Useful force relations:

$$F = BIL\sin\theta$$

$$F = qvB\sin\theta$$

SITUATION	DIRECTION RULE
straight current-carrying wire	right-hand grip rule
solenoid	curled fingers show current, thumb points north pole
force on current in field	relevant motor-effect hand rule if introduced

CONCEPT CHECK

1. Around a straight current-carrying wire, magnetic field lines are:

- A. circular around the wire
- B. straight away from the wire only
- C. absent
- D. always vertical

Answer: A.

2. A solenoid's field is strengthened by:

- A. reducing current to zero
- B. increasing turns or current
- C. removing all coils
- D. using no core under any condition

Answer: B.

3. Magnetic force on a moving charge is greatest when velocity is:

- A. parallel to the field
- B. perpendicular to the field
- C. zero
- D. unrelated to field direction

Answer: B.

APPLIED PRACTICE

A `0.30 m` wire carries `4.0 A` perpendicular to a `0.20 T` magnetic field. Find the magnetic force.

$$F = BIL \sin\theta = 0.20 \times 4.0 \times 0.30 \times \sin 90^\circ$$

$$F = 0.24\ \mathrm{N}$$

Final answer: $0.24\ \mathrm{N}$; force is maximum because the wire is perpendicular to the field.

DEEP PRACTICE AND WRITING

Prompt: explain how an electromagnet can be strengthened and why each change affects the magnetic field.

MAINTENANCE LOOP

Retrieve field pattern around a wire, solenoid field direction, and the condition for maximum magnetic force.

STUDENT WORKING