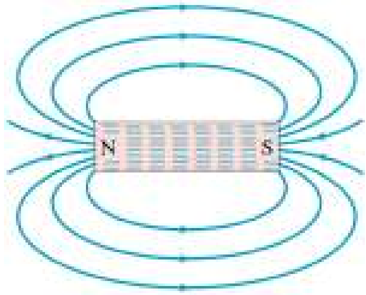
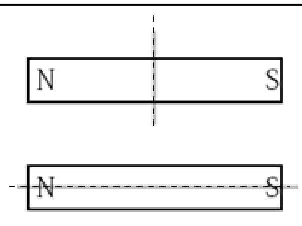
Magnetism Review

Permanent magnets are dipoles



- Every magnet has north and south pole
    - Only magnetic dipoles exist ("di" meaning two)
    - Pieces of broken magnets always have two poles
    - No magnetic monopoles
- Opposite poles attract, likes repel
- Magnetic field lines are closed loops pointing from North to South.
- The Earth's magnetic poles are opposite the geographic poles

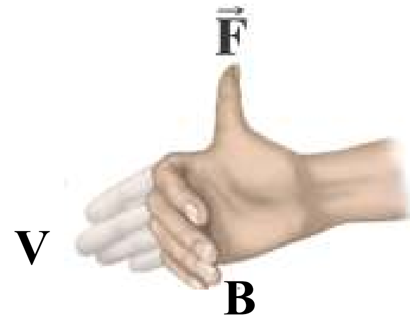


Two bar magnets are to be cut in half along the dotted lines shown. None of the pieces are rotated. After the cut:
A) None of the halves will attract any other
B) The two halves of each magnet will attract each other
C) The two halves of each magnet will repel each other
D) The two halves of the top magnet will repel, the two halves of the bottom magnet will attract
E) The two halves of the top magnet will attract, the two halves of the bottom magnet will repel

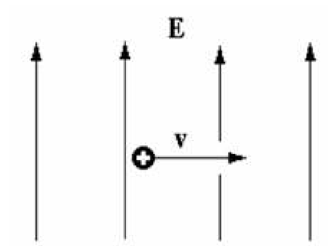
A charge moving through magnetic field is forced

- Unless:
    1. charge is stationary
    2. charge is moving parallel to magnetic field

Right Hand Rule #1



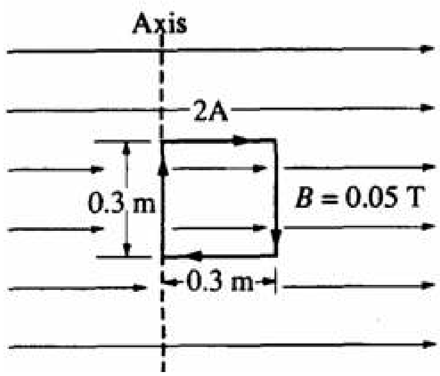
- Electric charges are forced by magnetic field if they are moving perpendicular to it.
    - Positive charge: Right hand rule #1 gives direction of force
    - Negative charge: Opposite direction (or use left hand)
    - **F=qvB**
      F: Force in Newtons (N)
      q: charge in coulombs (C)
      v: velocity in meters per second (m/s)
      B: magnetic field in Teslas (T)
    - Magnetic force is centripetal: $qvB=mv^2/r$
    - Magnetic force does no work because it is always perpendicular to velocity



A positively charged particle moves to the right. It enters a region of space in which there is an electric field directed up the plane of the paper as shown. In which direction does the magnetic field have to point in this region so that the particle maintains a constant velocity?

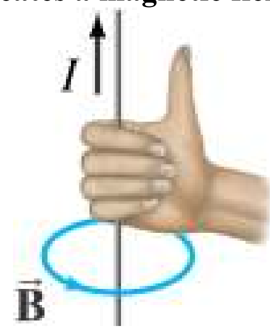
A) into the plane of the page
B) out of the plane of the page
C) to the right
D) to the left
E) up the plane of the page

- Straight wire carrying current is forced by magnetic field if perpendicular to it.
    - Conventional current (positive charge): right hand rule #1 gives direction of force
    - Electron flow: opposite direction (or use left hand)
    - **F=IlB**
      F: Force in Newtons (N)
      I: Current in Amperes (A)
      l: length of wire in meters (m)
      B: magnetic field in Teslas (T)
- Loops of wire in a magnetic field:
    - use right hand rule #1 for force on each section of wire
    - loop can be stretched outward, forced inward, or rotate (torque)



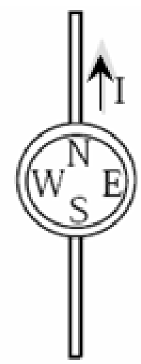
A square loop of wire 0.3 meter on a side carries a current of 2 amperes and is located in a uniform 0.05-tesla magnetic field. The left side of the loop is aligned along and attached to a fixed axis. When the plane of the loop is parallel to the magnetic field in the position shown, what is the magnitude of the torque exerted on the loop about the axis?
A) 0.00225 Nm
B) 0.0090 Nm
C) 0.278 Nm
D) 1.11 Nm
E) 111 Nm

A current creates a magnetic field

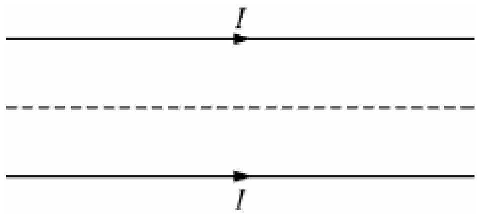


Right hand rule #2

- Magnetic field of straight wire forms closed circular loops around wire
    - Right hand rule #2 gives direction of field
    - For electron flow, reverse direction (or use left hand)
    - **B=μoI/(2πr)**
      B: Magnetic field in Teslas (T)
      μo: $4\pi \times 10^{-7}$ Tm/A
      I: current in Amperes (A)
      r: distance from center of wire in meters (m)



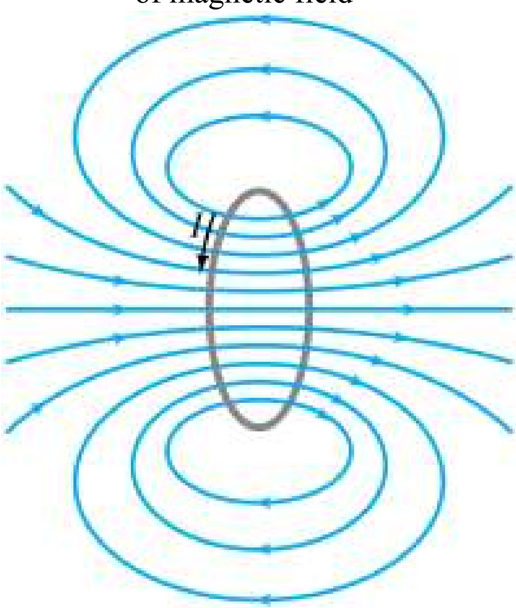
A long straight wire conductor is placed below a compass as shown in the top view figure. When a large conventional current flows in the conductor as shown, the N pole of the compass:
A) remains undeflected
B) points to the south
C) points to the west
D) points to the east
E) has its polarity reversed

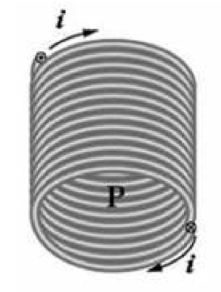


Two long, straight, parallel wires in the plane of the page carry equal currents *I* in the same direction, as shown above. Which of the following correctly describes the forces acting on the wires and the resultant magnetic field at points along the dotted line midway between the wires?

Forces	Field
(A) Attractive	Not zero
(B) Attractive	Zero
(C) Zero	Zero
(D) Repulsive	Not zero
(E) Repulsive	Zero

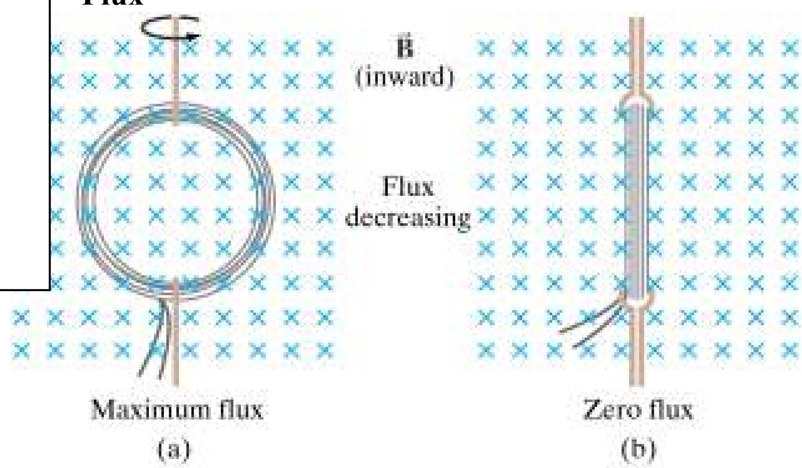
- Magnetic field of a loop of wire resembles magnetic field of a dipole.
    - Right hand rule #3 gives direction of magnetic field



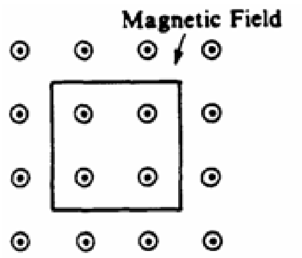


The magnetic field line passing through point P inside the solenoid is directed
A) to the right
B) to the left
C) downward toward the bottom of the page
D) upward toward the top of the page
E) in no direction since the magnetic field is zero

Flux



- The number of B-field lines passing through a loop of wire.
- **Φ=BA**
    - Φ: *Flux (Wb)*
      B: Magnetic field in Teslas (T)
      A: Area (m^2)
- Lenz's Law: Nature HATES changes in flux, and an induced current will be produced in a direction to cancel a change in flux.
- $\varepsilon = \frac{\Delta\Phi}{\Delta t} = \frac{(BA)_f - (BA)_i}{t}$
    - ε: *emf/voltage (V)*
      Φ: *Flux (Wb)*
      t: time (s)
- For a rectangular loop of wire moving into/out of a B-field with speed v: **ε=Blv**
    - l is the length of the loop that is always entirely inside the field



A square loop of wire of side 0.5 meter and resistance 10^{-2} ohm is located in a uniform magnetic field of intensity 0.4 tesla directed out of the page as shown. The magnitude of the field is decreased to zero at a constant rate in 2 seconds. As the field is decreased, what are the magnitude and direction of the current in the loop?

(A) Zero
(B) 5 A, counterclockwise
(C) 5 A, clockwise
(D) 20 A, counterclockwise
(E) 20 A, clockwise