
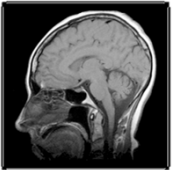



Physics 1161: Lecture 10

Magnetism

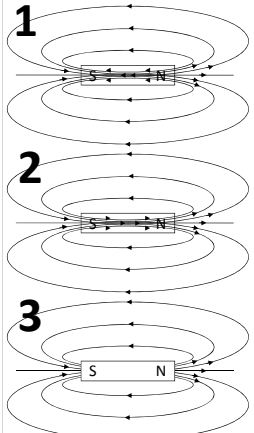
Textbook Sections 22-1 – 22-3, 22-8

Preflight 12.1



Which drawing shows the correct field lines for a bar magnet?

(1)
(2)
(3)




Magnetic Field Units

- $F = q \mathbf{v} \times \mathbf{B}$
- SI units: N-s/C-m = Tesla
- 1 Tesla = 10,000 Gauss
- Earth's magnetic field is approximately 0.5 Gauss
- Refrigerator magnets are about 100 Gauss
- Superconducting electromagnets can be as much as 40 Tesla

Nikola Tesla
1856- 1943



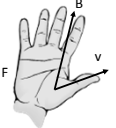
Carl Friedrich Gauss
1777-1855

Direction of Magnetic Force on Moving Charges

Velocity	B	Force
out of screen	right	
out of screen	left	
out of screen	up	
out of screen	down	

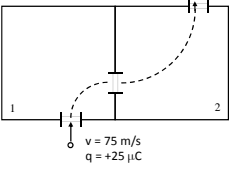
Right Hand Rule

- Thumb v , Fingers B , palm F
- Negative charge has opposite F !



Preflight 12.3

Each chamber has a unique magnetic field. A positively charged particle enters chamber 1 with velocity 75 m/s up, and follows the dashed trajectory.

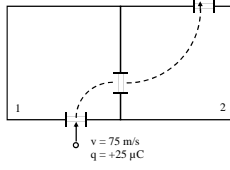


What is the direction of the force on the particle just as it enters region 1?

- 1) up
- 2) down
- 3) left
- 4) right
- 5) into page
- 6) out of page

Preflight 12.4

Each chamber has a unique magnetic field. A positively charged particle enters chamber 1 with velocity 75 m/s up, and follows the dashed trajectory.



What is the direction of the magnetic field in region 1?

- 1) up
- 2) down
- 3) left
- 4) right
- 5) into page
- 6) out of page

Each chamber has a unique magnetic field. A positively charged particle enters chamber 1 with velocity 75 m/s up, and follows the dashed trajectory. What is the direction of the magnetic field in region 2?

1. up
2. down
3. left
4. right
5. into page
6. out of page

Magnitude of Magnetic Force on Moving Charges

- The magnetic force on a charge depends on the magnitude of the charge, its velocity, and the magnetic field.

$F = q v B \sin(\theta)$

- Direction from RHR
 - Thumb (), fingers (), palm ()
- Note if v is parallel to B then $F = 0$

The three charges below have equal charge and speed, but are traveling in different directions in a uniform magnetic field. Which particle experiences the greatest magnetic force?

1. 1
2. 2
3. 3
4. All Same

The three charges below have equal charge and speed, but are traveling in different directions in a uniform magnetic field. The force on particle 3 is in the same direction as the force on particle 1.

1. True
2. False

Electric Force vs Magnetic Force

	Electric	Magnetic
Source:	Charges	Moving charges
Acts on:	Charges	Moving charges
Magnitude:	$F = qE$	$F = qvB \sin\theta$
Direction:	Parallel to E	Perpendicular to v & B

Velocity Selector

Example

Determine magnitude and direction of magnetic field such that a positively charged particle with initial velocity v travels straight through and exits the other side.

What direction should B point if you want to select negative charges?

- 1) Into Page
- 2) Out of page
- 3) Left
- 4) Right

Motion of Q in uniform B field

- Force is perpendicular to B, v
 - B does no work! ($W = F d \cos \theta$)
 - Speed is constant ($W = \Delta K.E.$)
 - Circular motion

$$a_c = \frac{v^2}{R}$$

$$F_{net} = ma_c$$

$$F_{net} = m \frac{v^2}{R} \quad F_{net} = qvB$$

Uniform B into page

Trajectory in Constant B Field

- Suppose charge q enters B -field with velocity v as shown below. What will be the path q follows?

- Force is always \perp to velocity and B . What is path?

Radius of Circular Orbit

- Lorentz force:
- centripetal acc:
- Newton's 2nd Law:

Preflight 12.6

Each chamber has a unique magnetic field. A positively charged particle enters chamber 1 with velocity $v_1 = 75$ m/s up, and follows the dashed trajectory.

$v = 75$ m/s
 $q = +25$ mC

What is the speed of the particle when it leaves chamber 2?

- $v_2 < v_1$
- $v_2 = v_1$
- $v_2 > v_1$

Preflight 12.8

Each chamber has a unique magnetic field. A positively charged particle enters chamber 1 with velocity $v_1 = 75$ m/s up, and follows the dashed trajectory.

$v = 75$ m/s
 $q = +25$ mC

Compare the magnitude of the magnetic field in chambers 1 and 2

- $B_1 > B_2$
- $B_1 = B_2$
- $B_1 < B_2$

Preflight 12.9

Each chamber has a unique magnetic field. A positively charged particle enters chamber 1 with velocity $v_1 = 75$ m/s up, and follows the dashed trajectory.

$v = 75$ m/s
 $q = ??$ mC

A second particle with mass $2m$ enters the chamber and follows the same path as the particle with mass m and charge $q = 25$ mC. What is its charge?

- $Q = 12.5$ mC
- $Q = 25$ mC
- $Q = 50$ mC