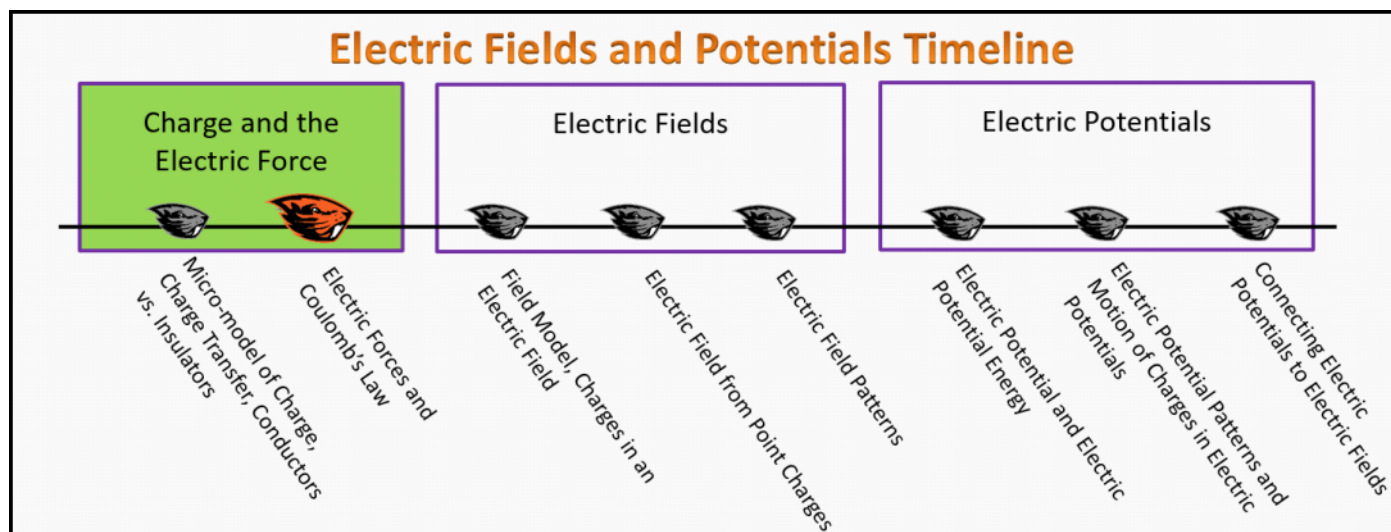


Magnetic Fields and Forces Foundation Stage (MF.L1.2)

Lecture 1 Magnetic Fields, Magnetism



Key Equations

$$\vec{B} = \frac{\mu_0}{4\pi} q \frac{\vec{v} \times \widehat{\Delta r}}{|\Delta r|^2}$$

Act I: Cross Products

MF.L1.2-01:

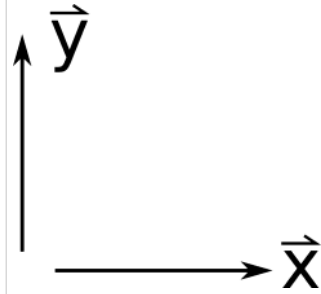
Problem Statement: Consider the cross product: $\vec{z} = \vec{x} \times \vec{y}$.

(a) What is the magnitude of the vector \mathbf{z} ? Let θ be the smallest angle between the vectors \mathbf{x} and \mathbf{y} when placed tail to tail.

(1) $|\vec{z}| = |\vec{x}| |\vec{y}| \cos(\theta)$

(2) $|\vec{z}| = |\vec{x}| |\vec{y}| \sin(\theta)$

(3) $|\vec{z}| = |\vec{x}| |\vec{y}|$



(b) What is the direction of the vector \mathbf{z} ?

- (1) Into the page
- (2) Out of the page
- (3) Right
- (4) Left
- (5) Up
- (6) Down
- (7) Points nowhere because it's zero

MF.L1.2-01:

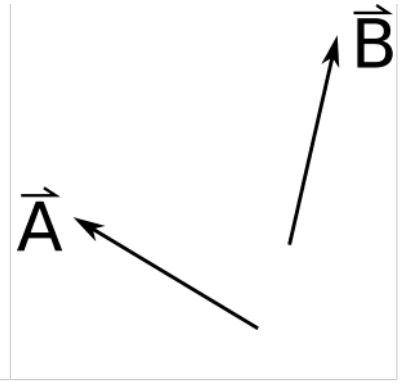
Problem Statement: Consider the cross product: $\vec{C} = \vec{A} \times \vec{B}$.

(a) What is the magnitude of the vector \mathbf{C} ? Let θ be the smallest angle between the vectors \mathbf{A} and \mathbf{B} when placed tail to tail.

$$(1) \quad |\vec{C}| = |\vec{A}| |\vec{B}| \cos(\theta)$$

$$(2) \quad |\vec{C}| = |\vec{A}| |\vec{B}| \sin(\theta)$$

$$(3) \quad |\vec{C}| = |\vec{A}| |\vec{B}|$$



(b) What is the direction of the vector **C** ?

- (1) Into the page
- (2) Out of the page
- (3) Right
- (4) Left
- (5) Up
- (6) Down
- (7) Points nowhere because it's zero

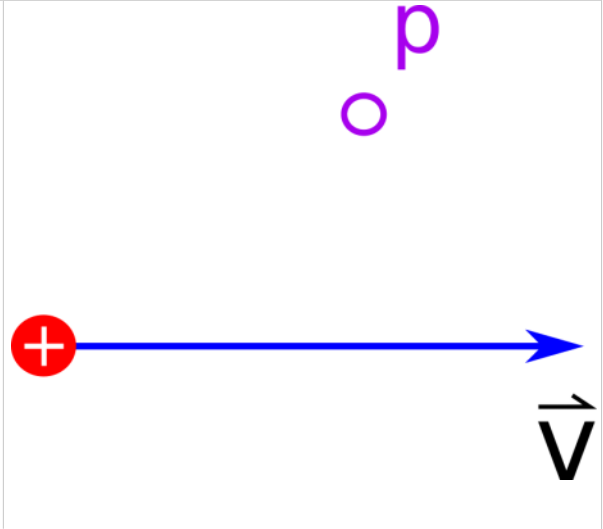
Act II: Magnetic Fields from Moving Charges

MF.L1.2-01:

Problem Statement: Consider a positive point charge with a velocity as shown below. What

is the direction of the magnetic field at the labeled point **P**?

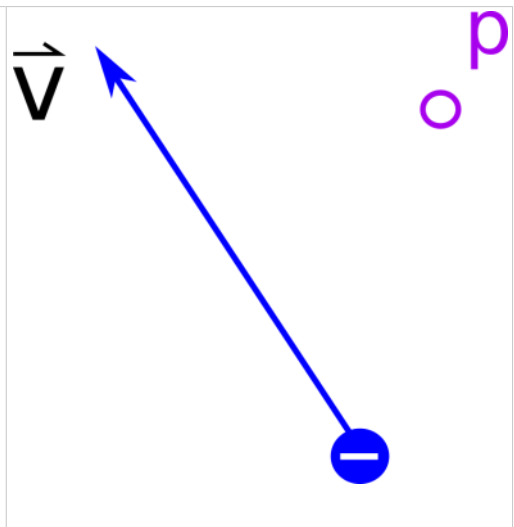
- (1) Into the page
- (2) Out of the page
- (3) Right
- (4) Left
- (5) Up
- (6) Down
- (7) Points nowhere because it's zero



MF.L1.2-01:

Problem Statement: Consider a negative point charge with a velocity as shown below. What is the direction of the magnetic field at the labeled point **P**?

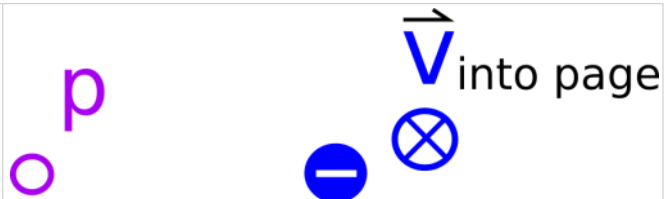
- (1) Into the page
- (2) Out of the page
- (3) Right
- (4) Left
- (5) Up
- (6) Down
- (7) Points nowhere because it's zero



MF.L1.2-01:

Problem Statement: Consider a negative point charge with a velocity as shown below. What is the direction of the magnetic field at the labeled point **P**?

- (1) Into the page
- (2) Out of the page
- (3) Right
- (4) Left
- (5) Up
- (6) Down
- (7) Points nowhere because it's zero

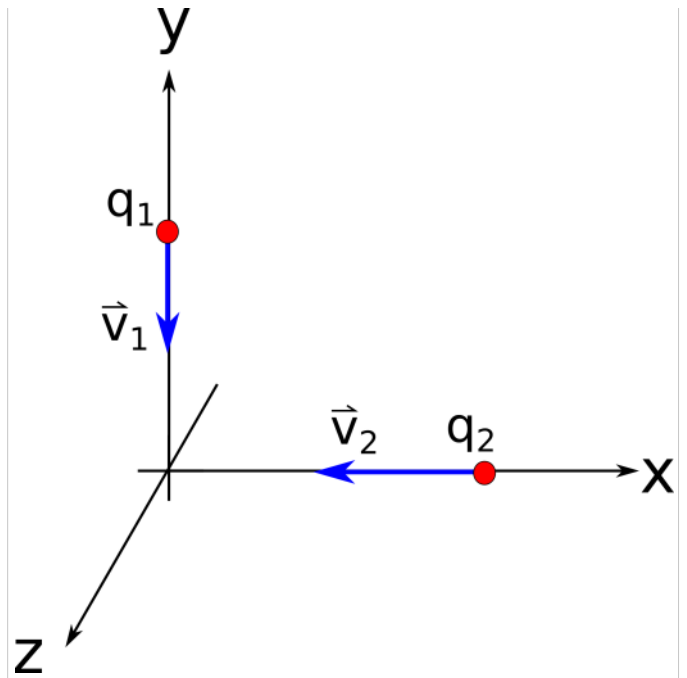


MF.L1.2-01:

Problem Statement: Suppose q_1 and q_2 are both positive charges.

(a) The magnetic field due to q_1 at the location of q_2 at this snapshot in time

- (1) points towards the + x direction.
- (2) points towards the + y direction.
- (3) points towards the + z direction.
- (4) points towards the - x direction.
- (5) points towards the - y direction.
- (6) points towards the - z direction.
- (7) points nowhere because it's zero.
- (8) points in some other direction.

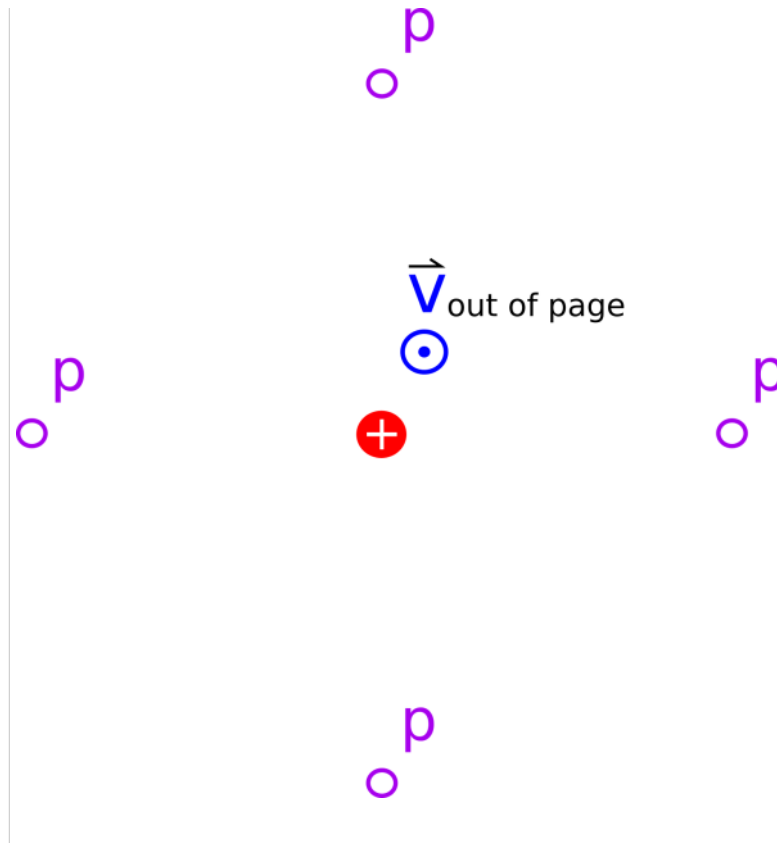


(b) The magnetic field due to q_2 at the location of q_1 at this snapshot in time

- (1) points towards the + x direction.
- (2) points towards the + y direction.
- (3) points towards the + z direction.
- (4) points towards the - x direction.
- (5) points towards the - y direction.
- (6) points towards the - z direction.
- (7) points nowhere because it's zero.
- (8) points in some other direction.

MF.L1.2-01:

Problem Statement: Consider a positive point charge with a velocity as shown below. Sketch the direction of the magnetic field at the multiple points **P**?



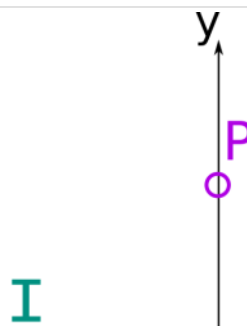
Simplification?

Act III: Magnetic Fields from Straight Current Carrying Wires

MF.L1.2-01:

Problem Statement: Consider a long thin straight wire carrying a current I as shown in the figure below. What is the direction of the magnetic field at the labeled point P ?

- (1) Into the page
- (2) Out of the page
- (3) Right
- (4) Left
- (5) Up
- (6) Down
- (7) Points nowhere because it's



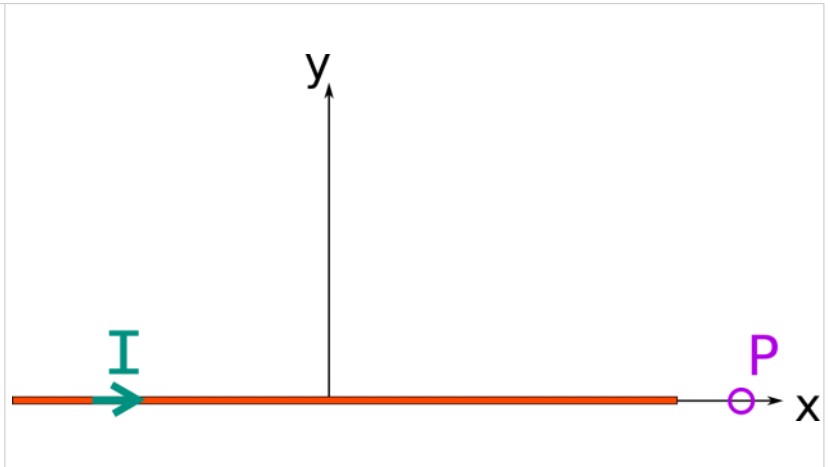
zero



MF.L1.2-01:

Problem Statement: Consider a long thin straight wire carrying a current I as shown in the figure below. What is the direction of the magnetic field at the labeled point P ?

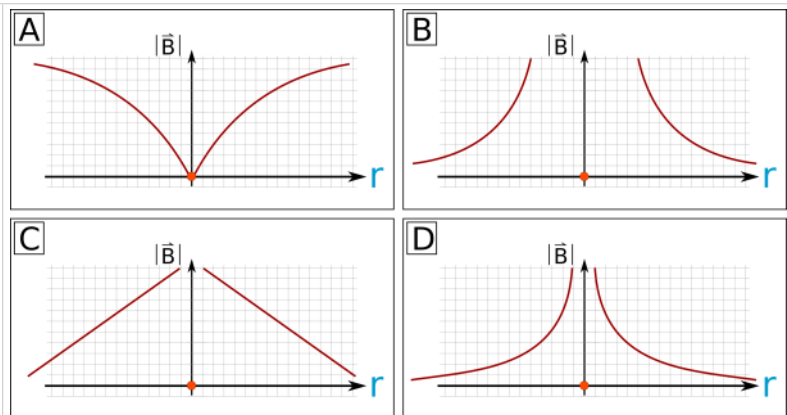
- (1) Into the page
- (2) Out of the page
- (3) Right
- (4) Left
- (5) Up
- (6) Down
- (7) Points nowhere because it's zero



MF.L1.2-01:

Problem Statement: A long thin straight wire carrying a current I is positioned into and out of the page as shown in the figure below. Which graph best represents the strength of the magnetic field as a function of the perpendicular distance r away from the wire?

- (1) A
- (2) B
- (3) C
- (4) D



MF.L1.2-01:

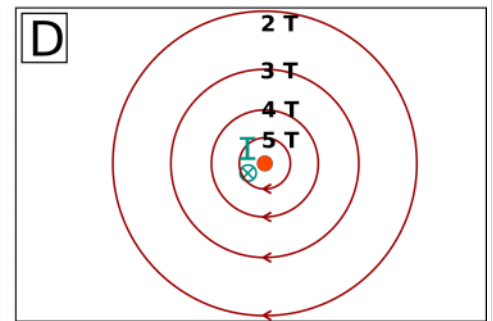
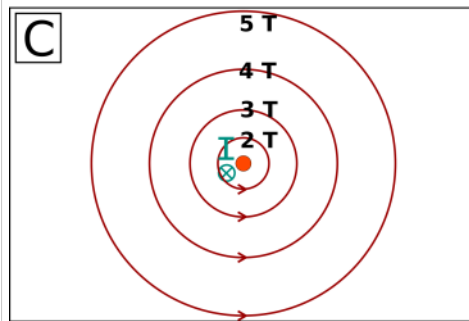
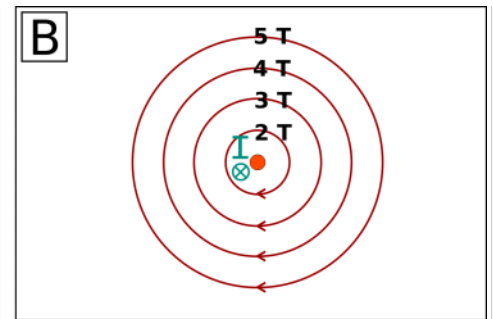
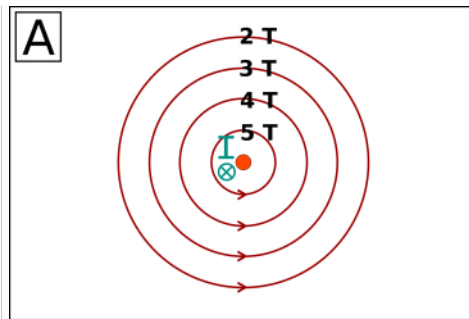
Problem Statement: A long thin straight wire carrying a current I creates a magnetic field with a strength of B at a location r away from it. What is the magnetic field at a location $3/5 r$ if the current is tripled?

- (1) B
- (2) $3/5 B$
- (3) $3 B$
- (4) $5/3 B$
- (5) $5 B$
- (6) $9/5 B$
- (7) $5/9 B$

MF.L1.2-01:

Problem Statement: A long thin straight wire carrying a current I is positioned into and out of the page as shown in the figure below. Which figure best represents the magnetic field lines created by the current carrying wire?

- (1) A
- (2) B
- (3) C
- (4) D

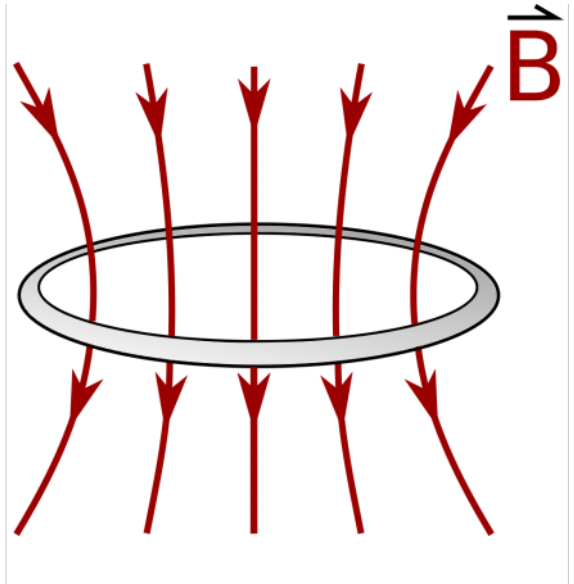


Act IV: Magnetic Fields from Loops Carrying Current

MF.L1.2-01:

Problem Statement: In which direction does the current travel in this loop as viewed from above? And which side is the north pole?

- (1) Current counterclockwise ; north pole on bottom.
- (2) Current counterclockwise ; north pole on top.
- (3) Current clockwise ; north pole on bottom.
- (4) Current clockwise ; north pole on top.



MF.L1.2-01:

Problem Statement: A current carrying loop of wire produces a magnetic field at the center of the loop of strength \mathbf{B} . The radius of the loop is \mathbf{R} . If the radius is quadrupled and the current halved, what is the new strength of the magnetic field at the center of the loop?

- (1) \mathbf{B}
- (2) $\frac{1}{2} \mathbf{B}$
- (3) $\frac{1}{4} \mathbf{B}$
- (4) $\frac{1}{8} \mathbf{B}$
- (5) $2 \mathbf{B}$
- (6) $4 \mathbf{B}$
- (7) $8 \mathbf{B}$

MF.L1.2-01:

Problem Statement: Given the current carrying loop of wire and magnetic field it produces, which figure is the alternative representation using the magnetic moment?

(1) A		A		B	
(2) B		C		D	
(3) C					
(4) D					

MF.L1.2-01:

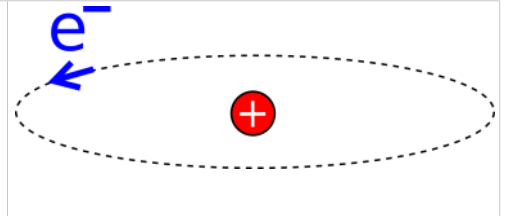
Problem Statement: Given the current carrying loop of wire and magnetic field it produces, which figure is the alternative representation using the magnetic moment?

(1) A		A		B	
(2) B		C		D	
(3) C					
(4) D					

MF.L1.2-01:

Problem Statement: In the classical model of the hydrogen atom, an electron moves in a circular orbit about the proton at the nucleus under the action of the electrical force. Assume that the electron is traveling in a counterclockwise direction when observed from above. The direction of the magnetic moment of the electron due to this orbital motion is

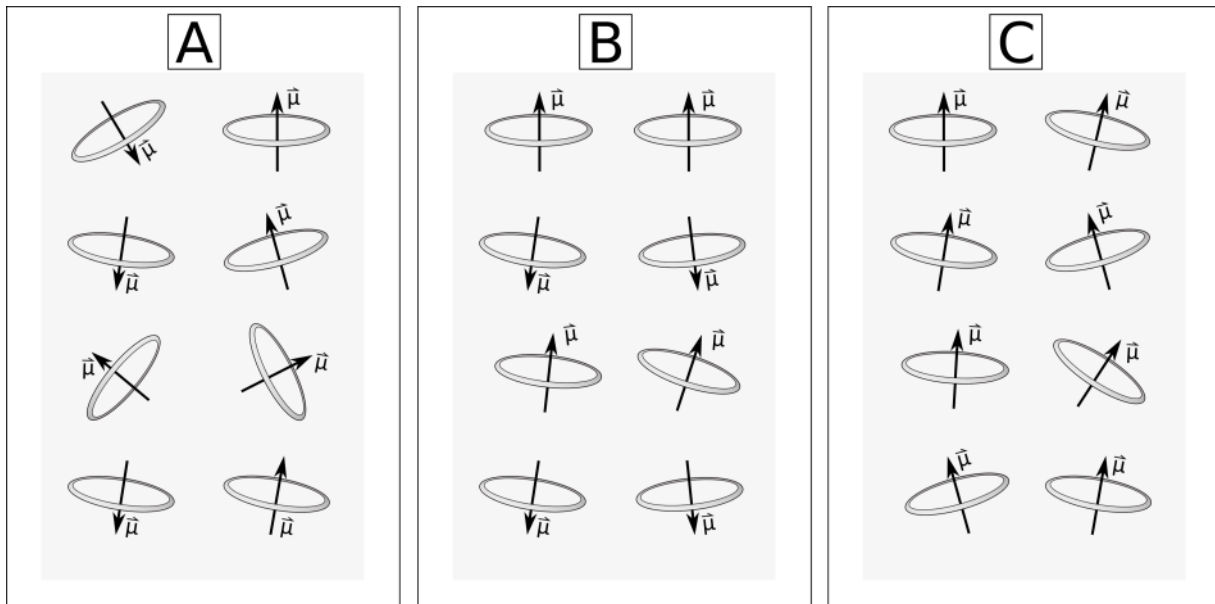
- (1) up
- (2) down
- (3) points in the plane of the orbit
- (4) not specified by the information given



Act V: Magnetism and Magnets

MF.L1.2-01:

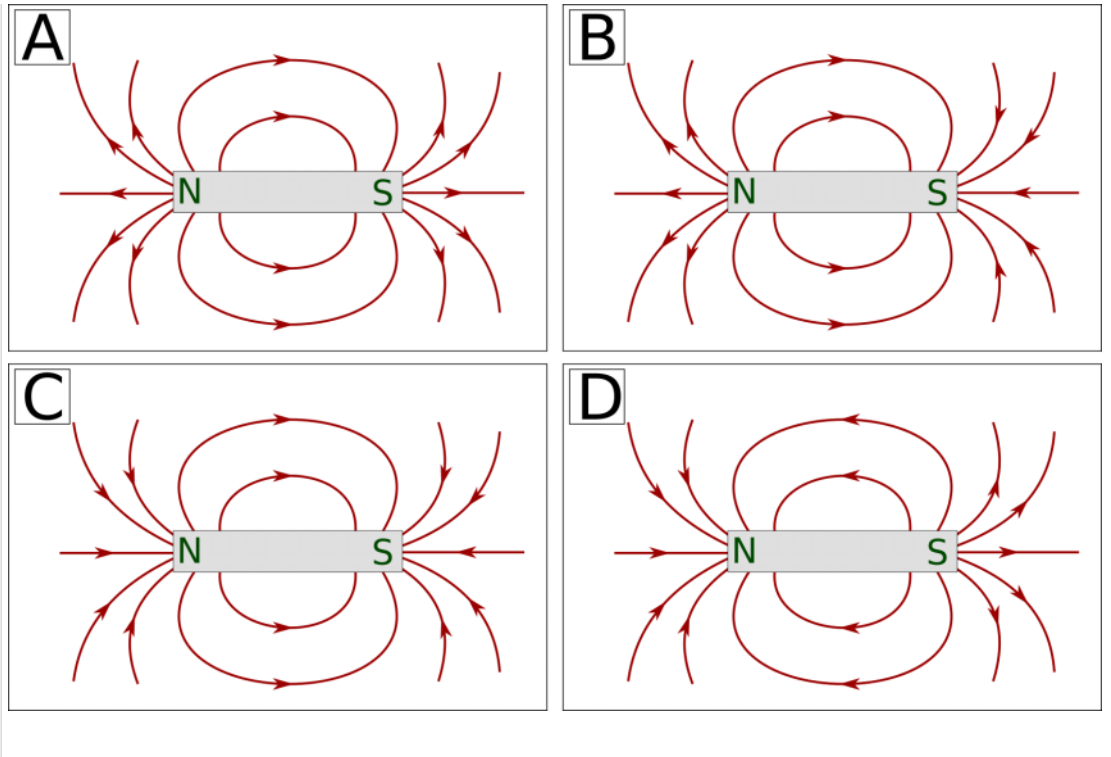
Problem Statement: Which of the following figures best represents the magnetic field created by a permanent magnet.



MF.L1.2-01:

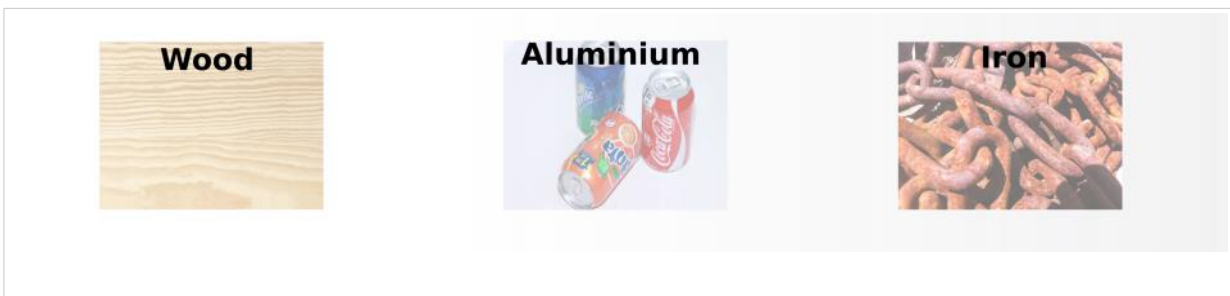
Problem Statement: Which of the following figures best represents the magnetic field created by a permanent magnet.

- (1) A
- (2) B
- (3) C
- (4) D



MF.L1.2-01:

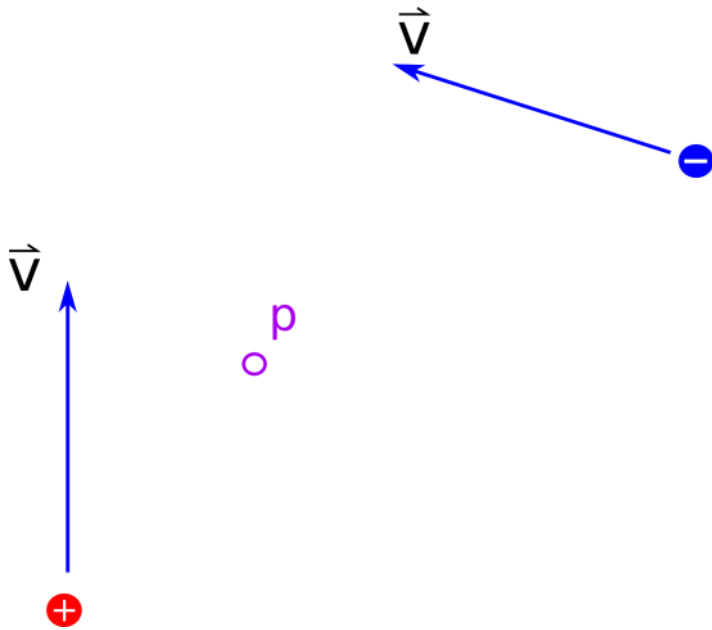
Problem Statement: With your neighbors, discuss the magnetic properties of the materials shown below.



Act VI: Superposition and Symmetry

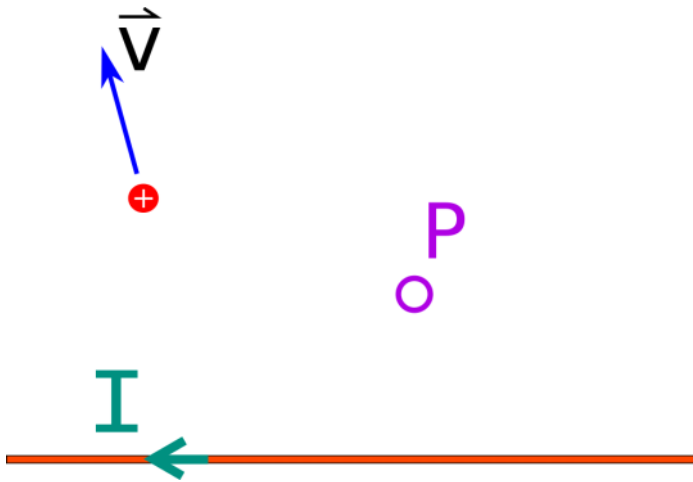
MF.L1.2-01:

Problem Statement: What is the direction of the magnetic field at point P?



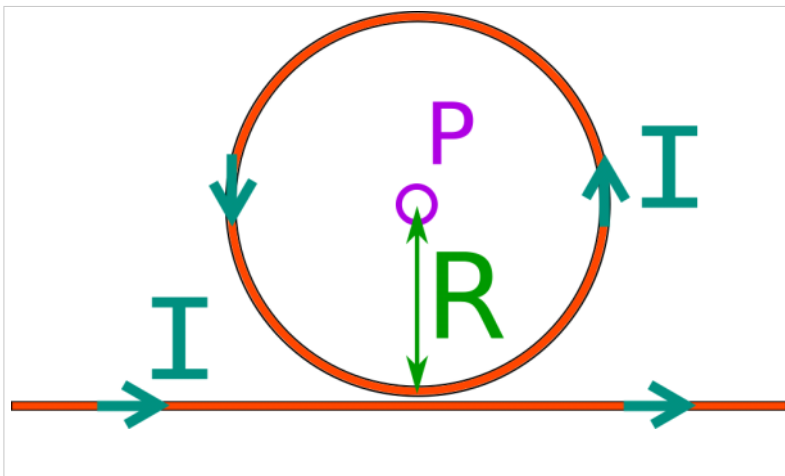
MF.L1.2-01:

Problem Statement: What is the direction of the magnetic field at point P?



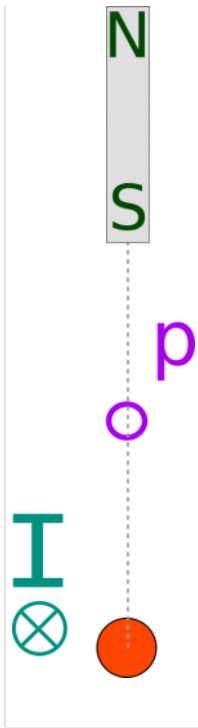
MF.L1.2-01:

Problem Statement: What is the direction of the magnetic field at point P?



MF.L1.2-01:

Problem Statement: What is the direction of the magnetic field at point P?



MF.L1.2-01:

Problem Statement: What is the direction of the magnetic field at point P?

