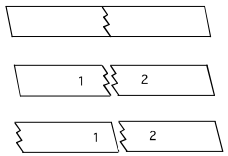
A permanent bar magnet is broken in half. One of the pieces is reversed, as shown. Do the pieces attract or repel?



A) attract

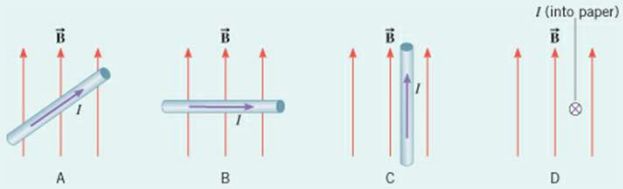
B) repel

Conceptual Example

At each of the labeled points above, in which direction A–E will a compass point?

A. B. C. D. E. $\vec{B} = 0$.

12. The same current-carrying wire is placed in the same magnetic field $\vec{B}$ in four different orientations (see the drawing). Rank the orientations according to the magnitude of the magnetic force exerted on the wire, largest to smallest.



The wire will feel a force (and thus will "jump")…

A) to the right, →

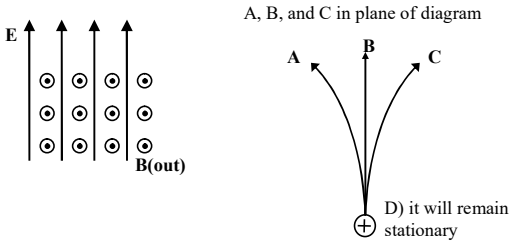
B) to the left, ←

C) toward the board, ⊗

D) away from the board, ⊙

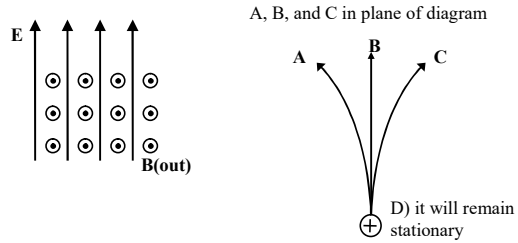
E) None of these

A positive particle is released from rest in a region of space where there is constant, uniform, electric field **E**, and a constant, uniform magnetic field **B**. The electric field points up and the magnetic field points out of the page in the diagram below. Which path will the positive particle follow?



E) it move out of the plane of the page

A positive particle is released from rest in a region of space where there is constant, uniform, electric field **E**, and a constant, uniform magnetic field **B**. The electric field points up and the magnetic field points out of the page in the diagram below. The work done by the ***magnetic*** field on the particle is…



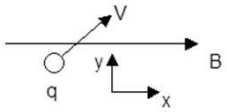
A) positive

B) negative

C) zero

E) it move out of the plane of the page

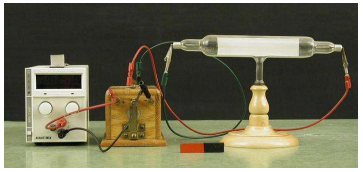
At time t_0, a particle with charge q has instantaneous velocity $\vec{v}$ as shown and is moving in a uniform magnetic field. Is the following statement true or false? *As time increases, the x-component of the velocity, v_x, remains constant.*



A) True

B) False

When the B field points INTO the board, what's the direction of the force on the electrons? Note: the electrons are moving left to right through the tube.



A) Left (←)

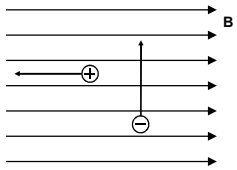
B) Up (↑)

C) Down (↓)

D) Into the board (⊗)

E) Out of the board (⊙)

A negative particle and a positive particle are moving with given velocities in a constant, uniform magnetic field **B**, as shown. The direction of the **B**-field is to the right. The (+) particle is moving directly left; the (–) particle is moving directly up. The force on the negative particle due to the B-field is…



A) into the screen (⊗)

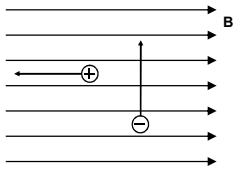
B) out of the screen (⊙)

C) zero

D) right (→)

E) left (←)

A negative particle and a positive particle are moving with given velocities in a constant, uniform magnetic field **B**, as shown. The direction of the **B**-field is to the right. The (+) particle is moving directly left; the (–) particle is moving directly up. The force on the positive particle due to the B-field is…



A) into the screen (⊗)

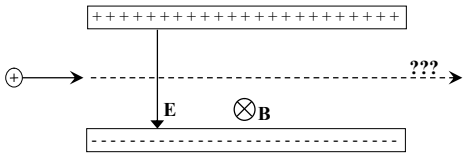
B) out of the screen (⊙)

C) zero

D) right (→)

E) left (←)

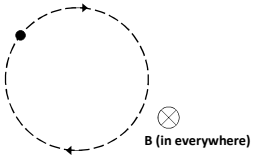
The **E**- and **B**-fields of the velocity selector are adjusted so that protons with a certain speed v pass through undeflected. Now electrons with the same speed are shot into the velocity selector (with same **E**- and **B**-fields as before). Do the electrons also pass through undeflected?



A) Yes, the electrons go straight through

B) No, the electrons' paths are bent

A particle is observed to be moving clockwise in a circle in a uniform B-field pointing into page, as shown. The charge of the particle is ..



A) Positive

B) Negative

C) Impossible to tell from the info given

Two particles with the same charge but different masses are moving in circular orbits in a magnetic field. They have the same speed. Which one will have the larger radius orbit?

A) Neither, the orbits have the same size

B) The larger mass particle will have a larger orbit

C) The smaller mass particle will have a larger orbit

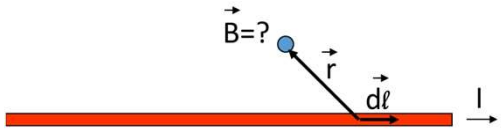
Particle A has twice the charge and four times the mass of particle B. Suppose A and B have the same kinetic energy and move perpendicular to a constant magnetic field. Which particle moves in the smallest circle? (Hint: KE can be expressed as $\mathrm{KE} = \frac{1}{2}mv^2 = \frac{p^2}{2m}$.)

A) Particle A moves in a smaller circle

B) Particle B moves in a smaller circle

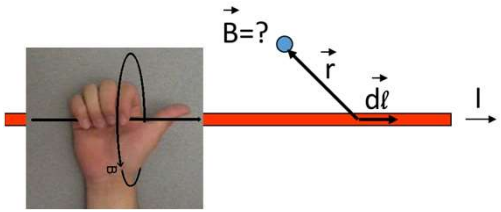
C) Particles A and B move in circles of the same radius.

A long wire has a current. What is the direction of the B-field created by the wire, just above?



A) ⊙
B) ⊗
C) →
D) ↓
E) other

A long wire has a current. What is the direction of the B-field created by the wire, just above?

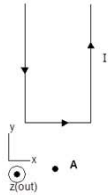


A) ⊙
B) ⊗
C) →
D) ↓
E) other

Point P is 5 cm above the wire as you look straight down at it. In which direction is the magnetic field at P?

A. × B. • C. ↑ D. ↓ E. →

A long U-shaped wire carries a current I in the sense shown. Consider the magnetic field B at the point A, which is equi-distant from the two corners of the U and in the same plane as the U. Which one of the following statements is true?



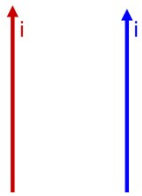
A) B has a z-component only which is due entirely to the bottom segment of the U

B) B has a z-component only which has contributions from the bottom and sides of the U

C) B has a non-zero x-component, as well as a z-component

D) B has a non-zero y-component, as well as a z-component

What is the direction of the B field created by the red wire (the one on the left) in the vicinity of the blue wire (the one on the right)?



A) Up

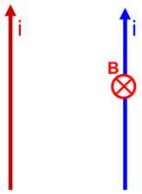
B) Right

C) Left

D) Into the board

E) Out of the board

What is the direction of the force acting on the blue wire (the one on the right)?



A) Up

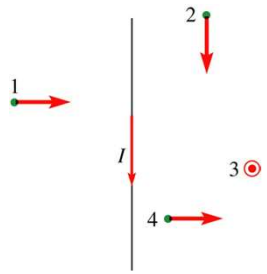
B) Right

C) Left

D) Into the board

E) Out of the board

A wire carries a current as shown. Charged particles at points 1, 2, 3, and 4 move in the directions indicated. What is the direction of the magnetic force on charge 2 if q2 < 0?



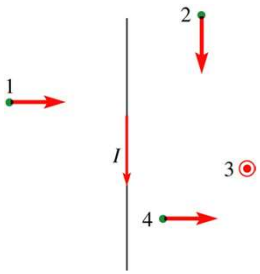
A) To the right

B) To the left

C) Into the page

D) Out of the page

A wire carries a current as shown. Charged particles at points 1, 2, 3, and 4 move in the directions indicated. What is the direction of the magnetic force on charge 1 if q1 > 0?



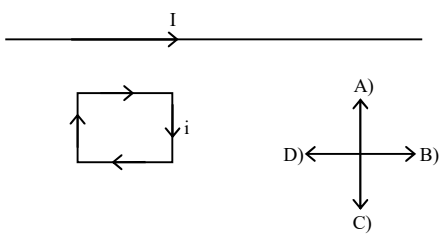
A) Up

B) Down

C) Into the page

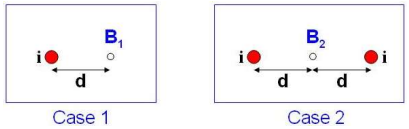
D) Out of the page

A rectangular loop of wire is carrying a current i in the clockwise direction and is near a long straight wire carrying a current I, as shown. What is the direction of the net force on the rectangular loop, due to the B-field from the long, straight wire.



E) Net force is zero

The magnitude of the magnetic field at a point a distance d to the right of a long straight wire carrying current i out of the plane of the page is B_1 (Case 1 - the red dot represents the wire). Suppose a second current carrying wire identical to the first is placed the same distance to the right of the point (Case 2). Which statement is true about the magnitude of the net field in Case 2?

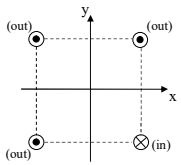


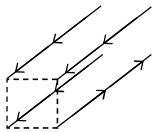
A) $B_2 = B_1$

B) $B_2 > B_1$

C) $B_2 < B_1$

4 parallel wires each carry a current I. Three of the wires carry current out the page, one carries current into the page, as shown. What is the direction of the B-field at the **center** of the square?





B)

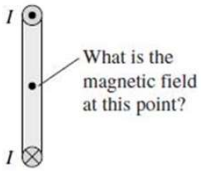
C)

D)

E) None of these

Hint:

The diagram below shows a current loop perpendicular to the page; the view is a "slice" through the loop. The direction of the current in the wire at the top and the bottom is shown. What is the direction of the magnetic field at a point in the center of the loop?



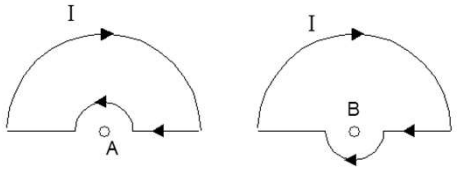
A) To the left

B) Up

C) To the right

D) Down

Which point has the the larger magnetic field?

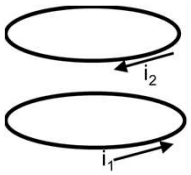


A) A

B) B

C) The field is the same at both A and B

Two loops of wire have current going around in opposite directions. The forces between the loops are:

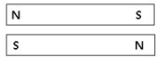


A) Attractive

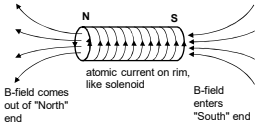
B) Repulsive

C) Zero

Two bar magnets are brought near each other as shown. The magnets…



Hint:

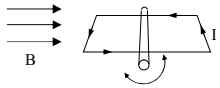


A) attract

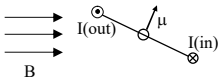
B) repel

C) exert no net force on each other

A square loop of wire carrying current I is a uniform magnetic field and it can rotate about an axis, as shown:



Seen from along the axis of rotation, the loop is tilted relative to the B-field as shown:



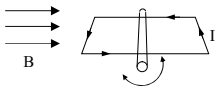
The magnetic forces on the loop from the B-field ...

A) Will cause the loop to rotate counter-clockwise

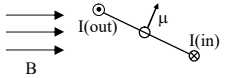
B) Will cause the loop to rotate clockwise

C) Will not cause the loop to rotate

A square loop of wire carrying current I is a uniform magnetic field and it can rotate about an axis, as shown:



Seen from along the axis of rotation, the loop is tilted relative to the B-field as shown:



The direction of the torque on the loop is...

A) Into the page

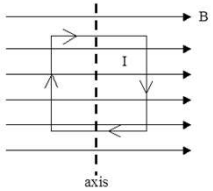
B) Out of the page

C) To the right

D) To the left

E) None of these

A coil of wire carrying current I can rotate freely about an axis in a magnetic field. If released from rest in the position shown, which way does it rotate?

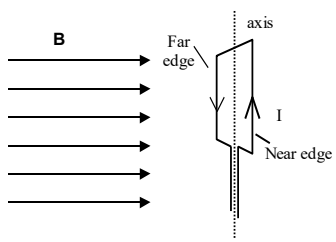


A) The right side will move out of the page

B) The left side will move out of the page

C) The loop will not rotate at all

A square loop of wire carrying a current I, is in a constant uniform magnetic field B. The magnetic field is perpendicular to the plane of the loop. The loop can rotate freely about the axis. The loop tends to rotate so that the near edge moves…

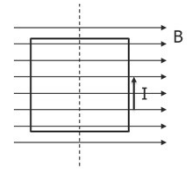


A) To the right

B) To the left

C) The net torque on the loop is zero, so it does not tend to move.

A current loop is placed in a magnetic field as indicated. Will the loop tend to rotate clockwise, counter-clockwise, or not at all about a vertical axis (viewed from the top)?

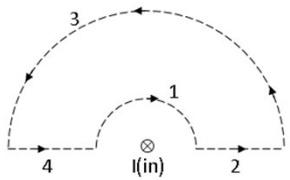


A) Clockwise

B) Counter-clockwise

C) Not at all

The imaginary loop near a wire with current I has 4 segments labeled 1, 2, 3, and 4, as shown. What is $\int \vec{\boldsymbol{B}} \cdot \vec{\boldsymbol{dl}}$ for each of the segments? For 1, 2, 3, 4, the line integral is…



A) +, +, 0, -

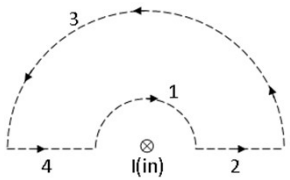
B) 0, +, -, 0

C) +, 0, -, 0

D) +, 0, +, 0

E) none of these

Let the inner radius be r_1 and the outer radius be r_2. Compute $\oint_{loop} \vec{\boldsymbol{B}} \cdot \vec{\boldsymbol{dl}}$



A) $\frac{\mu_0 I}{2\pi r_1} - \frac{\mu_0 I}{2\pi r_2}$

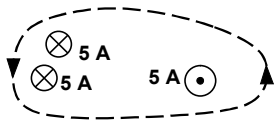
B) $\frac{\mu_0 I}{\pi(r_1+r_2)}$

C) $\mu_0 I$

D) zero

E) none of these

We need a sign convention for I_{encl}. Place the fingers of your right hand around the imaginary loop and your thumb points in the direction of positive I_{encl}. What is I_{encl} here, where all three wires have 5 A?



A) +15 A

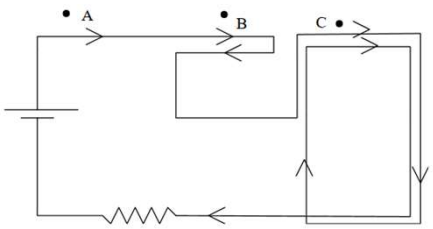
B) -10 A

C) +10 A

D) -5 A

E) none of these

Rank the magnitudes of the magnetic field at the three points shown



A) A > B > C

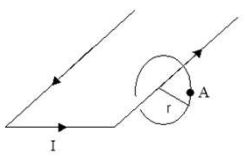
B) C > B > A

C) B > C > A

D) A > C > B

E) None of these

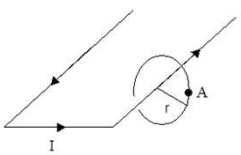
A long U-shaped wire carries a current I in the sense shown. Consider the (imaginary) loop of radius r centered on the right side of the U as shown. True or False? For the loop shown, $\oint \vec{\boldsymbol{B}} \cdot d\vec{\boldsymbol{l}} = \mu_0 I$.



A) True

B) False

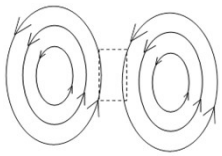
A long U-shaped wire carries a current I in the sense shown. Consider the (imaginary) loop of radius r centered on the right side of the U as shown. True or False? At point A, the magnitude of the magnetic field is $\frac{\mu_0 I}{2\pi r}$



A) True

B) False

Consider the following configuration of B-field lines (solid lines) and the imaginary rectangular loop (dotted line). Which one of the following statements is true?

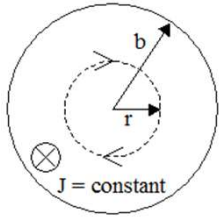


A) There must be a non-zero current going through the imaginary loop into the page

B) There must be a non-zero current going through the imaginary loop out of the page

C) There is no current going through the imaginary loop

A long straight copper wire has radius b and carries a constant current of magnitude I. The current density of magnitude $J = \frac{I}{\pi b^2}$ is uniform throughout the wire. What is the current enclosed in the dashed *Amperian* loop, with radius r?



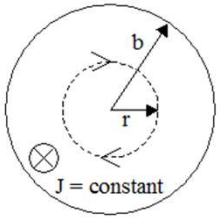
A) $\frac{r}{b} I$

B) $\left(\frac{r}{b}\right)^2 I$

C) $\left(\frac{r}{b}\right)^3 I$

D) none of these

How does the magnitude of the B-field a distance r < b from the center of the wire depend on r?



A) $B \propto r$

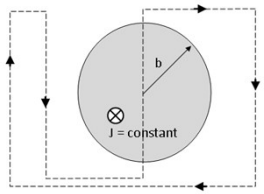
B) $B = const$

C) $B \propto 1/r$

D) $B \propto 1/r^2$

E) none of these

For the dashed *Amperian* loop shown, compute $\oint_{loop} \vec{\boldsymbol{B}} \cdot \vec{\boldsymbol{dl}}$



A) $= \mu_0 I/2$

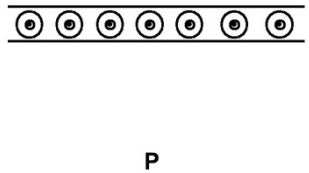
B) $> \mu_0 I/2$, but $< \mu_0 I$

C) $< \mu_0 I/2$

D) $= \mu_0\, I$

E) None of these

An infinite sheet of current coming out of the board produces a magnetic field pointing in what direction at point P?



A) ←

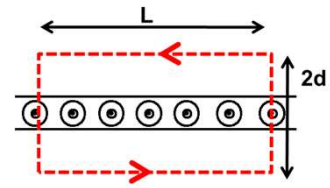
B) →

C) ↑

D) ↓

E) None of these

Suppose the current per unit length is λ A/m. How much current is encircled by the Amperian Loop?



A) λL

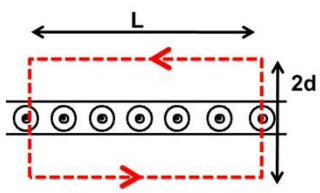
B) λd

C) $2\lambda L$

D) $2\lambda d$

E) zero

Use symmetry to simplify the loop integral $\oint_{loop} \vec{\boldsymbol{B}} \cdot \vec{\boldsymbol{dl}}$



A) $\mathrm{B}Ld$

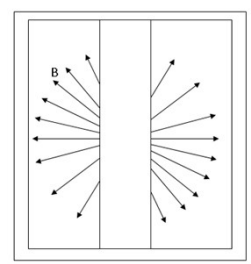
B) $4\mathrm{B}Ld$

C) $2\mathrm{B}L$

D) BL

E) none of these

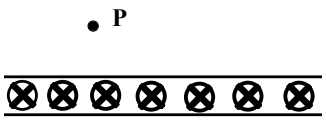
The (perhaps incorrect) magnetic field lines around an object are partly obscured by a screen. Is this partial field line diagram possible?



A) Yes

B) No

Now take an identical infinite sheet of current, except the current runs AWAY from you. What is the B field at a point P above the sheet?



A) ←

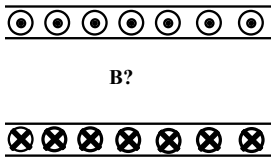
B) →

C) ↑

D) ↓

E) None of these

What is the direction of the B field in the region between the sheets?



A) ←

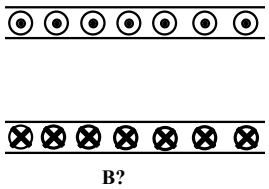
B) →

C) ↑

D) ↓

E) None of these

What is the direction of the B field in the region below both sheets?



A) ←

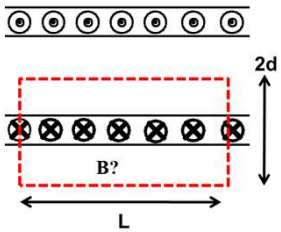
B) →

C) ↑

D) ↓

E) None of these

How much current is encircled by the Amperian loop?



A) λL

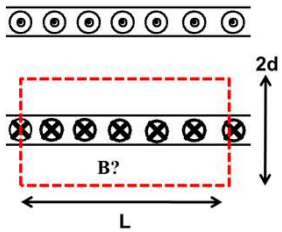
B) λd

C) $2\lambda L$

D) $2\lambda d$

E) zero

What is the loop integral $\oint_{loop} \vec{\boldsymbol{B}} \cdot \vec{\boldsymbol{dl}}$ equal to?



A) $\mathrm{B}Ld$

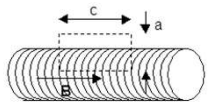
B) $4\mathrm{B}Ld$

C) $2\mathrm{B}L$

D) BL

E) none of these

A long solenoid with many turns per length has a uniform magnetic field B within its interior. Consider the imaginary rectangular path of length c and width a with one edge entirely within the solenoid as shown. Use symmetry to simplify the LHS of Ampere's Law: $\oint \vec{\boldsymbol{B}} \cdot d\vec{\boldsymbol{l}} = \cdots?$



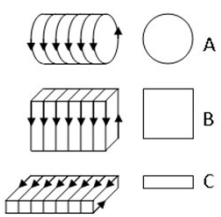
A) Bc

B) $2B(c+a)$

C) $2Bc$

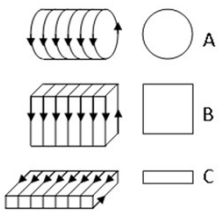
D) None of these

Three long straight solenoids all of length L and all with the same (large) number of closely-packed turns N, all with the same current I, have different cross-sections as shown. Which solenoid has the largest field B at its center?



or D) All three have the same field

True or False: All three solenoids have uniform B-fields in their interiors



A) True

B) False