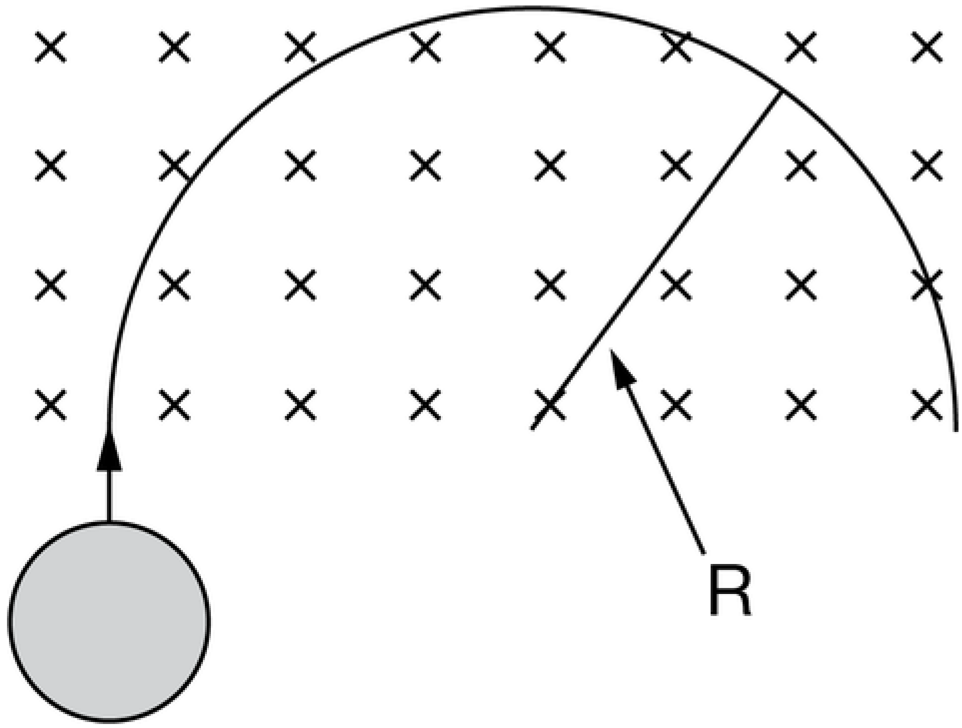
Advanced Physics Term 2 Practice: Charges in B Fields

1.



A charged particle of mass m and charge q is injected into a region of uniform magnetic field, directed into the page as shown above. The speed of the particle as it enters the field is v, and it travels in a circular path of radius R_1. A second particle of mass $2m$, charge q, and speed v is then injected into the field. It moves in a circular path of radius R_2. Which of the following represents the correct relationship between R_1 and R_2?

(A) $R_2 = R_1$

(B) $R_2 = \frac{1}{2}R_1$

(C) $R_2 = 2R_1$

(D) $R_2 = 4R_1$

(E) $R_2 = \frac{1}{4}R_1$

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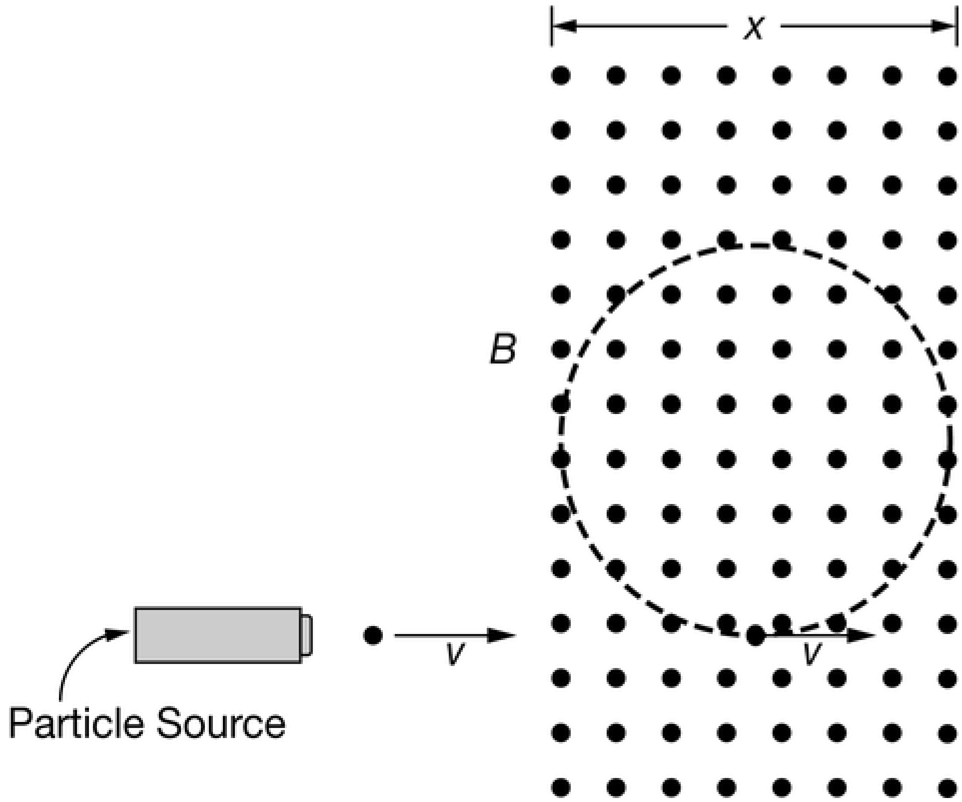
2.



Scientists set up an experiment as shown above. Charged particles of mass m and charge q are emitted from a source and initially move with a constant velocity, v. The scientists wish to temporarily confine the particles in a uniform magnetic field, B. The region of the magnetic field has a horizontal range x. To confine the particles, the scientists switch on the magnetic field at the moment when the particles reach the center of its horizontal range. Which of the following is a correct prediction of the results of the experiment?

(A) If the scientists set $B > \frac{2mv}{qx}$, then the particle will be confined to the field.

(B) If the scientists set $B > \frac{2mv}{qx}$, then the particle will not be confined to the field.

(C) If the scientists set $B > \frac{mv}{qx}$, then the particle will be confined to the field.

(D) If the scientists set $B < \frac{mv}{2qx}$, then the particle will be confined to the field.

(E) If the scientists set $B = \frac{mv}{2qx}$, then the particle will be confined to the field.

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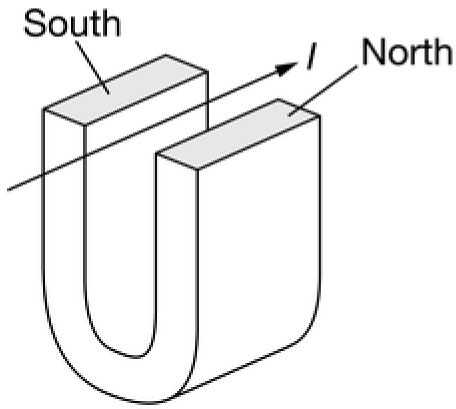
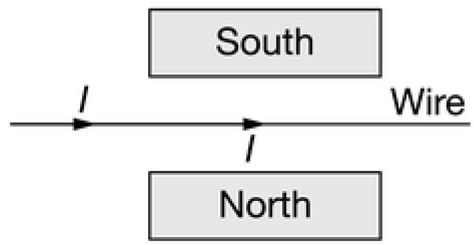
3.





An experiment is set up with a copper wire placed between the poles of a U-shaped magnet, as shown above. A current I is applied to the wire in the direction shown. Which of the following statements correctly predicts the resulting force on the wire and states why?

(A) The magnetic force will push the wire down as predicted by Ohm’s law.

(B) The magnetic force will push the wire down as predicted by definition of the magnetic force on a current-carrying wire.

(C) The magnetic force will push the wire up as predicted by Ohm’s law.

(D) The magnetic force will push the wire up as predicted by definition of the magnetic force on a current-carrying wire.

(E) The magnetic force on the wire will be zero as predicted by the fact that the cross-product is zero for the equation for a force on a current-carrying wire.

4. Correct statements about a constant magnetic field acting on a charged particle include which of the following?

I. The field can accelerate the particle.

II. The field can change the kinetic energy of the particle.

III. The field can do positive work on the particle.

(A) I only

(B) III only

(C) I and II only

(D) II and III only

(E) I, II, and III

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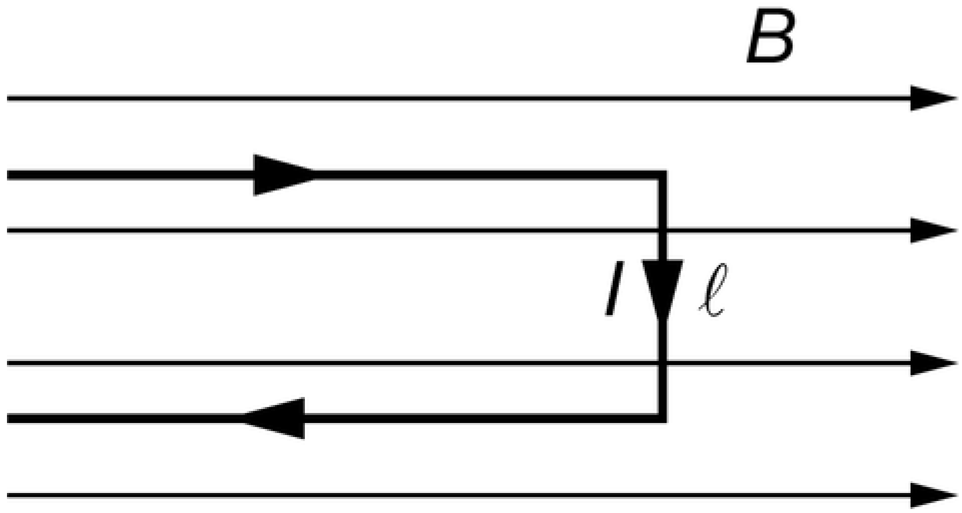
5.



In an experiment, a wire with current I is placed in a uniform magnetic field of magnitude B directed to the right, as shown in the figure. The end segment of the wire has length L and is perpendicular to the magnetic field. The experiment is modified so that the direction of the magnetic field is rotated 10° such that a component of the field is now directed out of the page. The magnetic field is still perpendicular to the end segment. Which of the following statements correctly describes the change in the magnetic force on the end segment of the wire?

(A) The magnitude will not change, and the direction will not change.

(B) The magnitude will decrease, and the direction will not change.

(C) The magnitude will not change, and the direction will change by 10°.

(D) The magnitude will decrease, and the direction will change by 10°.

(E) The magnitude will increase, and the direction will change by 10°.

6. A long, straight horizontal wire carrying a current $2.0\ \mathrm{A}$ is in a region with a $5.0 \times 10^{-5}\ \mathrm{T}$ magnetic field that is directed at an angle of 58° below the horizontal. What is the magnitude of the magnetic force per unit length exerted on the current-carrying wire?

(A) $0.5 \times 10^{-4}\ \frac{\mathrm{N}}{\mathrm{m}}$

(B) $0.85 \times 10^{-4}\ \frac{\mathrm{N}}{\mathrm{m}}$

(C) $1.0 \times 10^{-4}\ \frac{\mathrm{N}}{\mathrm{m}}$

(D) $1.2 \times 10^{-4}\ \frac{\mathrm{N}}{\mathrm{m}}$

(E) $1.9 \times 10^{-4}\ \frac{\mathrm{N}}{\mathrm{m}}$

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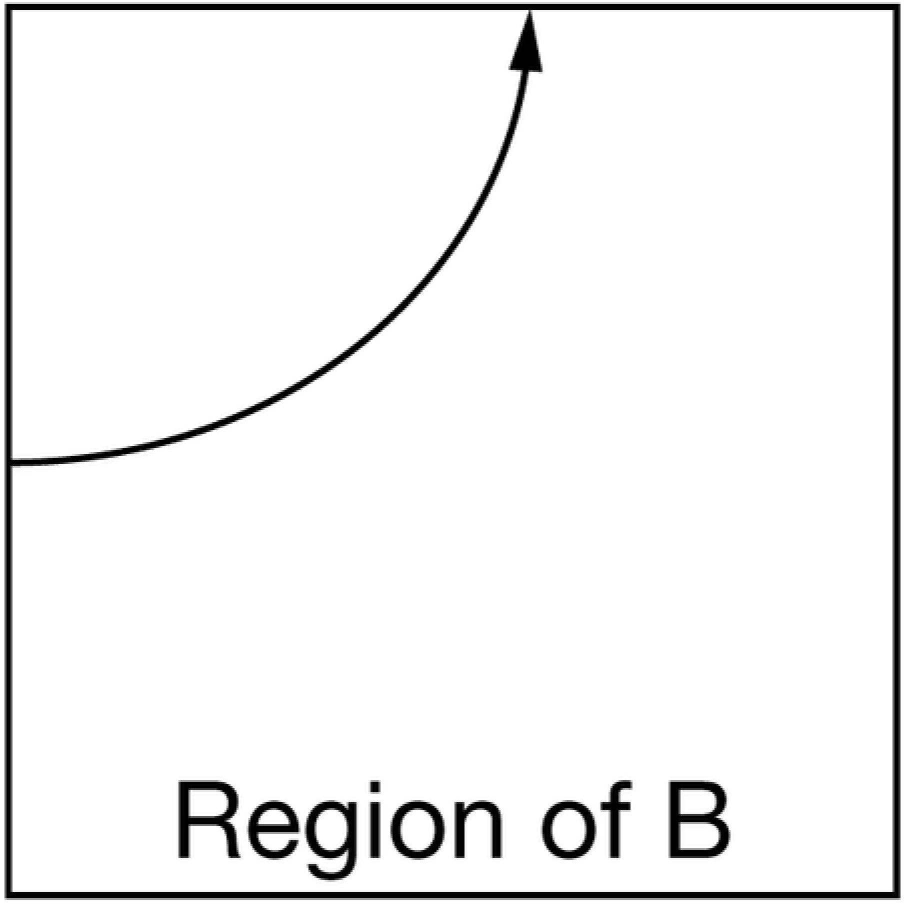
7.



Students want to find the direction of a uniform magnetic field in their experimental setup. They direct electrons from the left side of the page into the setup and observe that the path of the electrons curves toward the top of the page, as shown above. Which is the correct prediction for the direction of the magnetic field in this region?

(A) Into the page

(B) Out of the page

(C) Toward the top of the page

(D) Toward the bottom of the page

(E) Toward the left side of the page

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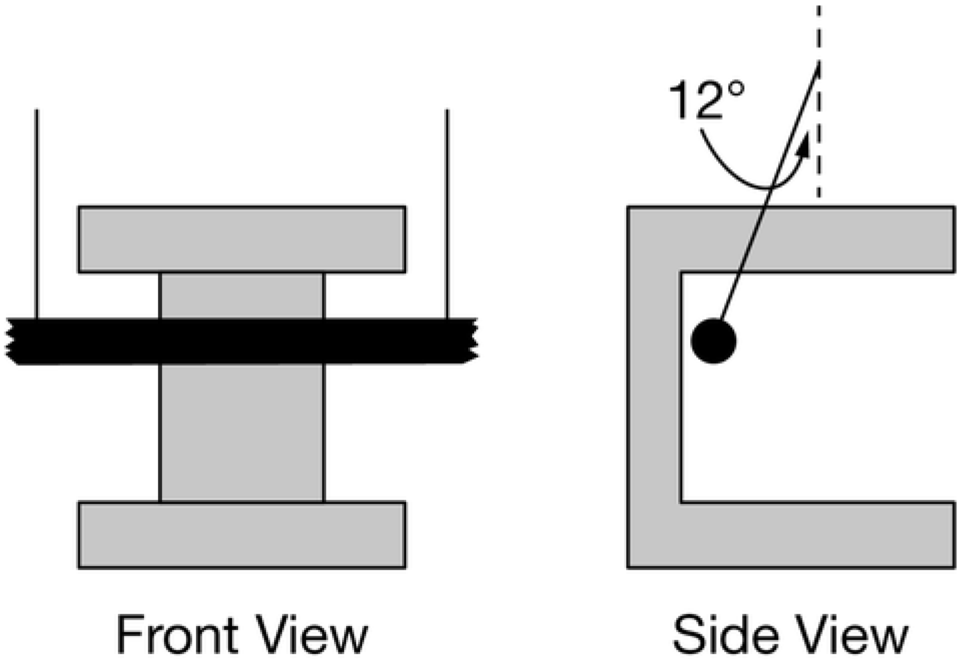
8.



Note: Figures not drawn to scale.

A current-carrying wire is suspended between the poles of a permanent magnet by light strings, as shown in the front view figure. When the wire carries a current of $3\ \mathrm{mA}$, the string makes a 12° angle with the vertical, as shown in the side view figure. The length of the wire within the region of the magnetic field is $10\ \mathrm{cm}$. Which of the following quantities should a student measure to determine the magnitude of the magnetic field between the poles of the magnet?

I. Vertical distance between the poles of the magnet
II. Mass of the wire
III. Length of the supporting strings

(A) I only

(B) II only

(C) III only

(D) I and II only

(E) I, II, and III

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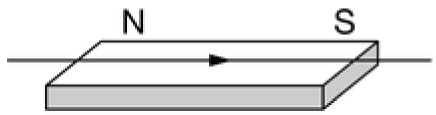
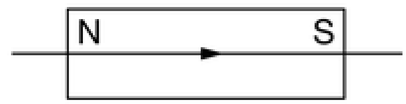
9.





In an experiment, a student lays a copper wire parallel to and on top of a dipole magnet, as shown in the figure. The student then allows a current to travel through the wire in the direction indicated in the figure. Which of the following claims is correct regarding the effect that the magnet has on the wire once the current flows through the circuit and provides appropriate reasoning?

(A) The wire will be attracted toward the magnet, because the magnetic force exerted on the wire is toward the magnet.

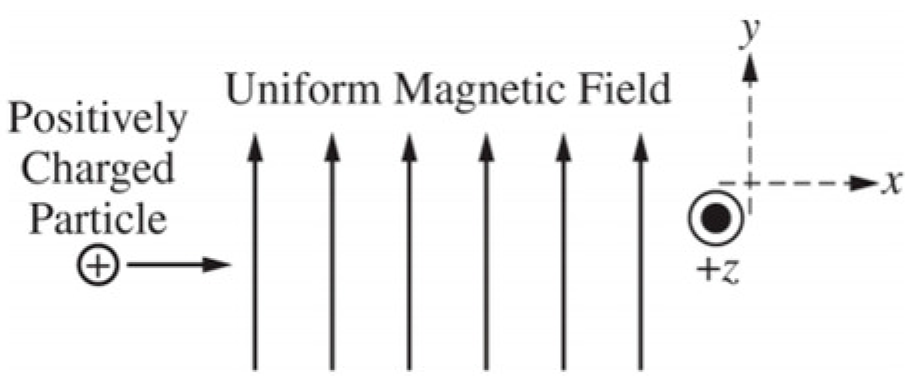
(B) The wire will be repelled from the magnet because the magnetic force exerted on the wire is away from the magnet.

(C) The wire will rotate clockwise, because the force that the magnet exerts on opposite ends of the wire are in opposite directions.

(D) The wire will rotate counterclockwise, because the force that the magnet exerts on opposite ends of the wire are in opposite directions.

(E) There will be no effect on the wire, because the magnetic field is parallel to the direction of the current that travels through the wire.

10.



A positively charged particle moves in the positive x-direction in a uniform magnetic field directed in the positive y-direction. The net force on the particle could be zero if there is also an electric field present in the

(A) positive z-direction

(B) negative z-direction

(C) positive x-direction

(D) negative x-direction

(E) negative y-direction

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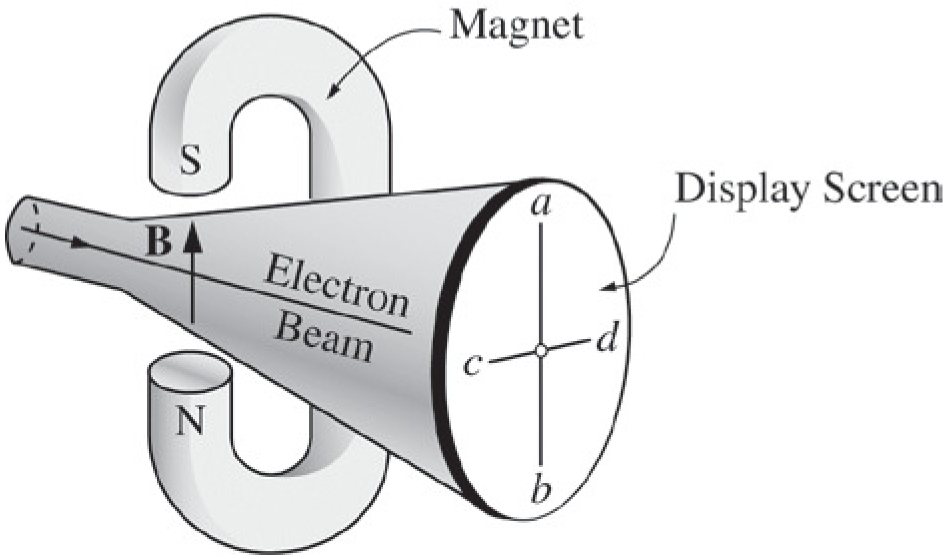
11.



A horizontal electron beam in an oscilloscope is aimed at the center of the display screen, as shown in the diagram above. A C-shaped magnet is placed around the oscilloscope, producing a vertical magnetic field **B**, which is perpendicular to the beam. Which way, if any, will the beam be deflected by the magnetic field?

(A) Toward point *a*

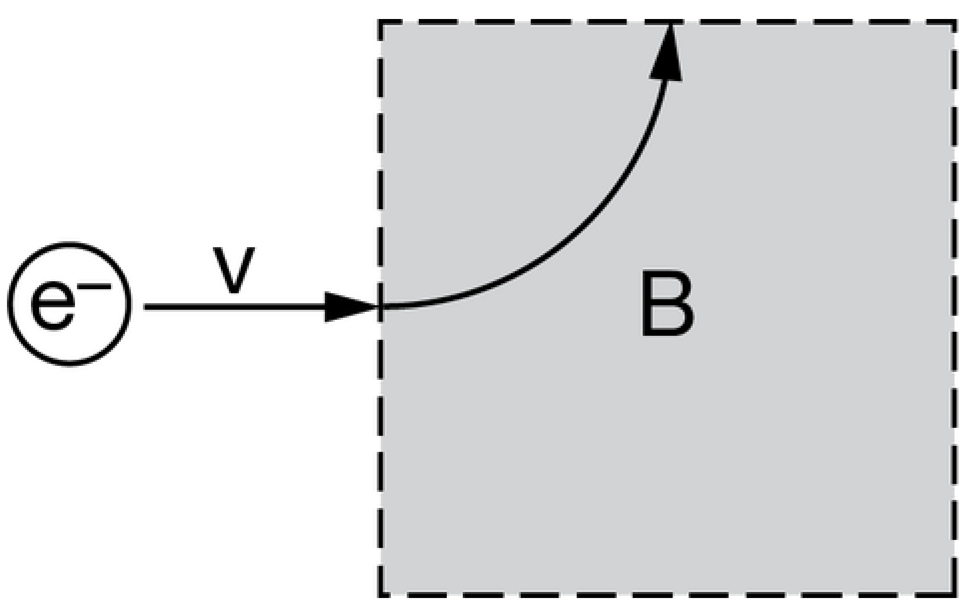
(B) Toward point *b*

(C) Toward point *c*

(D) Toward point *d*

(E) The beam will not be deflected.

12.



An electron enters a region that contains a uniform magnetic field. The electron is deflected in the direction that is shown in the figure. Which of the following represents the direction of the magnetic field and provides supporting evidence?

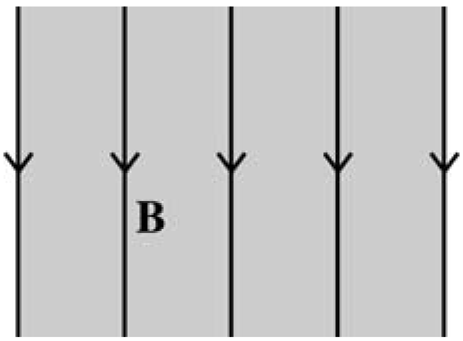
(A) The magnetic field is toward the top of the page, because the electron is deflected toward the top of the page.

(B) The magnetic field is into the page, because setting $\frac{mv^2}{r} = qvB$ indicates that the centripetal force is in the same direction as the magnetic field.

(C) The magnetic field is into the page, because using the right-hand rule, the magnetic force would deflect the electron toward the top of the page.

(D) The magnetic field is out of the page, because setting $\frac{mv^2}{r} = qvB$ indicates that the centripetal force is in the same direction as the magnetic field.

(E) The magnetic field is out of the page, because using the right-hand rule, the magnetic force would deflect the electron toward the top of the page.



A uniform magnetic field **B** directed downward parallel to the plane of the page exists in the shaded region shown above. An electron can enter the field from different directions.

13. Suppose that the electron is moving straight down in the same direction as **B** when it enters the region of the magnetic field. What is the direction of the magnetic force, if any, on the electron when it first enters the field region?

(A) Toward the bottom of the page

(B) Toward the top of the page

(C) To the left

(D) To the right

(E) None; there is no magnetic force on the electron.

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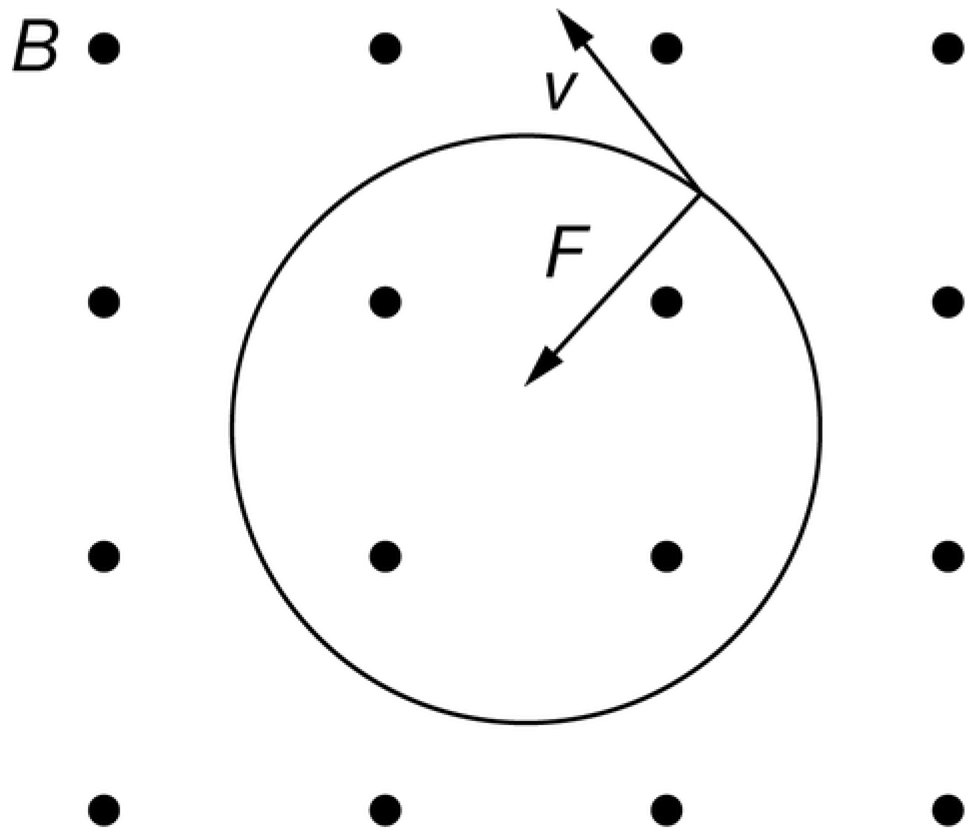
14.



An electron moves in a circle at speed v in a uniform magnetic field B as shown above. The magnetic force F acting on the electron does not do work because

(A) the electron has zero displacement and always comes back to the initial position after it completes a circle

(B) the electron is moving so it does not have a charge

(C) the magnetic force on the electron is perpendicular to its velocity at any moment, and the work, which is the dot product of the force and instantaneous displacement, is zero

(D) the magnetic force points toward different directions as the electron changes position and the average is zero

(E) the magnetic force only does work on a charged particle if the velocity has a component that is parallel to the magnetic field

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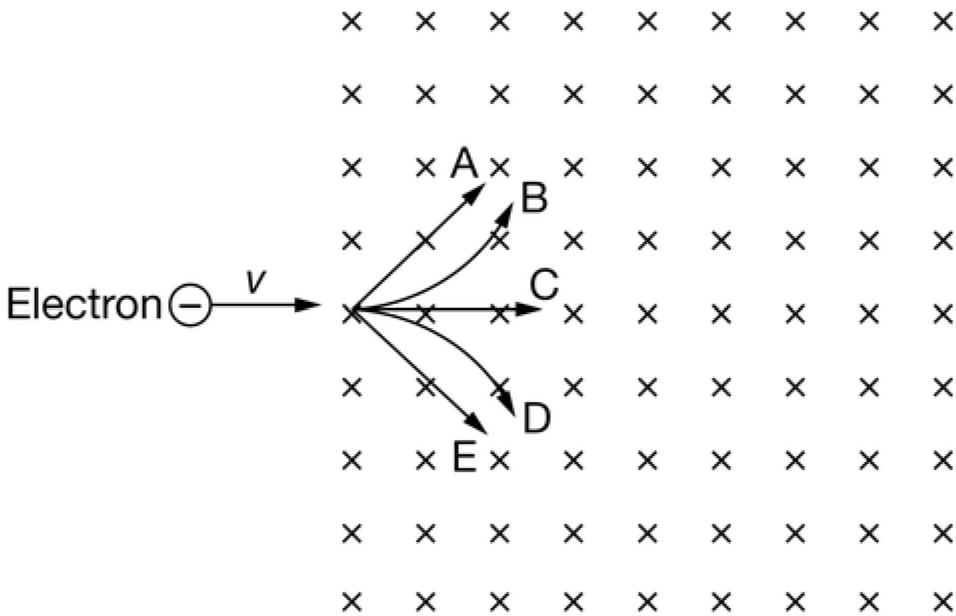

An electron is traveling with speed v when it enters a uniform magnetic field that is directed into the page, as shown above. Five paths in the magnetic field are labeled A, B, C, D, and E.

15. The electron is replaced with a proton that is traveling at the same speed v in the same direction as it enters the magnetic field. Which of the following best describes the motion of the proton as it passes through the magnetic field?

I. The speed of the proton changes less than the speed of the electron did.
II. The proton is deflected in the opposite direction.
III. The proton is deflected more than the electron.

(A) I only
(B) I and II only
(C) II only
(D) II and III only
(E) I, II, and III

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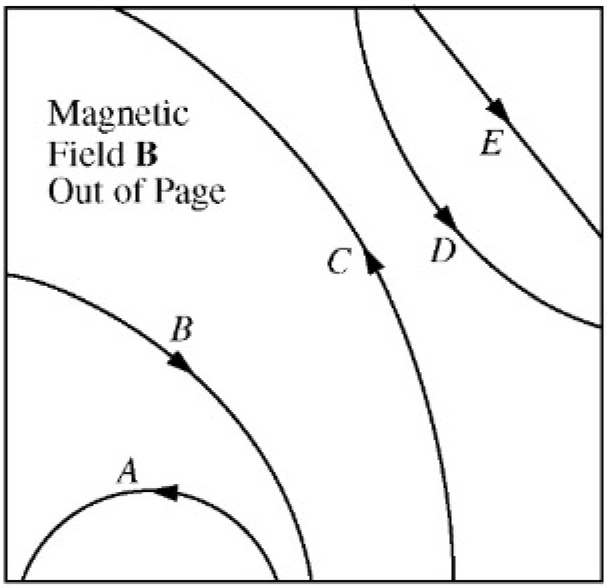
16.



The figure above shows the paths of five particles as they pass through the region inside the box that contains a uniform magnetic field **B** directed out of the page. Which particle has a positive charge?

(A) A

(B) B

(C) C

(D) D

(E) E