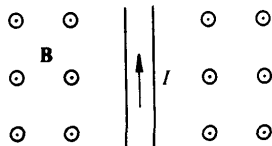
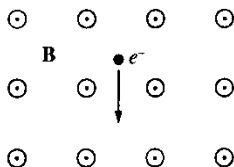


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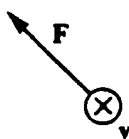
AP Problems: Force Due to a Magnetic Field



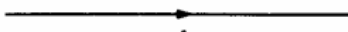
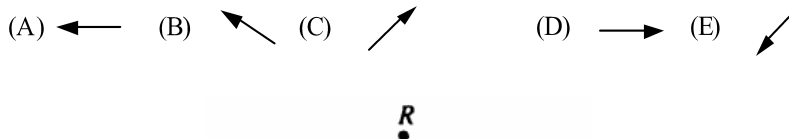
- 1988B_47. A wire in the plane of the page carries a current directed toward the top of the page as shown above. If the wire is located in a uniform magnetic field \mathbf{B} directed out of the page, the force on the wire resulting from the magnetic field is:
- (A) directed into the page (B) directed out of the page (C) directed to the right
 (D) directed to the left (E) zero



- 1998B_21. An electron is in a uniform magnetic field \mathbf{B} that is directed out of the plane of the page, as shown above. When the electron is moving in the plane of the page in the direction indicated by the arrow, the force on the electron is directed
- (A) toward the right (B) out of the page (C) into the page (D) toward the top of the page
 (E) toward the bottom of the page
- 1984C_51. A charged particle is projected with its initial velocity parallel to a uniform magnetic field. The resulting path is a
- (A) spiral (B) parabolic arc (C) circular arc (D) straight line parallel to the field
 (E) straight line perpendicular to the field



- 1988C_52. In a region of space there is a uniform \mathbf{B} field in the plane of the page but no \mathbf{E} field. A positively charged particle with velocity \mathbf{v} directed into the page is subject to a force \mathbf{F} in the plane of the page as shown above. Which of the following vectors best represents the direction of \mathbf{B} ?



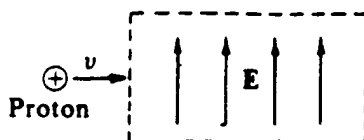
- 1993B_18. The direction of the magnetic field at point R caused by the current I in the wire shown above is
- (A) to the left (B) to the right (C) toward the wire (D) into the page (E) out of the page

Questions 46-47

A magnetic field of 0.1 T forces a proton beam of 1.5 mA to move in a circle of radius 0.1 m. The plane of the circle is perpendicular to the magnetic field.

- 1998B_46. Of the following, which is the best estimate of the work done by the magnetic field on the protons during one complete orbit of the circle?
 (A) 0 J (B) 10^{-22} J (C) 10^{-5} J (D) 10^2 J (E) 10^{20} J
- 1998B_47. Of the following, which is the best estimate of the speed of a proton in the beam as it moves in the circle?
 (A) 10^{-2} m/s (B) 10^3 m/s (C) 10^6 m/s (D) 10^8 m/s (E) 10^{15} m/s

Questions 44-45

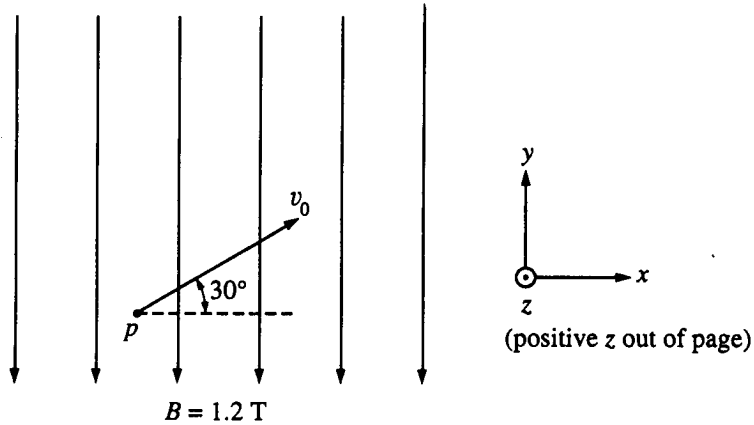


A proton traveling with speed v enters a uniform electric field of magnitude E , directed parallel to the plane of the page, as shown in the figure above. There is also a magnetic force on the proton that is in the direction opposite to that of the electric force.

- 1988C_44. Which of the following is a possible direction for the magnetic field?

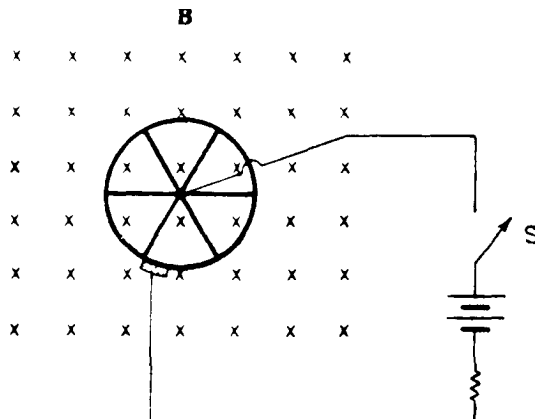
(A) (B) (C) (D) (directed out of the page) (E) (directed into the page)

- 1988C_45. If e represents the magnitude of the proton charge, what minimum magnitude of the magnetic field could balance the electric force on the proton?
 (A) E/v (B) eE/v (C) vE (D) eE (E) evE



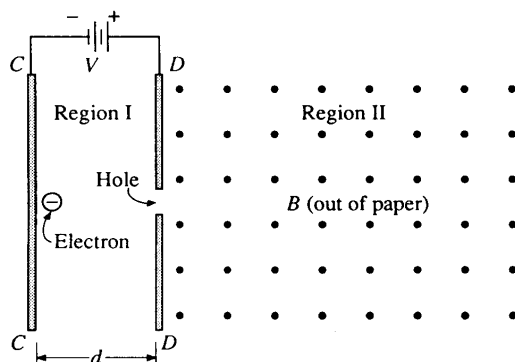
1995B7. A uniform magnetic field of magnitude $B = 1.2$ teslas is directed toward the bottom of the page in the $-y$ direction, as shown above. At time $t = 0$, a proton p in the field is moving in the plane of the page with a speed $v_0 = 4 \times 10^7$ meters per second in a direction 30° above the $+x$ axis.

- Calculate the magnetic force on the proton at $t = 0$.
- With reference to the coordinate system shown above on the right, state the direction of the force on the proton at $t = 0$.
- How much work will the magnetic field do on the proton during the interval from $t = 0$ to $t = 0.5$ second?
- Describe (but do not calculate) the path of the proton in the field.



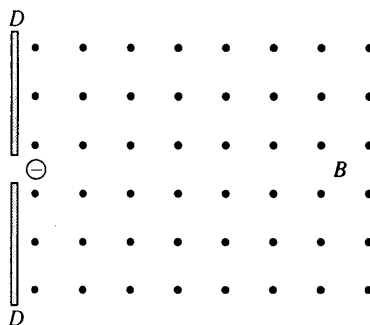
1977E3. A wheel with six spokes is positioned perpendicular to a uniform magnetic field B of magnitude 0.5 tesla (weber per square meter). The field is directed into the plane of the paper and is present over the entire region of the wheel as shown above. When the switch S is closed, there is an initial current of 6 amperes between the axle and the rim, and the wheel begins to rotate. The resistance of the spokes and the rim may be neglected.

- What is the direction of rotation of the wheel? Explain.
- The radius of the wheel is 0.2 meters. Calculate the initial torque on the wheel.
- Describe qualitatively the angular velocity of the wheel as a function of time.

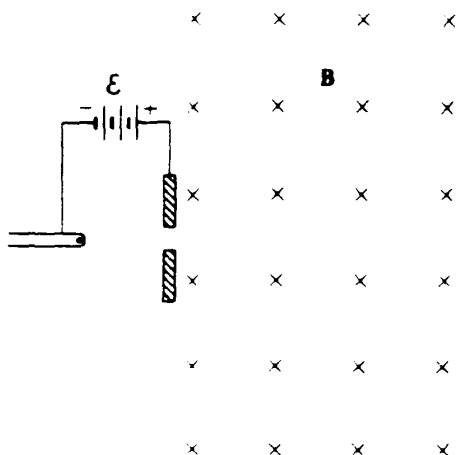


1991B2. In region I shown above, there is a potential difference V between two large, parallel plates separated by a distance d . In region II, to the right of plate D, there is a uniform magnetic field B pointing perpendicularly out of the paper. An electron, charge $-e$ and mass m , is released from rest at plate C as shown, and passes through a hole in plate D into region II. Neglect gravity.

- In terms of e , V , m , and d , determine the following.
 - The speed v_0 of the electron as it emerges from the hole in plate D
 - The acceleration of the electron in region I between the plates
- On the diagram below do the following.
 - Draw and label an arrow to indicate the direction of the magnetic force on the electron as it enters the constant magnetic field.
 - Sketch the path that the electron follows in region II.



- In terms of e , B , V , and m , determine the magnitude of the acceleration of the electron in region II.



1984B4. An electron from a hot filament in a cathode ray tube is accelerated through a potential difference \mathcal{E} . It then passes into a region of uniform magnetic field B , directed into the page as shown above. The mass of the electron is m and the charge has magnitude e .

- a. Find the potential difference \mathcal{E} necessary to give the electron a speed v as it enters the magnetic field.
- b. On the diagram above, sketch the path of the electron in the magnetic field.
- c. In terms of mass m , speed v , charge e , and field strength B , develop an expression for r , the radius of the circular path of the electron.
- d. An electric field E is now established in the same region as the magnetic field, so that the electron passes through the region undeflected.
 - i. Determine the magnitude of E .
 - ii. Indicate the direction of E on the diagram above.