Magnetic Force on a Current-Carrying Conductor

31. What is the direction of the magnetic force on the current in each of the six cases in Figure 22.59?\

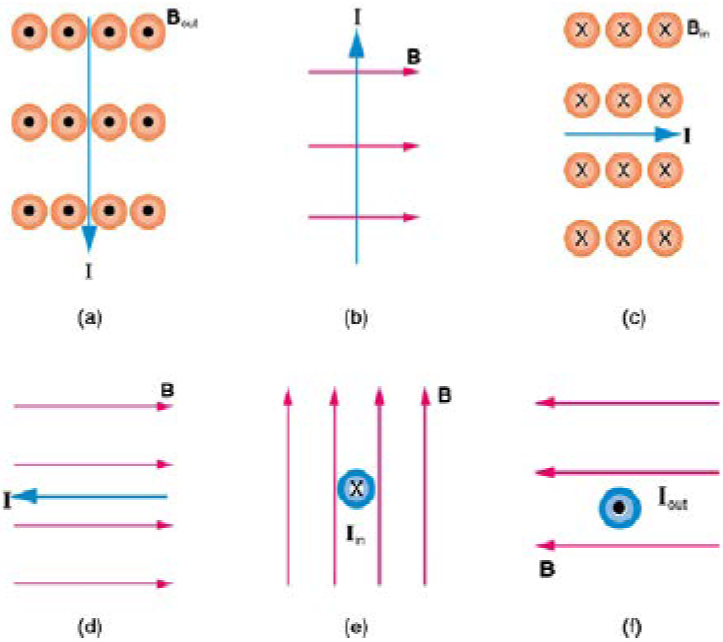


Figure 22.59

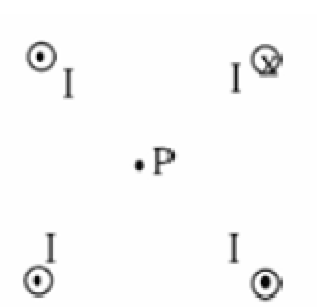
34. (a) What is the force per meter on a lightning bolt at the equator that carries 20,000 A perpendicular to the Earth's 3.00×10^{-5}-T field? (b) What is the direction of the force if the current is straight up and the Earth's field direction is due north, parallel to the ground?

35. (a) A DC power line for a light-rail system carries 1000 A at an angle of 30.0° to the Earth's 5.00×10^{-5} -T field. What is the force on a 100-m section of this line? (b) Discuss practical concerns this presents, if any.

36. What force is exerted on the water in an MHD drive utilizing a 25.0-cm-diameter tube, if 100-A current is passed across the tube that is perpendicular to a 2.00-T magnetic field? (The relatively small size of this force indicates the need for very large currents and magnetic fields to make practical MHD drives.)

37. A wire carrying a 30.0-A current passes between the poles of a strong magnet that is perpendicular to its field and experiences a 2.16-N force on the 4.00 cm of wire in the field. What is the average field

1. Four infinitely long wires are arranged as shown in the accompanying figure end–on view. All four wires are perpendicular to the plane of the page and have the same magnitude of current I. The conventional current in the wire in the upper right–hand corner is directed into the plane of the page. The other conventional currents are out of the plan of the page. Point P is a distance a from all four wires. What is the total magnetic field at point P?



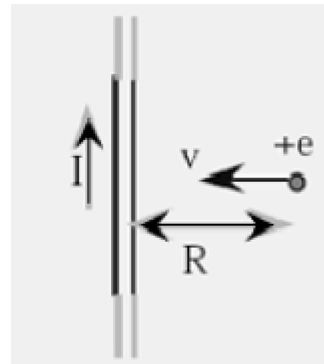
A) $\frac{\mu_o}{2\pi}\frac{I}{a}$ toward the upper left hand corner

B) $\frac{\mu_o}{2\pi}\frac{I}{a}$ toward the lower left hand corner

C) $2\frac{\mu_o}{2\pi}\frac{I}{a}$ toward the upper left hand corner

D) 0

2. The conventional current I in a long straight wire flows in the upward direction as shown in the figure. (Electron flow is downward.) At the instant a proton of charge +e is a distance R from the wire and heading directly toward it, the force on the proton is:



A) $\frac{\mu_o}{2\pi}\frac{I^2L}{R}$ upward (in the same direction as I)

B) $\frac{\mu_o}{2\pi}\frac{I^2L}{R}$ downward (in the opposite direction as I)

C) $ev\frac{\mu_o}{2\pi}\frac{I}{R}$ upward (in the same direction as I)

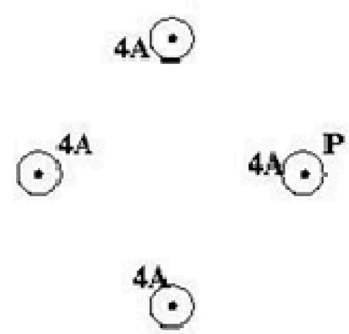
D) $ev\frac{\mu_o}{2\pi}\frac{I}{R}$ downward (in the opposite direction as I)

A wire moves through a magnetic field directed into the page. The wire experiences an induced charge separation as shown. Which way is the wire moving?

A) to the right C) toward the top of the page
B) to the left D) toward the bottom of the page

20. The diagram below shows a straight wire carrying a current i in a uniform magnetic field. An arrow indicates the magnetic force F on the wire. Of the following possibilities, the direction of the magnetic field must be
A) out of the page
B) into the page
C) up the plane of the page
D) down the plane of the page

21. For the four identical current-carrying wires shown (with conventional current coming out of the plane of the page), the wire on the right is labeled P. What is the direction of the total magnetic force on the wire
labeled P that is caused by the other wires?



A) To the left
B) To the right
C) Towards the top of the page
D) There is no force.

A magnetic field of 0.1T 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.

31. 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

32. 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

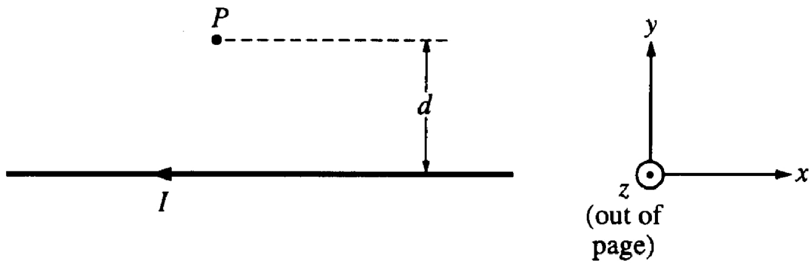


Figure 1

1998B8. The long, straight wire shown in Figure 1 above is in the plane of the page and carries a current I. Point P is also in the plane of the page and is a perpendicular distance d from the wire. Gravitational effects are negligible.

a. With reference to the coordinate system in Figure 1, what is the direction of the magnetic field at point P due to the current in the wire?

A particle of mass m and positive charge a is initially moving parallel to the wire with a speed v_o when it is at point P. as shown in Figure 2 below.

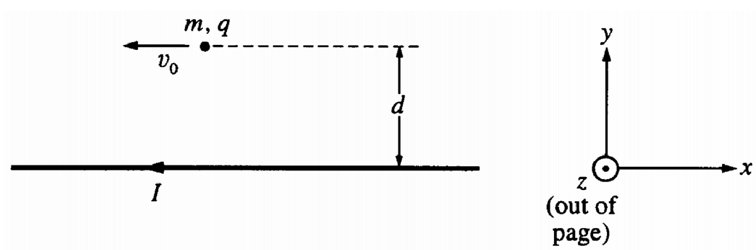


Figure 2

b. With reference to the coordinate system in Figure 2, what is the direction of the magnetic force acting on the particle at point P ?

c. Determine the magnitude of the magnetic force acting on the particle at point P in terms of the given quantities and fundamental constants.

d. An electric field is applied that causes the net force on the particle to be zero at point P.

i. With reference to the coordinate system in Figure 2, what is the direction of the electric field at point P that could accomplish this?

ii. Determine the magnitude of the electric field in terms of the given quantities and fundamental constants.

2003B3.

A rail gun is a device that propels a projectile using a magnetic force. A simplified diagram of this device is shown above. The projectile in the picture is a bar of mass *M* and length *D*, which has a constant current *I* flowing through it in the +*y* direction, as shown. The space between the thin frictionless rails contains a uniform magnetic field **B**, perpendicular to the plane of the page. The magnetic field and rails extend for a distance *L*. The magnetic field exerts a constant force **F** on the projectile, as shown.

Express all algebraic answers to the following parts in terms of the magnitude *F* of the constant magnetic force, other quantities given above, and fundamental constants.

(a) Determine the position x of the projectile as a function of time t while it is on the rail if the projectile starts from rest at $x = 0$ when $t = 0$.
(b) Determine the speed of the projectile as it leaves the right-hand end of the track.
(c) Determine the energy supplied to the projectile by the rail gun.
(d) In what direction must the magnetic field **B** point in order to create the force **F**? Explain your reasoning.
(e) Calculate the speed of the bar when it reaches the end of the rail given the following values.
$B = 5$ T $L = 10$ m $I = 200$ A $M = 0.5$ kg $D = 10$ cm