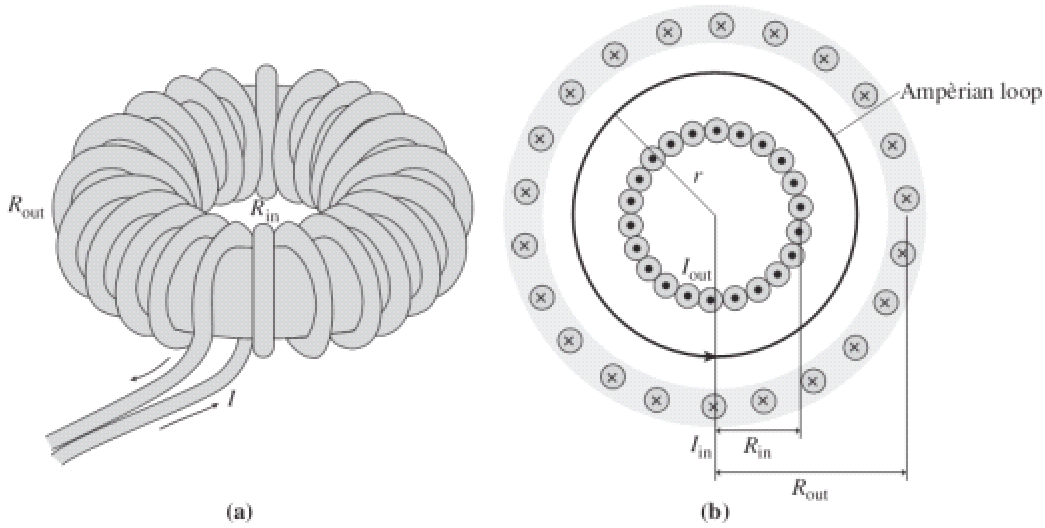
Section nine Magnetic Field

Part one

A toroid is a solenoid-like coil bent into a circle (Fig. 9.1a). Toroids are the configuration of choice in magnetic-confinement nuclear fusion experiments, which, if successful, could provide us with an almost un-limited energy source using deuterium fuel extracted from seawater. The ITER consortium, an international collaboration, is building a large toroidal fusion experiment in France; it's expected to be the first fusion device to produce energy on a large scale. Figure 9.1b shows a cross section of a toroid, with current emerging from the page at the inner edge and descending at the outer edge. The black circle is an Ampèrian loop.



1 The magnetic field associated with the toroid is nonzero

a. only within the "hole" in the donut-shaped coil.

b. only within the region bounded by the coils.

c. only outside the coils.

d. everywhere.

2 In Fig. 9.2b, the magnetic field lines must be

a. straight, and pointing into the page.

b. straight, and pointing out of the page.

c. straight, and pointing radially.

d. circular.

3 Doubling the total number of turns N in the toroid, without changing its size or the current, will

a. double the magnetic field.

b. quadruple the magnetic field.

c. halve the magnetic field.

d. not change the magnetic field.

4 The toroid has inner radius Rin and outer radius Rout. While r is the radial coordinate measured from the center. The toroid is made from wire wound into a total of N turns, and carries current I . Which of the following is the correct formula for the magnetic field within the coils?

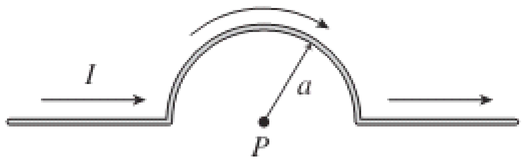
a.

b.

c.
d.

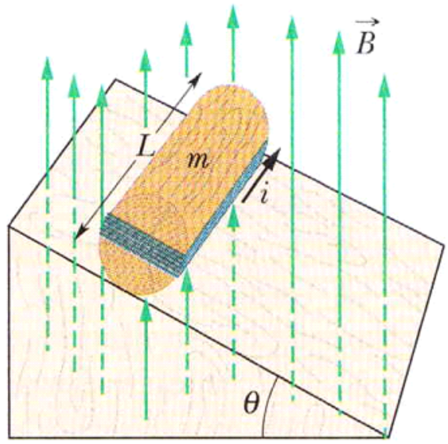
Part two

1 Part of a long wire carrying current I is bent into a semicircle of radius a , as in Fig.9.2. Use the Biot–Savart law to find the magnetic field at P, the center of the semicircle.

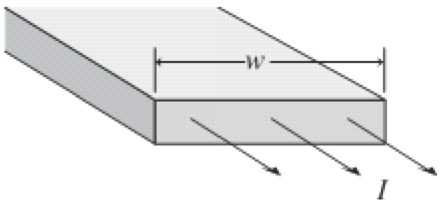


2 A 1.0 kg copper rod rests on two horizontal rails 1.0 m apart and carries a current of 50 A from one rail to the other. The coefficient of static friction between rod and rails is 0.60. What are the (a) magnitude and (b) angle (relative to the vertical) of the smallest magnetic field that puts the rod on the verge of sliding?

3 Figure 9.3 shows a wood cylinder of mass m=0.250 kg and length L=0.100m, with N =10.0 turns of wire wrapped around it longitudinally, so that the plane of the wire coil contains the long central axis of the cylinder. The cylinder is released on a plane inclined at an angle θ to the horizontal, with the plane of the coil parallel to the incline plane. If there is a vertical uniform magnetic field of magnitude 0.500 T, what is the least current i through the coil that keeps the cylinder from rolling down the plane?



4 A long, flat conducting bar of width w carries a total current I distributed uniformly, as shown in Fig. 9.4. Use approximations to write expressions for the magnetic field strength (a) near the conductor surface but not near its edges and (b) far from the conductor.



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5 In a Hall-effect experiment, a current of 3.0 A sent lengthwise through a conductor 1.0 cm wide, 4.0 cm long, and 10 µm thick produces a transverse (across the width) Hall potential difference of 10 µV when a magnetic field of 1.5 T is passed perpendicularly through the thickness of the conductor. From these data, find (a) the drift velocity of the charge carriers and (b) the number density of charge carriers. (c) Show on a diagram the polarity of the Hall potential difference with assumed current and magnetic field directions, assuming also that the charge carriers are electrons.