Problems on Force Exerted by a Magnetic Fields and on Sources of the Magnetic Fields (Ch 26-27 T&M)

26.27 A current-carrying wire is bent into a semicircular loop of radius R that lies in the xy plane. There is a uniform magnetic field **B** = B**k** perpendicular to the plane of the loop. Verify that the force acting on the loop is zero.

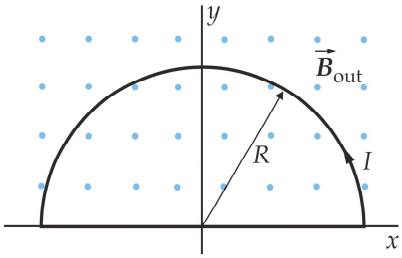

Fig. Problem 26.27

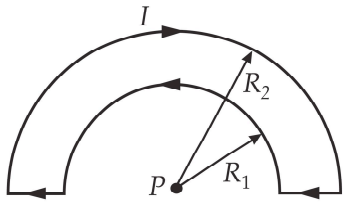

Fig. Problem 26.61+27.101

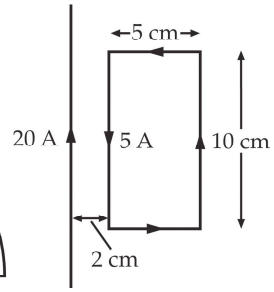

Fig. Problem 27.105

26.57 Torque on a loop with current
A rigid circular loop of radius R and mass m carries a current I and lies in the xy plane on a rough, flat table. There is a horizontal magnetic field of magnitude B. What is the minimum value of B so that one edge of the loop will lift off the table?
[Hint: The loop will start to lift off the table when the magnetic torque equals the gravitational torque.]

Problem 26.61+27.101 Magnetic moment of a loop and Magnetic field calculation
A wire loop consists of two semicircles connected by straight segements. The inner and outer radii are $R_1 = 0.3$ and $R_2 = 0.5$ m, respectively. A current I of 1.5 A flows in this loop with the current in the outer semicircle in the clockwise direction.
A) What is the magnetic moment of the current loop?
B) Find the magnetic field in P, which is at the common center of the 2 semicircular arcs.

Problem 27.105 Force between current wires
A long straight wire carries a current of 20 A, as shown in the figure. A rectangular coil with 2 sides parallel to the straight wire has sides 5 cm and 10 cm with the near side at a distance 2 cm from the wire. The coil carries a current of 5 A. (a) Find the force on each segment of the rectangular coil due to the current in the long straight wire. (b) What is the net force on the coil?

Probem 27.59 Magnetic field in a solenoid
A solenoid with length 30 cm, radius 1.2 cm, and 300 turns carries a current of 2.6 A. Find B on the axis of the solenoid (a) at the center, (b) inside the solenoid at a point 10 cm from one end, and (c) at one end.

Conceptual Problem 27.67
Show that a uniform magnetic field with no fringing field, such as that shown in the figure, is impossible because it violates Ampere's law. Do this by applying Ampere's law to the rectangular curve shown by the dashed line.

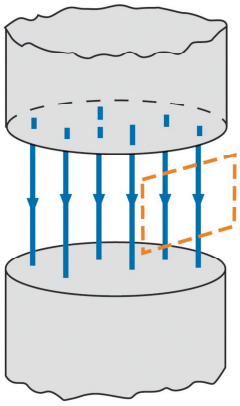

Fig. Problem 27.67

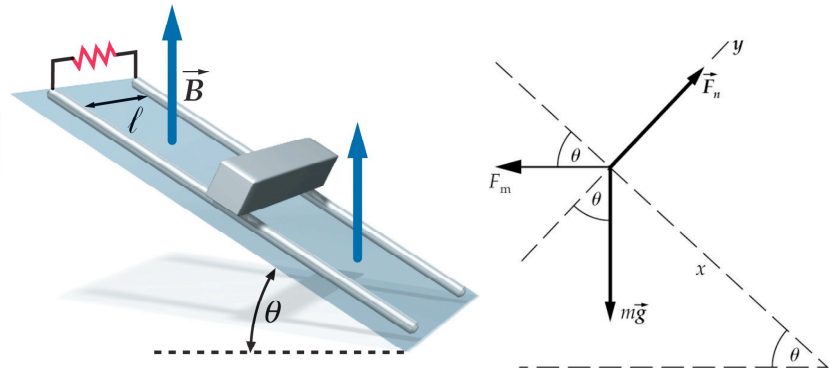

Fig. Problem 28.50

Problem 28.45 on Induction

A conducting rod of mass m and negligible resistance is free to slide without friction along 2 parallel rails of negligible resistance separated by a distance l and connected by a resistance R, as shown in the figure. The rails are attached to a long inclined plane that makes an angle θ with the horizontal. There is a magnetic field B directed upward. (a) Show that there is a retarding force directed up the incline given by $F = (B^2 l^2 v^2 \cos\theta)/R$. (b) Show that the terminal speed of the rod is $v_t = (mgR \sin\theta)/(B^2 l^2 \cos^2\theta)$. [Hint: all the forces are shown in the figure.]

Problem 28.39

A 10-cm by 5-cm rectangular loop with resistance 2.5 Ω is pulled through a region of uniform magnetic field B = 1.7 T (see figure) with constant speed v = 2.4 cm/s. The front of the loop enters the region of magnetic field at time t=0. (a) Find and graph the flux through the loop as a function of time. (b) Find and graph the induced current in the loop as a function of time. Neglect any self-inductance of the loop and show your graphs from t=0 to t=16s.

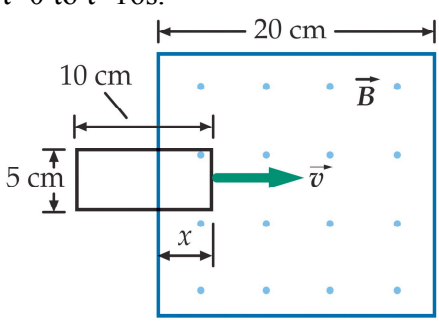

Fig. Problem 28.39

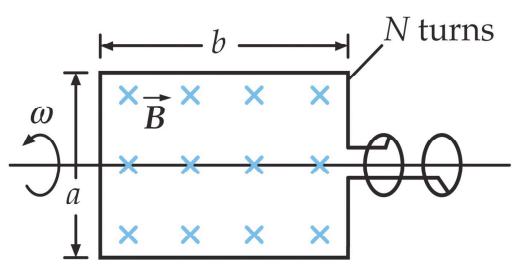

Fig. Problem 28.85

Problem 28.85 The AC generator

The figure shows an AC generator. The generator consists of a rectangular loop of dimensions a and b with N turns connected to slip rings. The loop rotates with an angular velocity ω in a uniform magnetic field **B**. (a) Show that the potential difference between the 2 slip rings is $\varepsilon = NBab\,\omega \sin \omega t$. (b) If a = 1 cm, b = 2 cm, N = 1000 and B = 2T, at what angular frequency ω must the coil rotate to generate an emf whose maximum value is 110 V?