Name:

Physics 51
Homework #13
October 24, 2016

33-P13*, 34-E23, 34-E30, 34-P9

33-P13* The current density inside a long, solid, cylindrical wire of radius a is in the direction of the axis and varies linearly with radial distance r from the axis according to $j = j_0 r/a$. Find the magnetic field inside the wire. Express your answer in terms of the total current i carried by the wire.

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34-E23 A rectangular loop of wire with length a, width b, and resistance R is placed near an infinitely long wire carrying current i, as shown in Fig. 34-49. The distance from the long wire to the loop is D. Find

(a) the magnitude of the magnetic flux through the loop and

(b) the current in the loop as it moves away from the long wire with speed v.

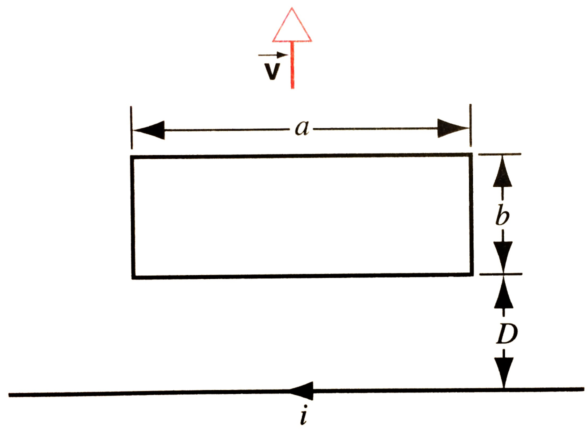

FIGURE 34-49. Exercise 23.

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34-E30 A long solenoid has a diameter of 12.6 cm. When a current i is passed through its windings, a uniform magnetic field $B = 28.6\,\text{mT}$ is produced in its interior. By decreasing i, the field is caused to decrease at the rate $6.51\,\text{mT/s}$. Calculate the magnitude of the induced electric field

(a) 2.20 cm and

(b) 8.20 cm from the axis of the solenoid.

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34-P9 A rod with length L, mass m, and resistance R slides without friction down parallel conducting rails of negligible resistance, as in Fig. 34-59. The rails are connected together at the bottom as shown, forming a conducting loop with the rod as the top member. The plane of the rails makes an angle θ with the horizontal, and a uniform vertical magnetic field $\vec{\mathbf{B}}$ exists throughout the region.

(a) Show that the rod acquires a steady-state terminal velocity whose magnitude is

$$v = \frac{mgR}{B^2L^2}\frac{\sin\theta}{\cos^2\theta}.$$

(b) Show that the rate at which the internal energy of the rod is increasing is equal to the rate at which the rod is losing gravitational potential energy.

(c) Discuss the situation if $\vec{\mathbf{B}}$ were directed down instead of up.

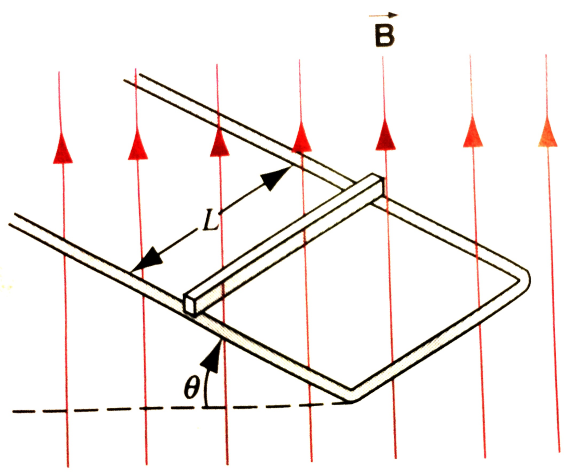

FIGURE 34-59. Problem 9.

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