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Problems set # 9 **Physics 169** April 21, 2015

1. Consider the hemispherical closed surface in Fig. 1. The hemisphere is in a uniform magnetic field that makes an angle θ with the vertical. Calculate the magnetic flux through *(i)* the flat surface S_1 and *(ii)* the hemispherical surface S_2.

2. A cube of edge length $\ell = 2.50$ cm is positioned as shown in Fig. 2. A uniform magnetic field given by $\vec{B} = (5\hat{\imath} + 4\hat{\jmath} + \hat{3}\hat{k})$ T exists throughout the region. *(i)* Calculate the flux through the shaded face. *(ii)* What is the total flux through the six faces?

3. A solenoid 2.50 cm in diameter and 30.0 cm long has 300 turns and carries 12.0 A. *(i)* Calculate the flux through the surface of a disk of radius 5.00 cm that is positioned perpendicular to and centered on the axis of the solenoid, as shown in Fig. 3 (a). *(ii)* Figure 3 (b) shows an enlarged end view of the same solenoid. Calculate the flux through the blue area, which is defined by an annulus that has an inner radius of 0.400 cm and outer radius of 0.800 cm.

4. The rectangular loop shown in Fig. 4 is coplanar with the long, straight wire carrying the current $I = 20$ A. Determine the magnetic flux through the loop.

5. Two parallel rails with negligible resistance are 10.0 cm apart and are connected by a 5.00-Ω resistor. The circuit also contains two metal rods having resistances of 10.0 Ω and 15.0 Ω sliding along the rails (Fig. 5). The rods are pulled away from the resistor at constant speeds of 4.00 m/s and 2.00 m/s, respectively. A uniform magnetic field of magnitude 0.01 T is applied perpendicular to the plane of the rails. Determine the current in the 5.00-Ω resistor.

6. A helicopter has blades of length 3.00 m, rotating at 2.00 rev/s about a central hub as shown in Fig. 6. If the vertical component of the Earths magnetic field is 50.0 μT, what is the emf induced between the blade tip and the center hub? *(ii)* What is the emf induced between any two blade tips?

7. A loop of area 0.1 m^2 is rotating at 60 rev/s with the axis of rotation perpendicular to a 0.2 T magnetic field; see Fig. 7. *(i)* If there are 1000 turns on the loop, what is the maximum voltage induced in the loop? *(ii)* When the maximum induced voltage occurs, what is the orientation of the loop with respect to the magnetic field?

8. Two infinitely long solenoids (seen in cross section) pass through a circuit as shown in Fig. 8. The magnitude of B inside each is the same and is increasing at the rate of 100 T/s. What is the current in each resistor?

9. The square loop shown in Fig. 10 is coplanar with a long, straight wire carrying a current $I(t) = 5\ \cos(2\pi \times 10^4 t)$ A. *(i)* Determine the emf induced across a small gap created in the loop. *(ii)* Determine the direction and magnitude of the current that would flow through a 4 Ω resistor connected across the gap. The loop has an internal resistance of 1 Ω.

10. The loop shown in Fig. 10 moves away from a wire carrying a current $I_1 = 10$ A at a constant velocity $u = 7.5$ m/s. If $R = 10\ \Omega$ and the direction of I_2 is as defined in Fig. 10, find I_2 as a function of y_0, the distance between the wire and the loop. Ignore the internal resistance of the loop.

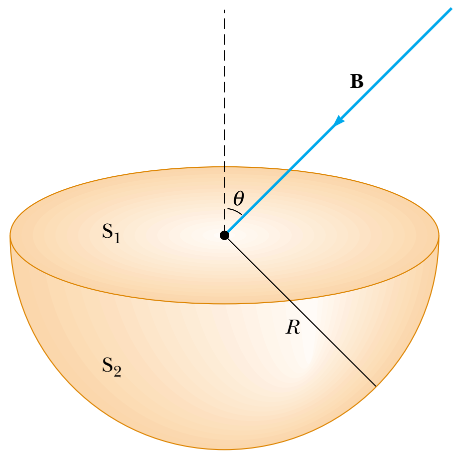

Figure 1: Problem 1.

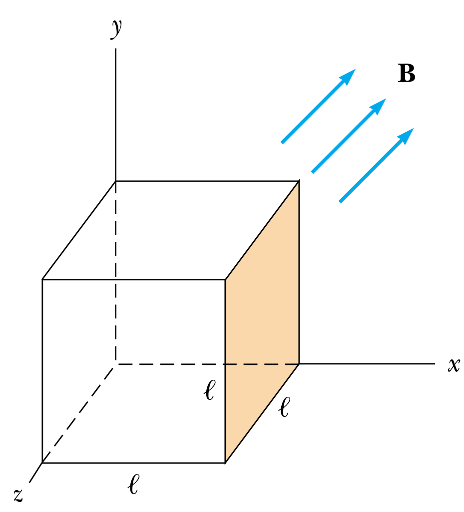

Figure 2: Problem 2.

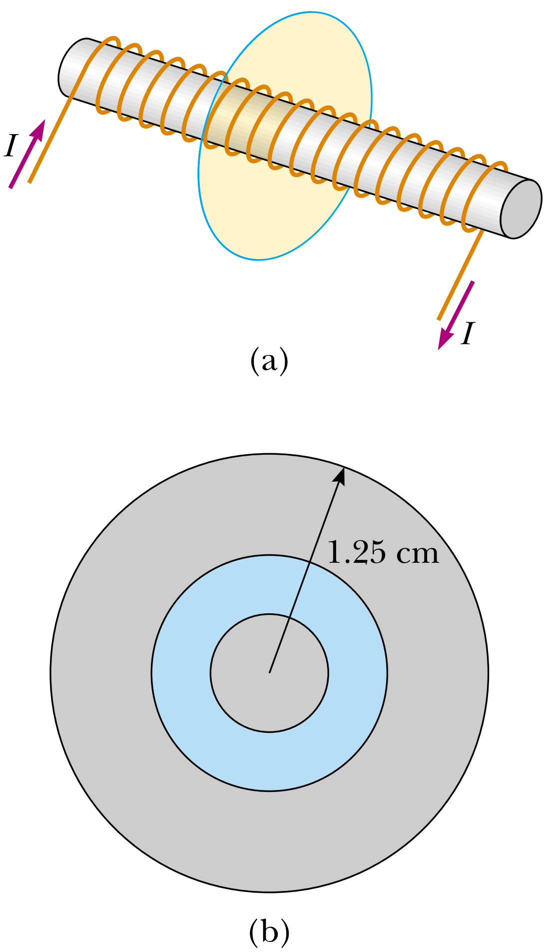

Figure 3: Problem 3.

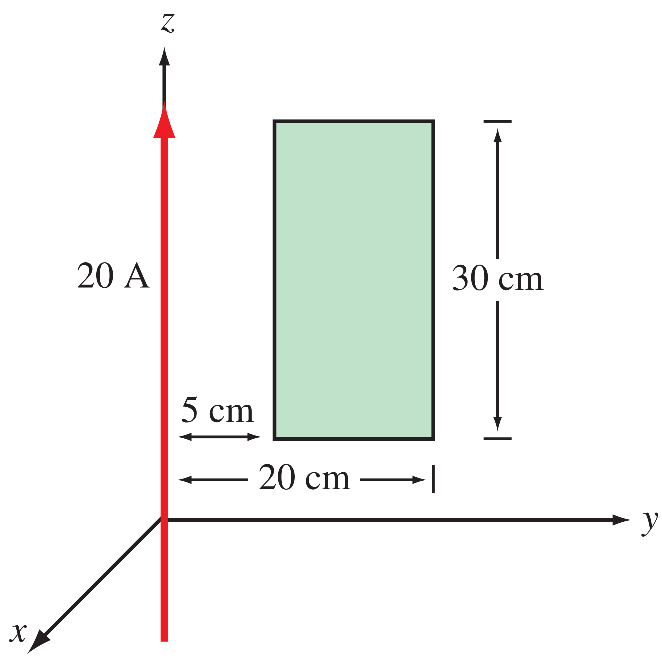

Figure 4: Problem 4.

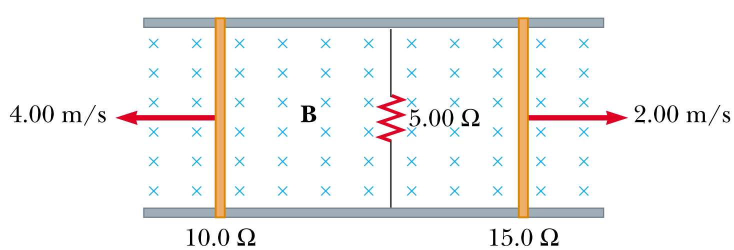

Figure 5: Problem 5.

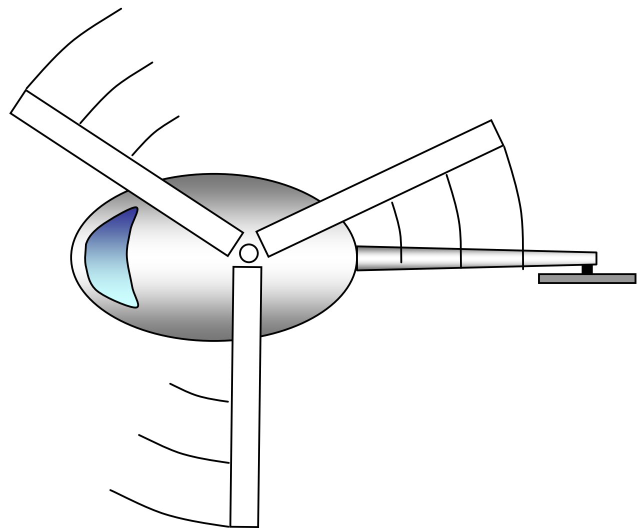

Figure 6: Problem 6.

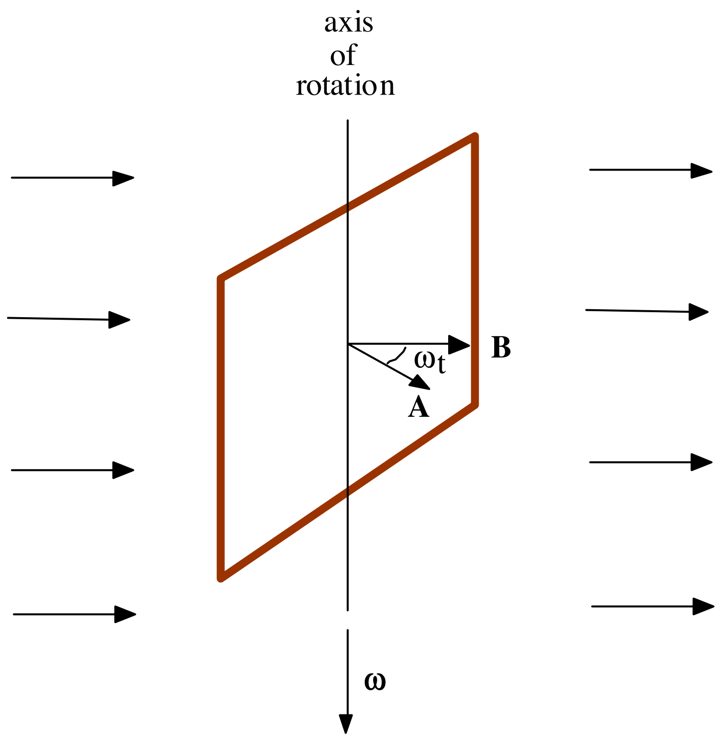

Figure 7: Problem 7.

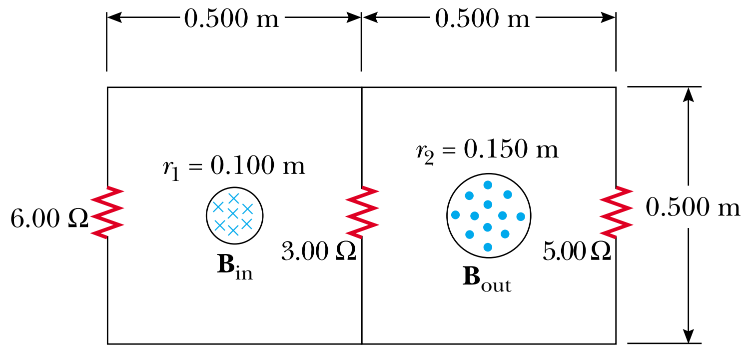

Figure 8: Problem 8.

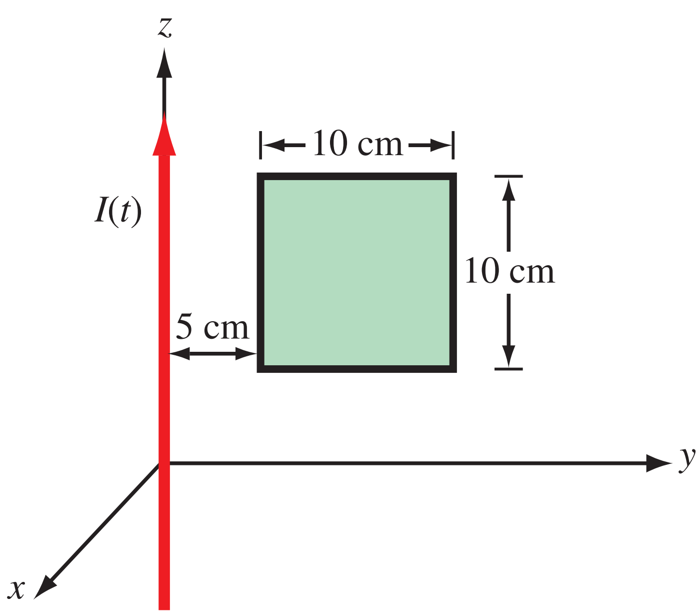

Figure 9: Problem 9.

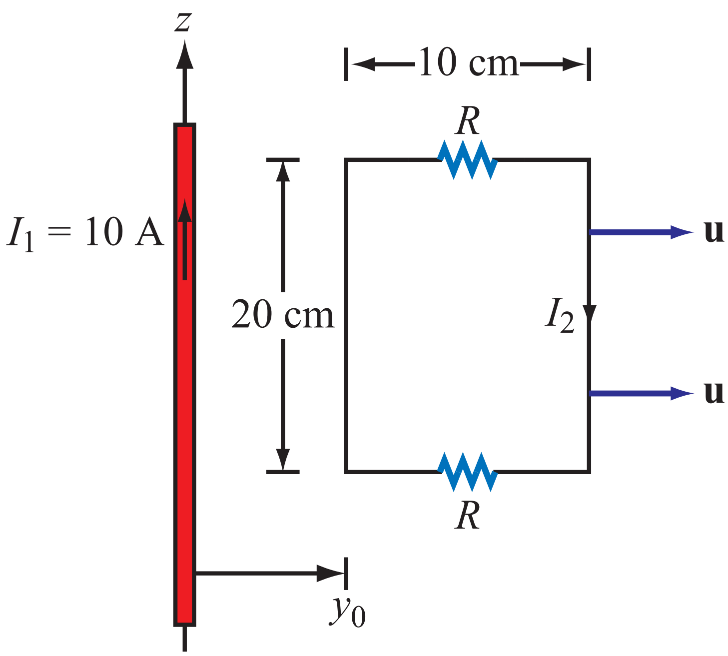

Figure 10: Problem 10.