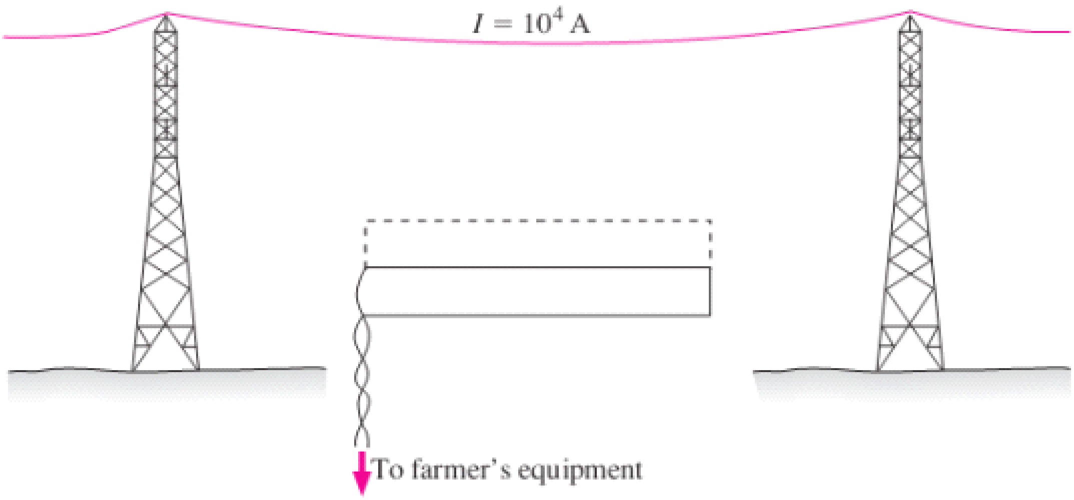
Section ten Induction

Part one

Clever farmers with power lines crossing their land have been known to steal power by stringing wire near the power line and making use of the induced current. At least one such crime went to court and resulted in a conviction—despite the defense's claim that the defendant didn't touch the lines. Figure 10.1 shows a possible crime scene, with a rectangular wire loop mounted in a vertical plane beneath a power line. The power line carries a current of A, alternating sinusoidally at 60 Hz.



1. If the loop were mounted in a horizontal rather than vertical plane at the same distance from the power line, the induced emf would

a. increase slightly.

b. decrease slightly.

c. remain the same.

d. become essentially zero.

2. If the loop's vertical dimension were doubled by extending it to-ward the power line (dashed line in Fig. 27.42), the induced emf

would

a. double.

b. quadruple.

c. more than double but not quadruple.

d. increase but not quite double.

3. Suppose the same crime were committed in Europe, where the standard frequency is 50 Hz. Assuming everything else about the situation were the same, the induced emf would

a. be greater.

b. be less.

c. be unchanged.

d. depend on the nature of the energy source.

4. When this crime occurs,

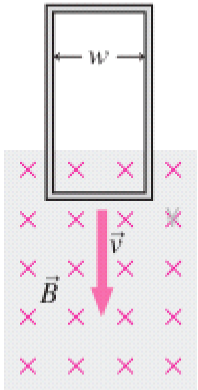
a. more fuel must be consumed at the power plant supplying the line.

b. the power company does not suffer any economic damage.

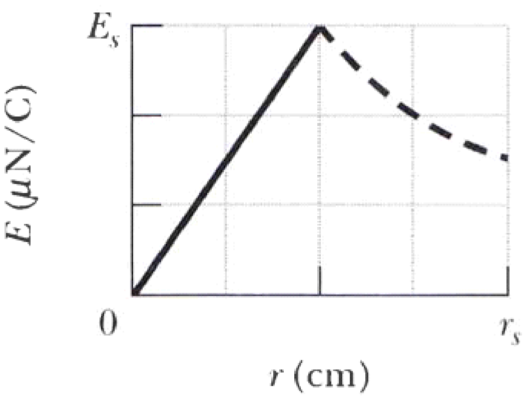
c. the power company can’t determine that it’s being robbed without an on-site inspection.
d. there’s no power left for customers further down the line.

Part Two

1 A rectangular conducting loop of resistance R , mass m , and width w falls into a uniform magnetic field as shown in Fig.10.2. (a) Explain why the loop eventually reaches a terminal speed. (b) Find an expression for the terminal speed.



2 A circular region in an a xy plane is penetrated by a uniform magnetic field in the positive direction of the z axis. The field's magnitude B (in teslas) increases with time r (in seconds) according to B=at, where a is a constant. The magnitude E of the electric field set up by that increase in the magnetic field is given by Fig. 10.3 versus radial distance r; the vertical axis scale is set by E =300 µN/C, and the horizontal axis scale is set by r=4.00 cm. Find a.



3 Two identical long wires of radius a=1. 53 mm are parallel and carry identical currents in opposite directions. Their center-to-center separation is d= I4.2 cm. Neglect the flux within the wires but consider the flux in the region between the wires. What is the inductance per unit length of the wires?

4. A single-turn loop of radius R carries current I . How does the magnetic-energy density at the loop center compare with that of a long solenoid of the same radius, carrying the same current, and consisting of n turns per unit length?