19. **A vertical wire with electron flow into this page has an associated magnetic field which is**

a. clockwise.

b. counterclockwise.

c. parallel to the wire.

d. none of the above.

20. **How much is the induced voltage when a magnetic flux cuts across 150 turns at the rate of 5 Wb/s?**

a. 7.5 kV.

b. 75 V.

c. 750 V.

d. 750 mV.

## Essay Questions

1. Draw a diagram showing two conductors connecting a battery to a load resistance through a closed switch. (a) Show the magnetic field of the current in the negative side of the line and a the positive side . (b) Where do the two fields aid? Where do they oppose?

2. State the rule for determining the magnetic polarity of a solenoid. (a) How can the polarity be reversed? (b) Why are there no magnetic poles when the current through the coil is zero?

3. Why does the motor action between two magnetic fields result in motion toward the weaker field?

4. Why does current in a conductor perpendicular to this page have a magnetic field in the plane of the paper?

5. Why must the conductor and the external field be perpendicular to each other to have motor action or to generate induced voltage?

6. Explain briefly how either motor action or generator action can be obtained with the same conductor in a magnetic field.

7. Assume that a conductor being cut by the flux of an expanding magnetic field has 10 V induced with the top end positive. Now analyze the effect of the following changes: (a) The magnetic flux continues to expand, but at a slower rate. How does this affect the amount of induced voltage and its polarity? (b) The magnetic flux is constant, neither increasing nor decreasing. How much is the induced voltage? (c) The magnetic flux contracts, cutting across the conductor with the opposite direction of motion. How does this affect the polarity of the induced voltage?

8. Redraw the graph in Fig. 14–18c for 500 turns with all other factors the same.

9. Redraw the circuit with the coil and battery in Fig. 14–10, showing two different ways to reverse the magnetic polarity.

10. Referring to Fig. 14–18, suppose that the flux decreases from 8 Wb to zero at the same rate as the increase. Tabulate all values as in Table 14–2 and draw the three graphs corresponding to those in Fig. 14–18.

11. Assume that you have a relay whose pickup and holding current values are unknown. Explain how you can determine their values experimentally.

12. List two factors that determine the strength of an electromagnet.

13. What is meant by magnetic hysteresis?

14. What is meant by the saturation of an iron core?

## Problems

### SECTION 14–1 AMPERE-TURNS OF MAGNETOMOTIVE FORCE (mmf)

14–1 What is (a) the cgs unit of mmf? (b) the SI unit of mmf?

14–2 Calculate the ampere-turns of mmf for a coil with the following values:

a. $I = 10$ mA, $N = 150$ turns.

b. $I = 15$ mA, $N = 100$ turns.

c. $I = 2$ mA, $N = 5000$ turns.

d. $I = 100\ \mu$A, $N = 3000$ turns.

14–3 Calculate the ampere-turns of mmf for a coil with the following values:

a. $I = 5$ mA, $N = 4000$ turns.

b. $I = 40$ mA, $N = 50$ turns.

c. $I = 250$ mA, $N = 40$ turns.

d. $I = 600$ mA, $N = 300$ turns.

14–4 Calculate the current required in a coil to provide an mmf of 2 A·t if the number of turns equals

a. 50.

b. 500.

c. 100.

d. 2000.

14–5 Calculate the number of turns required in a coil to provide an mmf of 100 A·t if the current equals

a. $I = 100$ mA.

b. $I = 25$ mA.

c. $I = 40$ mA.

d. $I = 2$ A.