Chapter 31: Faraday's Electromotive Force

$$\varepsilon = N\frac{d\Phi}{dt}$$

ε: is the electromotive force (electric potential difference)

(dΦ/dt): is the change in magnetic flux per unit time

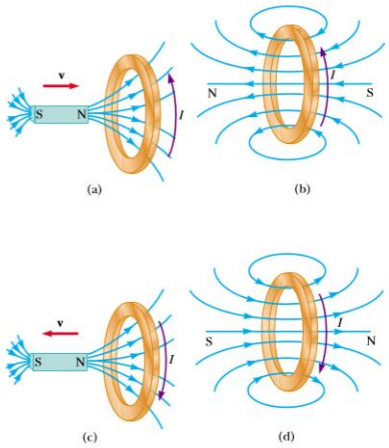
Three ways for changing magnetic flux:

1- By changing magnetic field (B) which depends on current (I).
2- Changing the area (A)
3- Changing the angle (θ)

Example (31.1): A coil consists of 200 turns of wire having a total resistance of 2.0 Ω. Each turn is a square of side 18cm, and a uniform magnetic field directed perpendicular to the plane of the coil is turned on. If the field changes linearly from 0 to 0.50 T in 0.80 s, what is the magnitude of the induced emf in the coil while the field is changing?

Lenz's Law:

The polarity of the induced emf generates a current that produces a magnetic flux to oppose the change in magnetic flux through the area enclosed by the current loop.

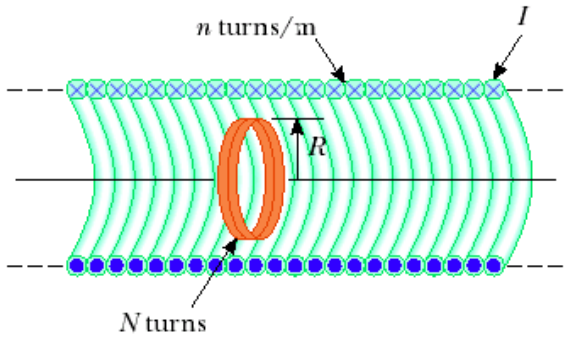


Problems from the textbook:

2. A flat loop of wire consisting of a single turn of cross-sectional area 8.00 cm^2 is perpendicular to a magnetic field that increases uniformly in magnitude from 0.500 T to 2.50 T in 1.00 s. What is the resulting induced current if the loop has a resistance of 2.00 **Ω**?

5. A strong electromagnet produces a uniform magnetic field of 1.60 T over a cross-sectional area of 0.200 m². We place a coil having 200 turns and a total resistance of 20.0 **Ω** around the electromagnet. We then smoothly reduce the current in the electromagnet until it reaches zero in 20.0 ms. What is the current induced in the coil?

13. A long solenoid has 400 turns per meter and carries a current given by $I = (30.0\ \text{A})(1 - e^{-1.60t})$. Inside the solenoid and coaxial with it is a coil that has a radius of 6.00 cm and consists of a total of 250 turns of fine wire (Fig. P31.13). What emf is induced in the coil by the changing current?



20. Consider the arrangement shown in Figure P31.20. Assume that $R = 6.00\ \Omega$, $\ell = 1.20$ m, and a uniform 2.50-T magnetic field is directed into the page. At what speed should the bar be moved to produce a current of 0.500 A in the resistor?

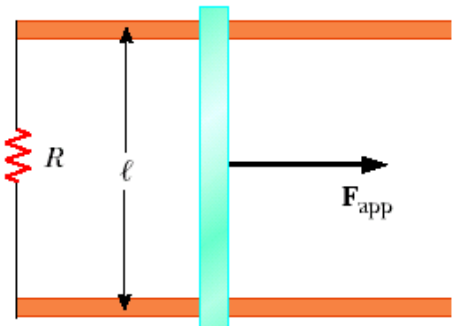


Figure P31.20