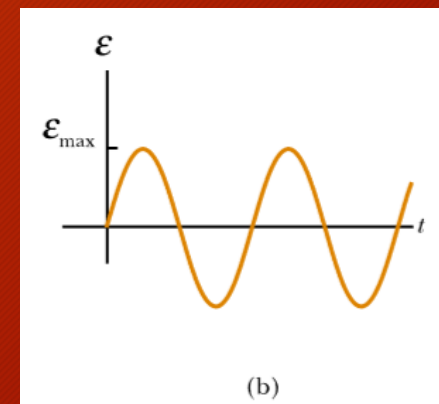
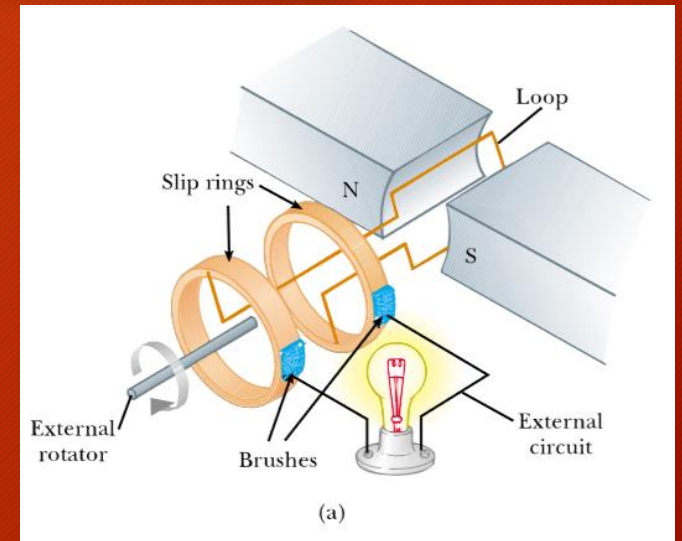


# 23-Generators and Motors

# AC Generator

- Electric generators are used to produce electrical energy.
- (a) Schematic diagram of an ac generator. An EMF is induced in a loop that rotates in a magnetic field.
- (b) The alternating EMF induced in the loop plotted as a function of time.



# AC Generator

- Suppose the loop has  $N$  turns, rotates with constant speed  $\omega$ .
- The magnetic flux through loop is given by:

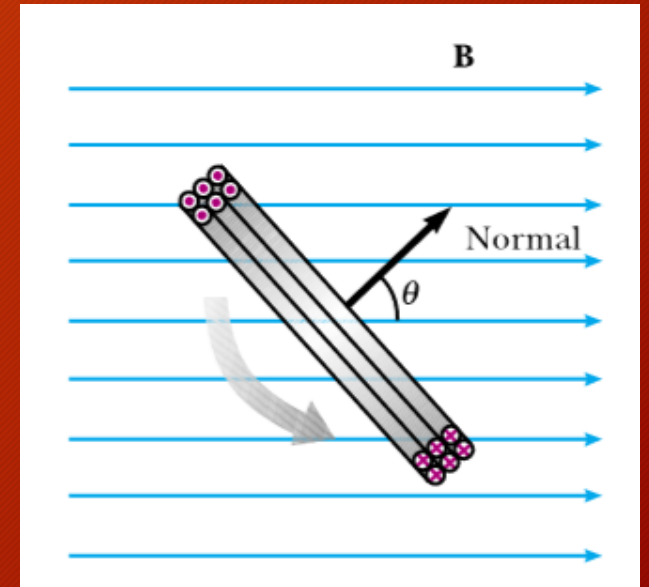
$$\Phi_B = BA \cos \theta = BA \cos \omega t$$

- Induced EMF in the coil is

$$\mathcal{E} = -N \frac{d\Phi_B}{dt} = -NAB \frac{d}{dt} (\cos \omega t) = NAB\omega \sin \omega t$$

- Maximum EMF has the value

$$\mathcal{E}_{\max} = NAB\omega$$





### EXAMPLE 31.9 emf Induced in a Generator

An ac generator consists of 8 turns of wire, each of area  $A = 0.0900 \text{ m}^2$ , and the total resistance of the wire is  $12.0 \Omega$ . The loop rotates in a  $0.500\text{-T}$  magnetic field at a constant frequency of  $60.0 \text{ Hz}$ . (a) Find the maximum induced emf.

**Solution** First, we note that  $\omega = 2\pi f = 2\pi(60.0 \text{ Hz}) = 377 \text{ s}^{-1}$ . Thus, Equation 31.11 gives

$$\mathcal{E}_{\max} = NAB\omega = 8(0.0900 \text{ m}^2)(0.500 \text{ T})(377 \text{ s}^{-1}) = 136 \text{ V}$$

(b) What is the maximum induced current when the output terminals are connected to a low-resistance conductor?

**Solution** From Equation 27.8 and the results to part (a), we have

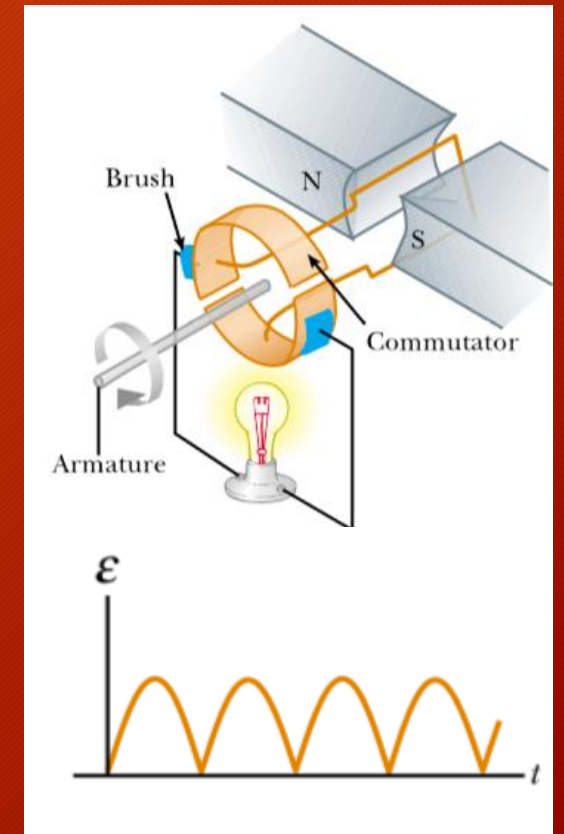
$$I_{\max} = \frac{\mathcal{E}_{\max}}{R} = \frac{136 \text{ V}}{12.0 \Omega} = 11.3 \text{ A}$$

**Exercise** Determine how the induced emf and induced current vary with time.

**Answer**  $\mathcal{E} = \mathcal{E}_{\max} \sin \omega t = (136 \text{ V}) \sin 377t$ ;  
 $I = I_{\max} \sin \omega t = (11.3 \text{ A}) \sin 377t$ .

# Direct Current (DC) Generators

- Schematic diagram of DC generator.
- The magnitude of EMF varies in time, but the polarity never changes.



# Motors

- Motors are devices that convert electrical energy to mechanical energy.
- Essentially, a motor is a generator operating in reverse.
- Instead of generating a current by rotating a loop, a current is supplied to the loop by battery, and torque acting on the current-carrying loop causes it to rotate.

