

Faraday's law

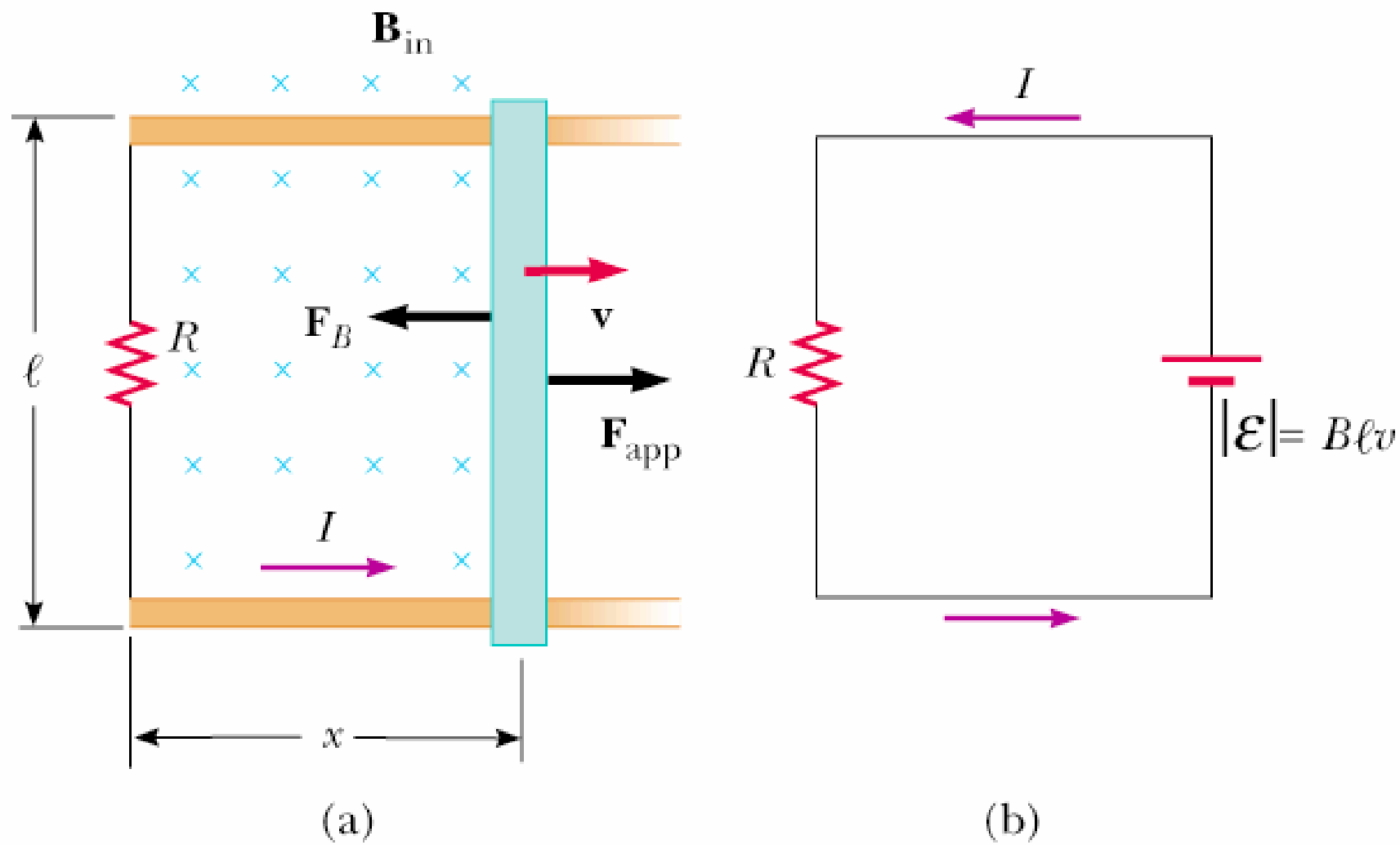
- An **emf** is induced in a circuit when the magnetic flux through that circuit is changing:

$$\varepsilon = - \frac{d\Phi_B}{dt} \quad (1)$$

$$\varepsilon = - \frac{d}{dt} (B A \cos \theta)$$

Lenz's law

The polarity of the induced *emf* is such that it tends to produce a magnetic flux to oppose the change in magnetic flux through the area enclosed by the current loop



Motional EMF

- The magnetic flux through the circuit:

$$\Phi_B = Blx$$

- The induced motional emf

$$\begin{aligned}\epsilon &= -\frac{d\Phi_B}{dt} & (2) \\ &= -\frac{d}{dt}(Blx) = -Bl\frac{dx}{dt} \\ &= -Blv\end{aligned}$$

- The current in the circuit:

$$\begin{aligned}I &= \frac{|\epsilon|}{R} & (3) \\ &= \frac{BLV}{R}\end{aligned}$$

- Due to this current in the moving bar, it experiences a magnetic force (F_B) that opposes the motion; need to apply an equal and opposite force (F_{app}) to maintain the velocity:

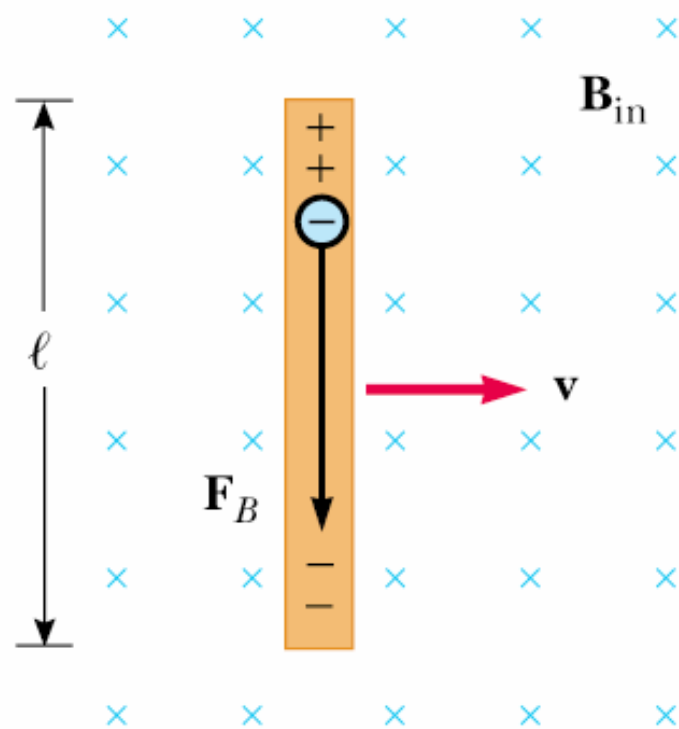
$$F = IlB$$

- Work required to move the bar (and the associated power)

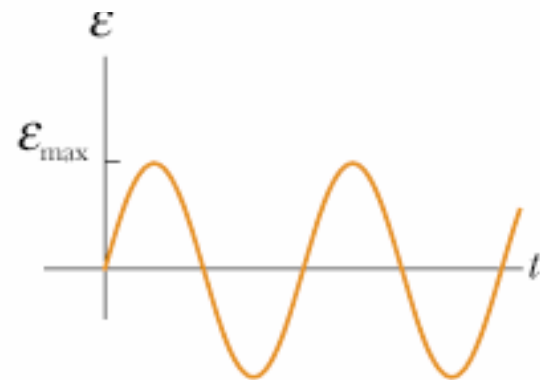
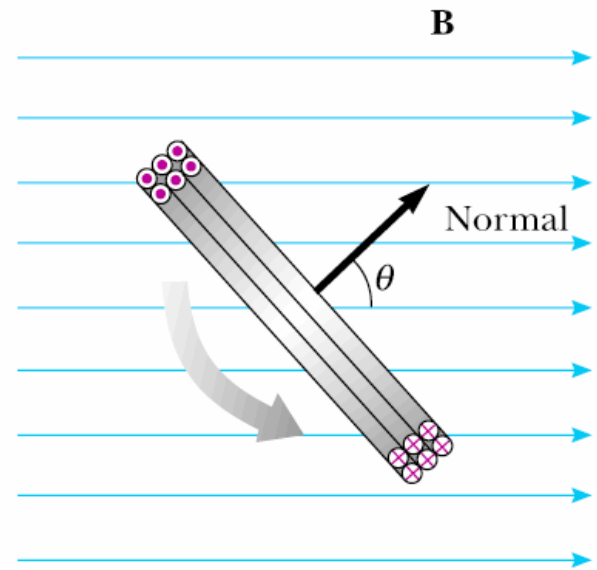
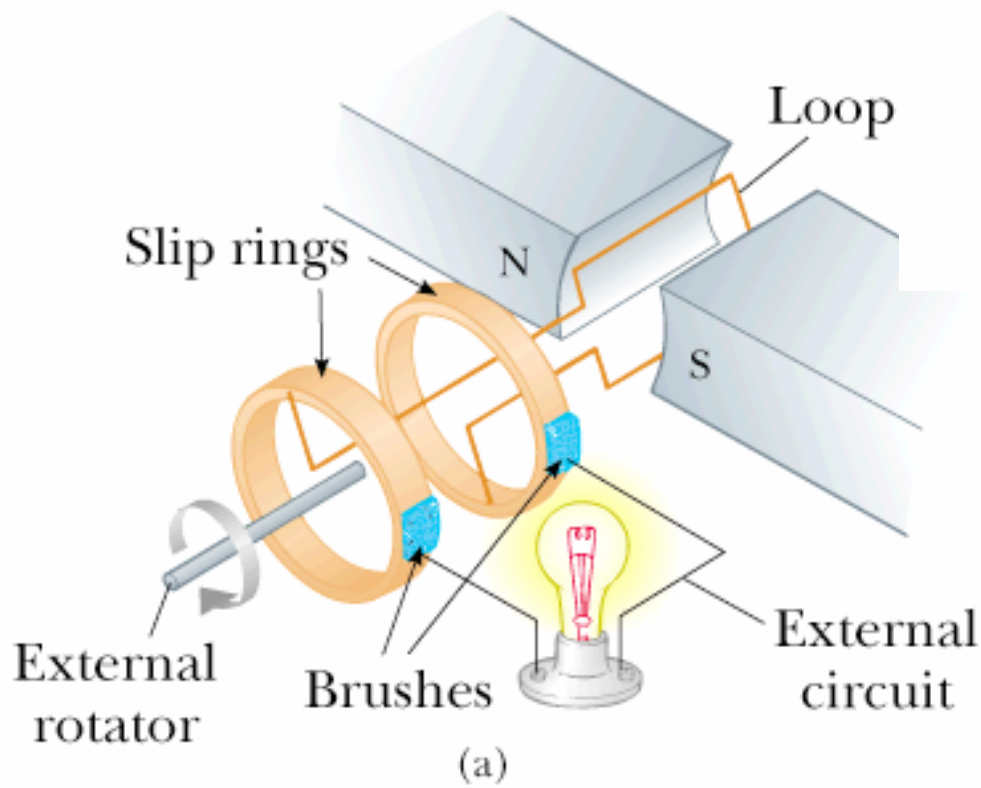
$$W = (F_{app})x = (IlB)x \quad (4)$$

$$P = \frac{d}{dt}W = (F_{app})v = (IlB)v = \frac{B^2 l^2 v^2}{R} = \frac{\epsilon^2}{R}$$

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Figure 31.8



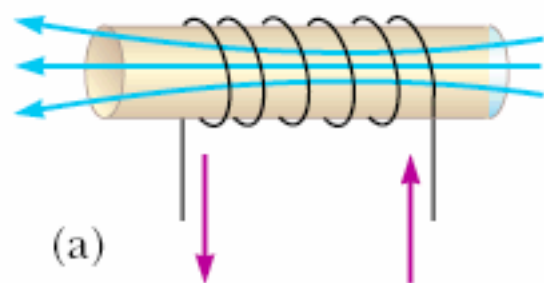
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Figure 31.19



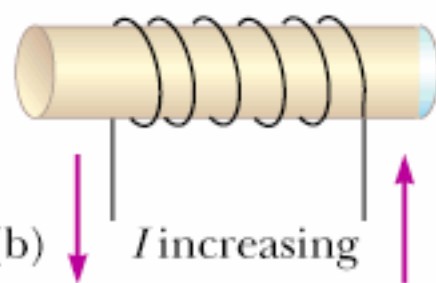
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B



Lenz's law emf



Lenz's law emf

