Motional emf

- Another way to produce an induced emf is by moving a conducting _____ through a constant magnetic _____.
- Each _____ in the rod is _____ through the magnetic field with velocity, v.
- So, each charge experiences a magnetic _____.

$$F = qvB \sin\theta$$

- Since the _____ can move they are _____ to one end of the rod leaving _____ charges at the other end.
- If there was a _____ connecting the _____ of the rod, the electrons would flow through the _____ to get back to the _____ charges.
  - This is called _____ _____ ($\mathcal{E}$)
- If the rod did _____ have the wire, the electrons would move until the _____ electrical force is balanced with the _____ force.

$$emf = vBL$$

- It takes a _____ to move the _____.
- Once the electrons are _____ in the rod, there is another _____. The moving electrons in a B-field create a magnetic _____ on the rod itself.
- According to the RHR, the force is _____ the motion of the rod. If there were no _____ pushing the rod, it would _____.

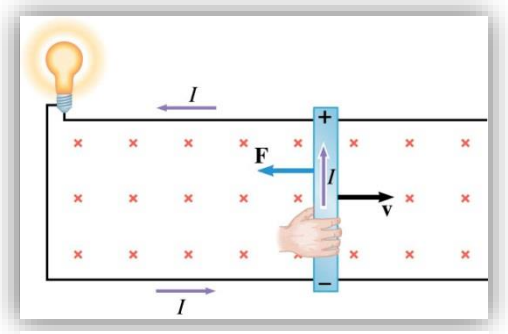

Figure 1

Damping

- When a conductor moves _____ (or out of) a magnetic field, an _____ current is created in the conductor
- As the conductor moves into B-field, the _____ increases
- This produces a current by _____ Law and is _____ in way that _____ change in flux.
- This current's _____ causes a _____ on the conductor
- The direction of the force will be _____ the _____ of the conductor

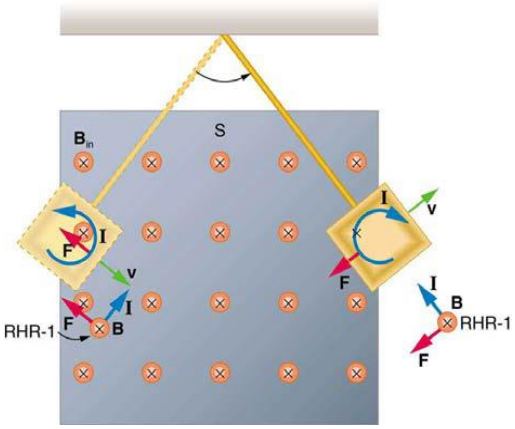

Figure 2

Applications of Magnetic Damping

- Stopping a _____ from moving
- _____ on trains/rollercoasters
  - No actual _____ parts, not effected by rain, smoother
  - Since based on speed, need _____ brakes to finish
- Sorting _____
  - Metallic objects move _____ down ramp with _____ under it
- _____ Detectors

Homework

1. Why must part of the circuit be moving relative to other parts, to have usable motional emf? Consider, for example, that the rails in Figure 1 above are stationary relative to the magnetic field, while the rod moves.
2. A powerful induction cannon can be made by placing a metal cylinder inside a solenoid coil. The cylinder is forcefully expelled when solenoid current is turned on rapidly. Use Faraday's and Lenz's laws to explain how this works. Why might the cylinder get live/hot when the cannon is fired?

3. An induction stove heats a pot with a coil carrying an alternating current located beneath the pot (and without a hot surface). Can the stove surface be a conductor? Why won't a coil carrying a direct current work?

4. (a) A jet airplane with a 75.0 m wingspan is flying at 280 m/s. What emf is induced between wing tips if the vertical component of the Earth's field is 3.00×10^{-5} T? (b) Is an emf of this magnitude likely to have any consequences? Explain. (OpenStax 23.17) **0.630 V, no**

5. (a) A nonferrous screwdriver is being used in a 2.00 T magnetic field. What maximum emf can be induced along its 12.0 cm length when it moves at 6.00 m/s? (b) Is it likely that this emf will have any consequences or even be noticed? (OpenStax 23.18) **1.44 V, no**

6. At what speed must the sliding rod in Figure 1 move to produce an emf of 1.00 V in a 1.50 T field, given the rod's length is 30.0 cm? (OpenStax 23.19) **2.22 m/s**

7. The 12.0 cm long rod in Figure 1 moves at 4.00 m/s. What is the strength of the magnetic field if a 95.0 V emf is induced? (OpenStax 23.20) **198 T**

8. A coil is moved through a magnetic field as shown in Figure 3. The field is uniform inside the rectangle and zero outside. What is the direction of the induced current and what is the direction of the magnetic force on the coil at each position shown? (OpenStax 23.27) **none; CW I, left F; none; CCW I, left F; none**

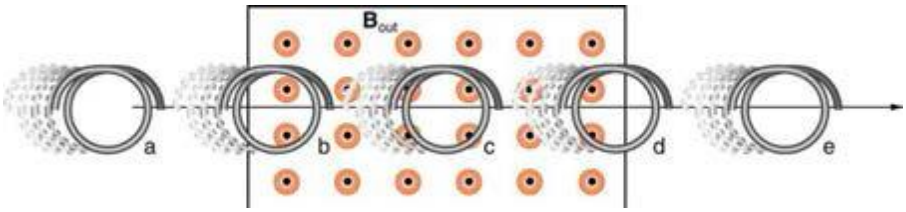

Figure 3