8.5.5: Lenz's Law

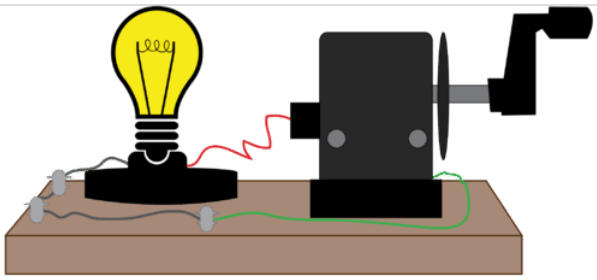


Figure 19.5.1

This is a diagram of a hand-cranked demonstration generator. Turning the hand crank spins a coil inside horseshoe magnets and generates an electric current that lights the bulb. In order to generate an electric current in a conductor, the conductor must be part of a complete circuit. If the light bulb is removed from this apparatus, the crank is very easy to turn. If the light bulb is absent, the circuit is incomplete and no current is generated. When the light bulb is place in the circuit, the circuit is complete and turning the crank will generate a current and light the bulb. When the crank is turned with bulb in the circuit, it is more difficult to turn the crank. A great deal more effort is needed to turn the crank while current is generated.

Lenz's Law

In the sketch below, moving the wire downward through the magnetic field causes electrons to flow in the wire as diagrammed. This is because relative motion between charged particles and magnetic fields produces a force on the charged particles . . . so the downward movement of the wire causes a force which moves the electrons, producing a current. When the electrons begin to flow, however, there is a second motion of the charged particles and this second motion will produce a second force on the particles.

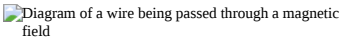


Figure 19.5.2

If we use the left hand rule on the electron flow, we point our fingers in the direction of the field and our thumb in the direction of electron movement and the palm of our hand indicates the direction of the force – UP !

This secondary force always opposes the first movement of the wire. **Lenz's law** states the induced current produces a magnetic field that opposes the motion that caused the induced current.

> *"An induced electromotive force generates a current that induces a counter magnetic field that opposes the magnetic field generating the current."*

Lenz's law also applies to electric motors. When an EMF is sent through a motor (aka, a current is passed through the armature of a motor) a force is produced that causes the armature to turn. This is electric energy converted to mechanical energy. The spin of the armature, however, now causes the motor to act like a generator and generate an EMF. The direction of the EMF is always the opposite of the original EMF that was sent through the motor. This second EMF is called **back-EMF**.

Summary

- Lenz's law states, "An induced electromotive force generates a current that induces a counter magnetic field that opposes the magnetic field generating the current."
- The spin of the armature, however, now causes the motor to act like a generator and generate an EMF. The direction of the EMF is always the opposite to the original EMF that was sent through the motor.

Review

1. Consider the sketch at below. Will a current be induced in the coil on the right when the magnet passes through?
    1. Yes
    2. No

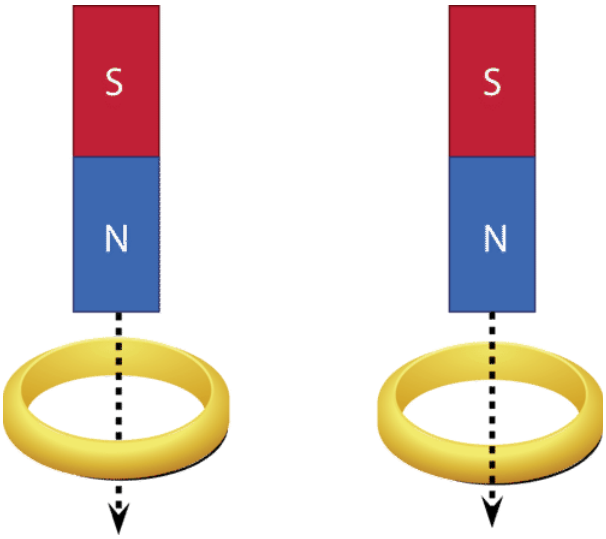


Figure 19.5.3

2. Will a current be induced in the coil on the left when the magnet passes through?
    1. Yes
    2. No
3. If a current is induced in the coil when the magnet passes through, which way will the current flow?
    1. clockwise
    2. counterclockwise
4. If both magnets are dropped though the loops shown at the same time, which magnet would reach the ground first?
    1. the one on the left
    2. the one on the right
    3. they would hit the ground together
5. Will a hand generator be more difficult to turn when it is generating current or when it is not generating current?
    1. generating
    2. not generating

Explore More

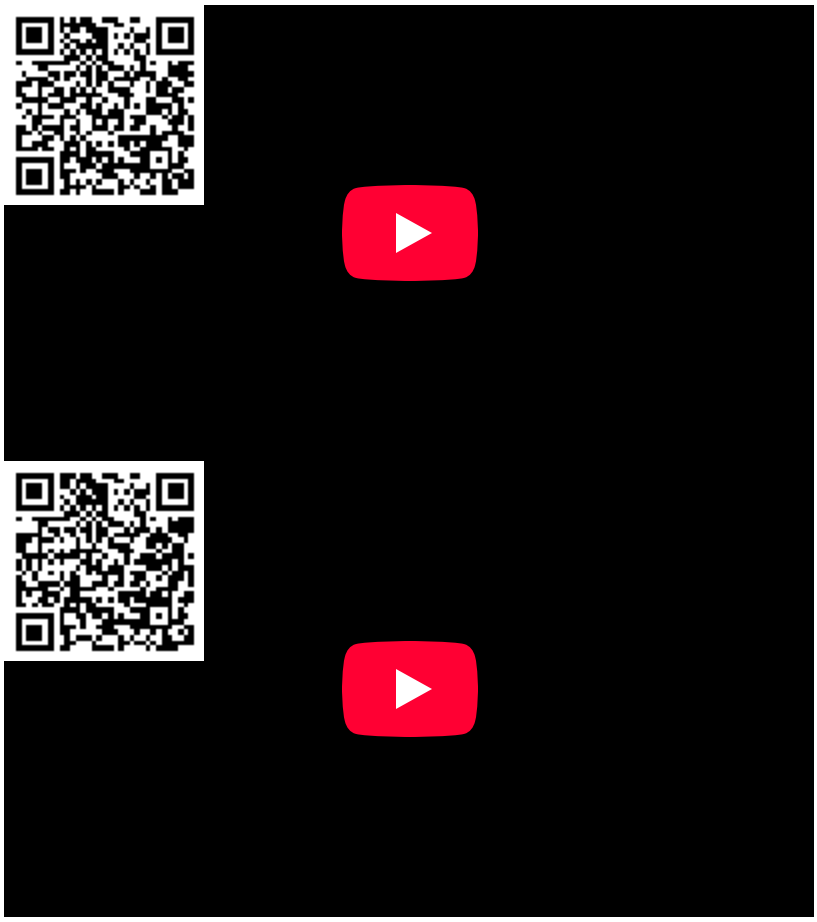
Use this resource to answer the questions that follow.

1. In general, how would the observation change if the aluminum tube were replaced with a copper tube?
2. In general, how would the observation change if the glass tube were replaced with a copper tube?

Additional Resources

Real World Application: Let's Play Pinball

Videos:



Study Guide: Magnetism Study Guide
