Activity 4 – Induction in an Aluminum Can

TEACHER'S GUIDE

In this activity, Lenz's Law is demonstrated. Lenz's Law states that an induced electromotive force generates a current that induces a counter magnetic field that opposes the magnetic field generating the current. In this activity, an empty aluminum can floats on water in a tray, such as a Petri dish. Students spin a magnet just inside the can without touching the can. The can begins to spin. Understanding what happens can be explained in steps:

- First, the twirling magnet creates an alternating magnetic field. Students can use a nearby compass to observe that the magnetic field is really changing.
- Second, the changing magnetic field permeates most things around it, including the aluminum can itself. A changing magnetic field will cause an electric current to flow when there is a closed loop of an electrically conducting material. Even though the aluminum can is not magnetic, it is metal and will conduct electricity. So the twirling magnet causes an electrical current to flow in the aluminum can. This is called an "induced current."
- Third, all electric currents create magnetic fields. So, in essence, the induced electrical current running through the can creates its very own magnetic field, making the aluminum can magnetic. Now the aluminum can's induced alternating magnetic field interacts with the twirling magnet's alternating magnetic field. This interaction spins the can since the magnetic forces are opposed, as Lenz's law states. Because the can sits on top of water, the friction between the can and the surface is very small, and only the magnetic forces act on the can while the students twirl the magnet .

Acknowledgment for this activity goes to Dindorf, W. —"Lenz's Law in the Kitchen." *The Physics Teacher*. Vol. 37, May, 1999.

GOALS

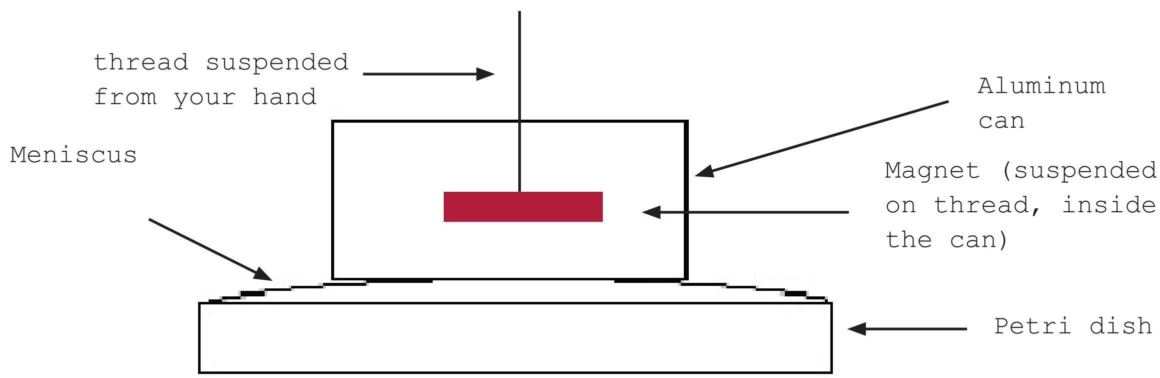
1) Students will know that electric current can be induced in non-magnetic metals through changing magnetic fields.
2) Students will know that the formation of an electrical current causes a magnetic field.
3) Students will know that magnetic fields interact with one another.
4) Students will know Lenz's Law: *"An induced electromotive force generates a current that induces a counter magnetic field that opposes the magnetic field generating the current."*

MATERIALS

- Small aluminum can
- Container (in which to float aluminum can)
- Spill tray
- Small cylindrical magnet (neodymium works best)
- Thread
- Tap water

PROCEDURE

1. Have enough materials on hand for student groups of two. Cat food cans work well. Just be sure they are made of aluminum. Soft drink cans do not work well. Their walls are too thin and sharp edges on cut cans poses a safety risk. Petri dishes make good float containers, and Styrofoam meat trays will do as spill trays.
2. Have students fill the container in which they will float the aluminum can as full as they can with water. They should form a meniscus at the top of the container so that the aluminum can floats above the top of the container.



3. The length of thread should be tied to the center of the magnet so that it hangs straight. When you dangle the magnet into the can, the magnet should also be at least one inch shorter than the diameter of the can so that it does not bang into the sides of the can while students attempt to spin it.
4. As you dangle the magnet from your hand, when you twist the thread between your fingers, the magnet should spin. Students may need to practice this so that they can successfully do it for the activity.
5. When the spinning magnet is lowered into the can, an electrical current is induced in the aluminum – which is a conductor. This electrical current itself creates a magnetic field in the metal of the can that opposes the magnetic field of the spinning magnet. These opposing fields cause the can to spin.
6. This is a demonstration of an electromagnetic effect known as Lenz's Law. Explicitly state Lenz's law (found on previous page) to the class.

TEACHER ANSWER KEY

1) No. Aluminum is not a magnetic metal; 2) The compass needle moves and/or the can is spinning; 3) The can slowly spins; 4) The answer to how this experiment works can be found above. **We recommend this question be used to determine if further discussions or explanations are needed with the class.**