TYNDALL SCIENCE AT HOME

LENZ LAW: MAGNETIC FORCE WITH A METAL CAN

AGES: 10 - 18

CONNECT Networks of the Future
Tyndall National Institute
Institiúid Náisiúnta
UCC Coláiste na hOllscoile Corcaigh, Éire University College Cork, Ireland
Rialtas na hÉireann Government of Ireland
Tionscadal Éireann Project Ireland 2040
Ireland's European Structural and Investment Funds Programmes 2014-2020
Co-funded by the Irish Government and the European Union
European Union European Structural and Investment Funds
sfi Science Foundation Ireland

#Tyndall200

A national celebration to mark the bicentenary of John Tyndall, one of Ireland's most imaginitive and influential scientists.

Take part by conducting this experiment at home. Take photos or make a video, and share it on social media using the hashtag **#Tyndall200**. You can also share photos or a 30-second video using our online entry form. Either way you'll be entered to win a #Tyndall200 prize pack for science lovers!

BACKGROUND

A magnet is a material or object which creates a magnetic field. This magnetic field is invisible and is responsible for creating the force that attracts or repels other objects.

Magnetism happens when tiny particles called electrons behave in a certain way. Spinning electrons form tiny magnetic forces. Sometimes lots of electrons in an object spin in the same direction and all the tiny magnetic forces from the electrons add up to make the object one big magnet.

Magnets can attract other materials. Only metals are attracted to magnets but not all metals are. Iron is magnetic, so any metal with iron in it will be attracted to a magnet. Steel contains iron, so a steel paperclip will be attracted to a magnet too. Most other metals, for example aluminium, copper and gold, are NOT magnetic.

Lenz Law, first hypothesized in 1834, is where any change made to a magnetic field will be resisted by a force. Some of John Tyndall's work on magnetism was inspired by the Lenz Law.

THE EXPERIMENT

In this experiment you use an aluminium can and a magnet to demonstrate Lenz Law in action. This is shown by the movement of the metal can as it resists changes to the magnetic field.

YOU WILL NEED:

- Any metal can
- Any magnet (stronger the better)
- String
- Sticky tape (optional)
- Measuring tape (optional)
- Protractor (optional)

The exact setup of experiment can be found on YouTube:
https://www.youtube.com/watch?v=yk4ACjzDFRY&t=126s

WHAT TO DO:

1. Hang the magnet above a surface using a piece of string (and sticky tape if needed). This step should ideally look like a pendulum with the magnet being the bob.
2. Move the can towards the magnet. As the effect is caused by changing magnetic field lines, the faster movements will result in greater deflections of the magnet.
3. Move the can away from the magnet.
4. Wiggle the can near the magnet
5. Optional when moving the can towards/away from magnet: Measure the greatest angle of deflection of the magnet.

WHAT YOU WILL SEE:

Aluminium is not attracted to magnets. However, if the aluminium can, or the magnet are moving, something strange happens. The motion creates tiny electric currents in the aluminium can. These currents create a magnetic field. The magnetic field created around the can then interacts with the magnetic field around the magnet and that's why we see the can move. When the magnet moves away, the can will follow. When the magnet approaches the can, the can will move away from the magnet. It is a very good experiment to show the consequences of Lenz' law.

EXPERIMENT NOTEBOOK

SCIENTIST NAME: ____

AGE: ____________ EXPERIMENT DATE: ___________________ TIME: ___________

One thing I learned was:

If I was doing this experiment again, I would try/use....

ADDITIONAL EXPERIMENT: AGES 15 - 18

You can work out the energy of the electrical currents in the can by the deflected angle in the magnet. Note the suspending magnet is effectively a pendulum. As the pendulum now has a swinging bob caused by the motion of the can, there has been energy transferred into the pendulum bob by the electrical currents in the can caused by the relative motion between the magnet and the can.

$$\textit{Energy in Swinging Bob:}\quad U = mgl\cos\theta$$

Here m is the mass of the suspended magnet (bob); g is the acceleration caused by Earth’s gravity (approximately 10); l is the length of the string; and θ is the angle of greatest deflection. From the conservation of energy, we can conclude that the energy in the pendulum must equal the energy of the electrical currents in the can.

John Tyndall (1820 - 1893) was one of Ireland’s most successful scientists and educators. Born in Leighlinbridge, County Carlow, he reached the pinnacle of 19th century science. His major scientific interest was the interaction of light with matter, and he is most widely known for the explanation of why the sky is blue. Tyndall National Institute, Ireland's leading ICT research institute, is named in recognition of his work.

Image: Carlow County Museum