# Adventures in creative recycling

## Classroom activity: eddy currents

Teacher Roberto Zamparini uses materials from obsolete electronic devices for science activities in the classroom. One such item is neodymium magnets from computer hard drives.

Made from an alloy of neodymium, iron and boron, neodymium magnets – also known as NIB (neodymium iron boron) magnets – are the most powerful permanent magnets known. They need careful handling, as they can cause injury as well as damage to computers and other devices, due to their very strong magnetic field. However, the high magnetic field strength of neodymium magnets means they are an excellent way to demonstrate magnetism-related phenomena in the classroom.

The following simple activity uses neodymium magnets, in conjunction with non-magnetic materials, to demonstrate magnetic braking due to eddy currents. There is no direct magnetic attraction between the materials, so the reason for the deceleration seen in the activity has to be found elsewhere: in Faraday's law of induction, and the associated Lenz's law.

**Safety note:** Take great care when handling neodymium magnets. If you take out the magnets from a hard drive, be careful as the two discs that compose it may slam together, possibly hurting your finger, and become hard to separate.

### Materials

- A neodymium magnet, ideally spherical or disc-shaped (so purchased rather than extracted from e-waste)
- A piece of non-magnetic metallic material (e.g. aluminium, copper) of a similar size and shape to the neodymium magnet (i.e. spherical if possible)
- A small, smooth copper plate
- A copper pipe with a diameter larger than that of the neodymium magnet and other metal pieces
- Clamp stand or other support made from non-magnetic material
- Stop watch (optional)
- Additional copper pipes of different diameters, all larger than the neodymium magnet and other metal pieces (optional)

### Procedure

1. Place one of the non-magnetic metal pieces at one end of the copper plate.
2. Now slowly tip the plate so that the metal piece starts to slide or roll down, under gravity.

Additional material for:

Florean C (2018) Adventures in creative recycling. *Science in School* **45**: 27–30. www.scienceinschool.org/2018/issue45/disassembly

3. Repeat this with the neodymium magnet. What do you observe? The magnet will move down the plate much more slowly than the non-magnetic material.
4. Repeat the same experiment with the copper pipe. Clamp the pipe in vertical position, and drop one of the non-magnetic metal pieces through the pipe. It will fall in a fraction of second, as expected.
5. Repeat this with the neodymium magnet. What do you observe? The magnet falls much more slowly than the metal piece – as if time were slowed down.
6. If you have two or more copper pipes with different diameters and a stop watch, you can record the time taken for the neodymium magnet to fall through each pipe. These results can be used to calculate the effect of the distance between the magnet and the copper pipe on the magnitude of the braking effect.

## Discussion

While the magnet is sliding down the copper plate, or falling through the pipe, the magnetic field inside the copper is changing. Changes in magnetic fields induce an electric current, called an eddy current. This current produces its own magnetic field. By Lenz's law, this current acts in a direction that opposes the change that generates it – that is, the falling magnet – thus slowing the magnet's fall. This effect is called magnetic braking.

Of course, the braking effect occurs because the pipes and plate are made from a material that is a good electrical conductor. The same effect would not occur using pipes made of plastic. Students could be asked to explain why.

## Resources

Watch a video showing a similar classroom demonstration of eddy currents using falling magnets. See: www.youtube.com/watch?v=otu-KV3iH_I