GENERATIONGENIUS
ALWAYS QUESTION. ALWAYS WONDER.

# TEACHER GUIDE

## ELECTRIC AND MAGNETIC
## GRADES 6-8

## COMMON MISCONCEPTIONS

- **Objects must be touching to exert forces.**
  Students are likely to have learned about forces in the context of objects in contact pushing and pulling on each other. Even if they have prior experience with magnets, they may not connect magnetic attraction and repulsion with contact forces.

- **Magnets attract all types of metal.**
  Students are likely to believe that magnets will attract all metal objects or all silver-colored objects. They may not understand that different metals have different compositions or that only certain metals will interact with magnets.

- **There is no connection between electricity and magnetism.**
  Students have likely encountered these topics separately, and they often believe that only magnets can produce magnetic fields. Middle school students are not likely to understand that all moving electric charges produce a magnetic field.

## NON-CONTACT FORCES

Some forces—magnetic, electric, and gravitational—can act between objects even when those objects are not in contact. These non-contact forces act through fields that extend through the space around an object and can be mapped by their effect on a test object (a magnetic object, a charged object, or a ball, respectively). Gravitational fields exist around all objects with mass, whereas magnetic and electrical fields are associated with electric charges. Electric fields are associated with positive and negative charges, whereas magnetic fields are created by moving charges.

## ELECTRIC FIELDS

An electric field describes the area around a charged object in which another charged object will experience an attractive or repulsive force. Opposite charges (+/-) attract each other, whereas like charges (+/+ or -/-) repel each other. The strength of the forces exerted by an electric field increases as the distance between two charged objects decreases and as the magnitude of the charges increases. The size of an electric field also increases as the magnitude of the charge increases. Objects can become charged by the loss, gain, or redistribution of electrons (the negative particles found around the nuclei of atoms that make up the object).

## MAGNETIC FIELDS

A magnetic field describes the area around a magnet in which another magnet will experience an attractive or repulsive force. Magnetic fields are created by moving electric charges, either current moving through a conductor in an electromagnet or the coordinating orbits of electrons around the atoms of a permanent magnet. All magnets have two poles, a north pole where the magnetic field lines diverge and a south pole where these lines converge. Opposite poles (N/S) attract each other, whereas like poles (N/N or S/S) repel each other. The strength of the forces exerted by a magnetic field increases as the distance between two magnetic objects decreases and as the strength of the magnet(s) increases. The strength of a magnet increases as the amount of electric charge in motion increases. Increasing the current in an electromagnet will increase its strength, while a permanent magnet in which more of its electrons are orbiting in the same direction will be stronger.

## TEACHER TIPS

- Encourage student questions from the junkyard video to motivate the electromagnet investigation. The investigation is most authentic if it is generated by student questions.
- Facilitate student discourse among each other and publicly with the class to support consensus-building. It is important for the class to take stock in competing ideas and then use evidence to figure out science ideas.
- Be sure to remind students of important lab safety considerations when working with electrical circuits

## ABOUT THIS LESSON

**This lesson was created by the National Science Teaching Association (NSTA) to pair with the Generation Genius video and support *NGSS*.**

**They have requested we provide the following background with this lesson:**

*The Next Generation Science Standards (NGSS)* are the national standards on how students learn science, and they are based on contemporary research presented in *A Framework for K–12 Science Education (the Framework).* The shift in science teaching and learning required by the Framework is summarized in this infographic: A New Vision for Science Education.

At the start of each Generation Genius lesson, students are presented with a phenomenon, then they try to explain it. Students will notice they have gaps in their knowledge and ask questions, which motivates them to build ownership of science ideas they need in order to explain how or why the phenomenon occurred. The way students build ownership of science and engineering ideas is through active engagement in the science and engineering practices (SEPs). This process of sensemaking, or doing science to figure out how the world works, is one of the major shifts the *Framework* encourages.

To engage in the SEPs, students should be part of a learning community that allows them to share their ideas, evaluate competing ideas, give and receive critiques, and reach consensus. Students can start by sharing ideas with a partner, then with a small group, and finally, with the whole class. This strategy creates opportunities for all students to be heard, build confidence, and have something to contribute to whole-class discussions. Each Generation Genius lesson provides conversational supports to facilitate such productive student discussions to contribute to sensemaking.

Excited to continue your shift toward the new vision for science education? Check out the Generation Genius Teacher Guide page on the NSTA website for resources and strategies to engage every student in your classroom in **doing** science.