



TEACHER INFO

MAGNETS AND STATIC ELECTRICITY GRADES 3-5

COMMON MISCONCEPTIONS

- **All silver colored objects or metal are attracted to magnets.**
Not all metals are magnetic. While many students associate shiny or silver-colored objects with magnetism, only certain metals—such as iron, nickel, and cobalt—are magnetic. Other metals like aluminum or copper, even if they look similar, are not attracted to magnets.
- **Larger magnets are stronger than smaller magnets.**
The size of a magnet does not always determine its strength. A small magnet made from a strong material can be more powerful than a larger one made from a weaker material. However, combining multiple magnets of the same type can increase the magnetic force they exert.
- **All magnets are made of the same material.**
Students may not realize that magnets can be made from a variety of materials. Some magnets are naturally occurring (like lodestone), while others are made from manmade materials such as alloys (mixtures of metals) or ceramic compounds. What makes a material magnetic is its ability to be magnetized, which depends on its atomic structure.
- **Only magnets can produce magnetic fields.**
While bar and disc magnets are common in the classroom, magnetic fields can also be created by electricity. When electricity flows through a wire, it generates a magnetic field around the wire—this is the principle behind electromagnets.
- **Static electricity stays in one place because it's "static."**
Despite the name, static electricity involves the movement of electrons. It is called "static" because the electric charge tends to build up on the surface of an object until it is discharged, often in a quick spark or shock. Electrons move from one object to another during this process—they do not remain completely still.

MAGNETS

Magnets are materials that exhibit magnetism. Different types of materials are more susceptible to attraction to magnets than others. Initially, young children learn that metal is attracted to magnets, and other materials are not. While it is true that non-metallic objects are not attracted to magnets, there is some variation as to how magnets interact with metal. Some, but not all, metals are strongly attracted to magnets.

MAGNETIC MATERIALS

Materials that are magnetic all the time are called permanent magnets. Materials that are attracted to permanent magnets can be called magnetic. Types of metal that are the most magnetic, or influenced by/attracted to magnets include iron, nickel and cobalt and are collectively called ferromagnetic materials. Other types of metal may be more weakly attracted to magnets. These metals include magnesium, molybdenum, lithium, and tantalum and are called paramagnetic. At this level, it is enough for students to understand that metals are attracted to magnets, some more strongly than others.

MAGNETIC FIELD

Magnets don't have to touch other materials to apply force to them. However, the closer magnets are, the stronger that force will be. Although magnetic fields are invisible, there are methods that can be used to visualize them. In the video, Dr. Jeff shows two methods: iron filings and ferrofluid (a liquid suspension of tiny metallic particles). The lines of force that comprise the magnetic field exit from one pole of the magnet and reenter at the other.

POLARITY

Magnets exhibit what is called polarity. Polarity causes one end of the magnet to be attractive to other magnets and the other end to repel other magnets. The poles are labeled N for North and S for South on either end of the magnet. Polarity is caused by moving charged particles at the atomic level (not addressed in detail at this level). Magnets push and pull other magnets depending on how they are arranged. If two magnets are arranged so that their N poles align, they repel each other. If two magnets are arranged so that their N and S poles align, they attract each other.

NEODYMIUM MAGNETS

Neodymium is a material that was engineered to exhibit the strongest magnetic properties possible. These magnets are made with a combination of iron, boron and neodymium. They are relatively inexpensive and commonly used in electronics such as smart phones, hard drives and headphones. The pushing and pulling forces between neodymium magnets are so strong that they can be dangerous to humans. When same poles are aligned they can snap together, crushing fingers. Opposite poles repel strongly and fly apart with great force. Use caution when interacting with even small neodymium magnets.

ELECTROMAGNETS

Magnetic fields are caused by moving charged particles at the atomic level. Electricity moves charged particles (electrons). Ferromagnetic materials, those that are highly attracted to magnets, can become magnetized when exposed to flow of electricity. In the video, an iron nail is wrapped in copper wire. When electricity flows through the wire (when the ends of the wire come into contact with the battery), the electric field causes the iron nail to become magnetized. Unlike permanent magnets, when the electricity is turned off (wire and battery disconnected), the magnetic properties disappear.

STATIC ELECTRICITY

Static electricity is another type of force that attracts and repels, or pushes and pulls. No magnets are involved. Instead, attracting (pulling) or repelling (pushing) forces are caused due to same or opposite electric charges. When one object is rubbed against another, electrons build up creating a negative charge. If this object is exposed to another negatively charged object, the charges repel, pushing the objects away from each other. This happens between the balloon and plastic bag strip during the DIY Destination Activity and also in the video when Zoe's hair and confetti are forced apart because they have the same charge. If a negatively charged object is exposed to a positively charged object, the charges are opposite and attract, or pull towards one another. This occurs when balloons are rubbed against cloth and then stuck to the wall (or to your body as Izzy demonstrates in the video). In this lesson the focus is on same or opposite charges, not positive and negative. When discussing static electricity the concept of shocking might come up. Students may have experienced a shock when their feet rubbing against the carpet built up a static electric charge which is discharged when they touch something conductive, like a doorknob or person.

VAN DE GRAFF GENERATOR

As Dr. Jeff shows during the video, a Van de Graff generator produces a static electric charge by rubbing two materials together (for example, a rubber belt and felt or metal). This is the same concept as shoes on a carpet, but the charge produced can be much greater. Safety precautions need to be taken when using a Van de Graff generator as the charge may become great enough to be harmful. In the video, you can see that Zoe places her hand on the dome before it is turned on, and she is standing on a rubber pad. The rubber pad provides insulation so that the charge from the generator does not travel through her body into the ground. If she were to touch the dome after the charge had built up and without that protection, the charge would transfer to her body with a large and dangerous shock!