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TEACHER GUIDE

MAGNETS AND STATIC ELECTRICITY

GRADES 3-5

COMMON MISCONCEPTIONS

- **All silver-colored objects or metal objects are attracted to magnets.**
  See magnetic materials below.
- **Larger magnets are stronger than smaller magnets.**
  Size and strength of magnets are not necessarily related. Strength is determined by the type of magnet. However, more magnets have a stronger force than fewer (for example two of the same type of magnet together apply a stronger force than one).
- **All magnets are made of the same material.**
  Ferromagnetic materials - metals like iron, nickel, and cobalt - can be magnetized. Some magnets are made from man-made alloys or mixtures of metals, and some are naturally occurring.
- **Only magnets produce magnetic fields.**
  Electricity flowing through a wire produces a magnetic field (electromagnets).
- **Static electricity is "static".**
  Static electricity is the result of an imbalance of electrons between two materials. The electrons move from one material to the other—they do not remain static.

MAGNETS

Magnets are materials that exhibit magnetism. Different types of materials are more susceptible to magnetic attraction 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 they 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 the ends of magnets to be attracted to or repelled by one another. 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 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 from their feet rubbing against the carpet, building up a static electric charge, which is then discharged when they touch something conductive, like a doorknob or person.

VAN DE GRAAFF GENERATOR

As Dr. Jeff shows during the video, a Van de Graaff 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 Graaff 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!