STEM IN THE LAB

innovate. explore. discover.

## OUR MISSION

INL's K-12 STEM Program works to inspire Idaho's future STEM workforce, impact students, teachers and families by integrating best practices in STEM education, and empower employees to become STEM mentors to transform K-12 STEM into a driver for innovation.

## MAGNET MAGIC OVERVIEW

*The Idaho National Laboratory conducted a research study on manually disassembling 91 components from four of the most common U.S. vehicles to quantify their NdFeB magnet content. In the research study results presented that NdFeB magnets were found only in speakers, precisely front speakers of upgraded pickups and all speakers of cars contained 16-114 g NdFeB/vehicle. Opportunities for magnet recycling may exist, it will take time to form a supply chain that connects scrap yards to magnet remanufacturers and component manufacturers. Using the engineering design process, students will generate a magnet pyramid structure to test out 3 different magnet experiments. This STEM activity will give students a chance to explore the invisible and strong attractive force called magnetism and work with magnets like some researchers at INL.*

## SCIENCE BEHIND IT

*Magnets are objects that convey a strong force field around them that causes them to attract ferromagnetic materials and other magnets themselves. Strong magnets are drawn instantly together when placed in close proximity. The magnetic field is invisible but can be felt. This is an enjoyable sensory experience for students to try and "touch" an invisible force.*

## VOCABULARY

**MAGNETS:** *are objects that convey a strong force field around them that causes them to attract ferromagnetic materials and other magnets themselves.*

**FERROMAGNETIC:** *phenomenon displayed by materials like iron (nickel or cobalt) that become magnetized in a magnetic field and retain their magnetism when the field is removed.*

**MAGNETIC FIELD:** *The area around a magnet in which there is magnetic force. Moving electric charges can make magnetic fields. The closer the flux lines are to each other, the stronger the magnet is. The farther away they are, the weaker. The flux lines can be seen by placing iron filings over a magnet.*

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# MATERIALS

- *Ceramic Donut Magnet*
- *12" Bamboo Skewers*
- *Rectangular Ceramic Magnets*
- *Magnetic Wands or use a pencil with a ceramic disc magnet hot glued to the end*
- *Modeling clay or play dough*
- *String or yarn*

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# PROCEDURES

### RESEARCH QUESTIONS

*Similar to engineers, students will sketch a design of their magnet pyramid structure. While students are sketching designs, prompt them with questions.*

- *What materials do you plan on using to construct your pyramid?*
- *How will you hold the skewers together?*
- *How long are the skewers?*
- *What material will you use to attach the magnet?*

### PROCEDURES

- *After students have accomplished researching and sketching out their designs, allow students to construct their prototype.*
- *Once time is up, allow students to form a line and have a museum walk of their displayed projects.*
- *If time, give students time to share positive comments and feedback about each other's magnet pyramid structures.*
- *Like engineers, students can formulate problems that they think may arise with their structures and how they could fix those problems. This would be a great way for students to "think pair share" together in pairs or groups.*
- *After students have collaborated together about possible problems and solutions, give students three rectangular ceramic magnets.*
- *Students will place the three magnets on each side of their structure.*
- *Teacher or students may lead the four magnet experiments listed below.*

### TIPS AND TRICKS

- **STEP ONE:** *Cut a piece of string about 8" long and thread through a donut magnet. Tie tightly.*
- **STEP TWO:** *Give each child (2) strips of modeling clay. Ask them to tear each strip in half and the roll the halves in a clay sphere. They will need (4) spheres in total. Construct the triangular base with a clay sphere at each joint.*
- **STEP THREE:** *Once the base is complete, add a skewer to the top of each sphere and collect at the center point to form a pyramid. Use the last clay sphere to connect the top three skewers.*
- **STEP FOUR:** *The magnet on a string may be pressed into the top clay sphere to hold in place at the desired height.*

# EXPERIMENT ONE – FOLLOW THAT FORCE

*Can you move something without even touching it? Magnetic force is very strong when magnets are placed in close proximity to each other. To see just how strong it is try this: Take two rectangular magnets and place them under the center point of the hanging donut magnet. Gently slide the rectangular magnets around and watch as your donut magnet follows the magnetic force. Twists and turn the donut magnet by twisting and turning the rectangular magnets beneath. Seemingly defy gravity by suspending your donut magnet at an angle!*

# EXPERIMENT TWO – THE INDECISIVE MAGNET

*Magnets have a north and a south pole. This means that one end of a magnet attracts and the other side repels if placed next to another magnet. This is a fun observation to make with magnets of any kind. To see how this repelling and attracting can drive a magnet crazy try this: Place one ceramic magnet under the center point of each bottom chord of your triangle base. Now gently lift your donut magnet and let it swing. It will bounce back and forth between the three magnets' fields as it encounters the different polarities. It will look like a wildly indecisive magnet that has no idea where to go! Move the rectangular magnets around to see what happens to the center magnet and how it swings based on its proximity to the different magnetic fields.*

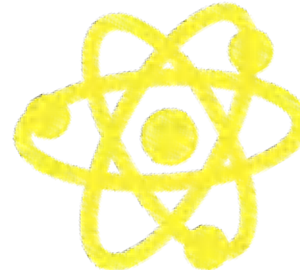
# EXPERIMENT THREE – AN INVISIBLE DANCE PARTNER

*This is my favorite experiment. Let the donut magnet rest as still as possible at the center of the pyramid. Now take a magnetic wand (or a strong magnet) and begin gently waving it near the donut magnet (don't get too close or the magnets will stick together). Watch as the donut magnet begins to sway and twirl. You can really make that donut magnet shake it's groove thing simply by moving your wand nearby! Because our donut magnet is suspended by a string it amplifies the twirling action. And for any doubters who think that the slight breeze generated by waving your hands is causing the magnet to dance, try waving your hand nearby without the wand. The donut stays put.*

# EXPERIMENT FOUR – THE JITTERS

*Place two rectangular magnets underneath the donut magnet. Gently pull on the donut magnet to release it from the magnetic field then let it drop and swing over the rectangular magnets. It will quickly be caught right back in the magnetic field and move quickly back and forth in a jitterbug dance.*

# EXTENSION ACTIVITIES



- *Students can write about their favorite experiment.*
- *Students can find a partner to share their favorite experiment with.*
- *Students can use different materials to attract their donut magnet.*
- *Students can build a new pyramid using different materials or students can make their pyramids taller.*
- *Students can analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.*

# RESOURCES

*https://www.sciencedirect.com/science/article/pii/S0956053X18306809?via%3Dihub#f0010*
*https://www.youtube.com/watch?v=0Y-oExd92eE*
*https://www.youtube.com/watch?v=MByZMQupHB0*
*https://www.nextgenscience.org/sites/default/files/K-2%20ETS-ED%207.1.13.pdf*
*https://www.nextgenscience.org/sites/default/files/K%20combined%20DCI%20standardsf.pdf*
*https://www.nextgenscience.org/sites/default/files/K%20combined%20DCI%20standardsf.pdf*
*https://www.sciencedirect.com/science/article/pii/S0956053X18306809?via%3Dihub#f0010*
*https://babbledabbledo.com/fun-science-experiments-magnet-magic/*

# STANDARDS

### K-2 NGSS ENGINEERING STANDARDS

- *K-2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.*
- *K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.*

### KINDERGARTEN NGSS STANDARDS

- *K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.*
- *K-PS2-2. Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.*

### THIRD GRADE NGSS STANDARDS

- *3-PS2-1. Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.*
- *3-PS2-2. Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.*
- *3-PS2-3. Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.*
- *3-PS2-4. Define a simple design problem that can be solved by applying scientific ideas about magnets.*