Teacher's Guide

For the Museum-on-the-Go's

"Electric Science" Program

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LETTER TO TEACHER OR EDUCATOR

The Museum-on-the-Go is coming to your school! We will be talking about something that we all use. We use it in our houses and at school. It helps us get work done. What is it? Electricity! We electricity can't exist without magnetism and magnetism can't exist without electricity so we will be talking about magnetism too.

The Museum-on-the-Go will be presenting the concept of electricity and magnetism. During the Museum visit, children will observe, explore and investigate the properties of electricity and magnetism through several hands on exhibits and facilitated inquiry. We will begin each class session with a few experiments demonstrated by the Museum-on-the-Go staff where we will explain the "magic" behind the experiments. After a brief introduction to our hands on exhibits, the students will have approximately 20 minutes of free exploration. We will end the class session with a closing demonstration.

To help get you and your students excited about the science of electricity and magnetism and the Museum-on-the-Go visit, we have provided you with some key vocabulary, fun facts about electricity and magnetism and a few demonstrations that you can do in the classroom before and after the Museum's visit.

Think of ways to extend the activities to compliment your current curriculum and don't hesitate to share any great ideas with us. Send your ideas to theresa@cmosc.org

Get excited about science!

Please don't hesitate to call me if you have questions. I look forward to seeing you and your students soon.

Theresa Giacomino,

Director of Education and Programs

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VOCABULARY

Some words relating to electricity and magnetism with Spanish translations:

Atom- átomo	Force-fuerza
Attract-atraer	Load-carga
Battery-batería	Lodestone-piedra o imán
Charge-carga (eléctrica)	Magnet-imán
Circuit-circuito	Molecule- molécula
Conductor-conductor de electricidad	Proton-proton
Current-corriente	Regulator-regulador
Electricity-electricidad	Repel-repeler
Electromagnet-electroimán	Resistor-resistente
Electron-electron	Static-estático

Can you think of anymore?

Vocabulary: assume that these definitions are in relation to electricity and magnetism. Some definitions have been given to better understand the vocabulary word given.

atom-*átomo* : a unit of matter, the smallest unit of an element, having all the characteristics of that element and consisting of a dense, central, positively charged nucleus surrounded by a system of electrons.

attract-*atraer* : to cause to draw near or adhere by physical force:Magnetic poles are attracted to their opposites.

battery-*batería*: two or more connected cells that produce a direct current by converting chemical energy to electrical energy.

charge-*carga(eléctrica):* the intrinsic property of matter responsible for all electric phenomena, in particular for the force of the electromagnetic interaction, occurring in two forms arbitrarily designated *negative* and *positive.*

circuit-circuito: a loop or circle that carries electric current from a power source to a load.

closed circuit-: an electric circuit providing an uninterrupted, endless path for the flow of current.

series circuit-: an electric circuit connected so that current passes through each circuit element in turn without branching.

parallel circuit-: a closed electrical circuit in which the current is divided into two or more paths and then returns via a common path to complete the circuit.

conductor-*conductor de electricidad*: a substance or medium that conducts heat, light, sound, or especially an electric charge. A lightning rod, as on a house or barn, certain metals, and people.

current-*corriente:* the flow of electricity in a conductor

electricity-*electricidad*: the physical phenomena arising from the behavior of electrons and protons that is caused by the attraction of particles with opposite charges and the repulsion of particles with the same charge.

electromagnet-*electroimán*: a magnet consisting essentially of a coil of insulated wire wrapped around a soft iron core that is magnetized only when current flows through the wire.
electron-*electron*: a stable, negatively charged subatomic particle. It orbits the nucleus of an atom and is attracted to the positively charged protons in the nucleus.

force-*fuerza*: active power, energy, or physical strength.

load-*carga*: any device to which electrical power is being delivered.

lodestone-*piedra o imán*: a piece of magnetite that has magnetic properties and attracts iron or steel.

magnet-*imán* : an object that is surrounded by a magnetic field and that has the property, either natural or induced, of attracting iron or steel.

magnetism-*magnetismo* : the class of phenomena exhibited by a magnetic field. The study of magnets and their effects. The force exerted by a magnetic field.

molecule-*molécula*: the smallest particle of a substance that retains the chemical and physical properties of the substance and is composed of two or more atoms.

proton-*protón*: a stable, positively charged subatomic particle. Part of the atom's nucleus.

regulator-*regulador*: a device used to control the flow of gases, liquids, or electric current.

repel-*repeler*: to present an opposing force to; push back or away by a force: *Electric charges of the same sign repel one another.*

resistor-*resistente*: a device used to control current in an electric circuit by providing resistance.

static-*estático*: having no motion; being at rest

static electricity-*estático de electricidad*: an accumulation of electric charge on an insulated body. Electric discharge resulting from the accumulation of electric charge on an insulated body.

FUN FACTS

(all demonstrations are attached)

FACT1 ***There is two types of electricity: static electricity and electrical current.***

Static electricity stays in one place, like the charge on something after you go down the playground slide and then get shocked. Electrical current moves and flows, like the current in the wires in a lamp.

Demonstration 1: Bend Water With Static Electricity This demonstration introduces the concept of positive and negative charges and the attraction and repelling properties that these charges can have.

Demonstration 2: Complete a Circuit Complete a circuit and demonstrate that electric current runs through a wire from the power source (battery) to a load (something that is being powered) and back to the power source.

FACT 2 ***A magnet has north and south poles that can attract and repel each other.***

Demonstration 3: Floating Magnets This very simple demonstrations shows the attracting and repelling effect that magnets have.

FACT 3 ***Magnetism is a force that is present in our own Earth. We can see this demonstrated with a compass.***

Demonstration 4: Make a Floating Compass Make your own compass and find out how it works.

FACT 4 ***Magnetism is electricity's close cousin. Moving magnets create electric current and is what we use to make motors and generators work.***

Demonstration 5: Motor Effect This simple device shows that when an electrical current flows through a magnetic field, a force is exerted on the current.

FACT 5 ***An electric current can create a magnetic field and make an electromagnet.***

Demonstration 6: Make an Electromagnet With wire, a battery and a nail you can make an electromagnet that will pick up small magnetic objects.

FACT 6 ***Static electricity is all about positive and negative charges.***

Demonstration 7: Static Balloon Gain a better understanding of how charges are attractive or repulsive just by playing with balloons.

DEMONSTRATIONS

*Experiments 1-6 have been correlated to California Science Content Standards for grades 2-6. This information is located on pages 12 thru 14.

Have fun with these demonstrations. There are some amazing activities available on the internet too. Here's a few just to get you started:

1. This is a great video explaining how we make electricity work for us. http://videos.howstuffworks.com/hsw/18618-electricity-and-magnetism-generating-electricity-video.htm
2. Great resource for the basics on how electricity works. http://science.howstuffworks.com/electricity.htm
3. Great website about physics for kids. http://www.physics4kids.com/files/elec_intro.html
4. Fun website with experiments with magnets. http://www.coolmagnetman.com/magindex.htm

Think of ways to extend the activities to compliment your current curriculum and don't hesitate to share any great ideas with us. Send your ideas to theresa@cmosc.org

Demonstration 1: Bend Water With Static Electricity

Some things to wonder about before starting the experiment:
What is static electricity? Where have we seen it? What makes it happen?

Have you ever gotten a shock coming off of the playground slide or heard your hair crackle and then stick to your sweatshirt when you take it off? Have you rubbed a balloon on your hair and stuck it to the wall? Have you seen lightning?

These things all happen because of static electricity.

Can you bend water with static electricity? Let's find out.

What you need for this demonstration:

- A dry day. A dry plastic comb
- An indoor faucet
- A head full of clean dry hair.

  Notice that everything needs to be dry. Moisture and humidity are a big factor for this demonstration. Why?

What to do:

1. Turn on the faucet and slowly turn down the water until you have a VERY thin stream of water flowing.

2. Take the plastic comb and brush it through your hair ten times.

3. Now slowly bring the comb close the the flowing water, (without actually touching the water) If all goes well, the stream of water should bend towards the comb! Magic you ask? Not really.

What's happening:

When you brushed that comb through your hair, tiny parts of the atoms in your hair, called ELECTRONS, collected on the comb. These electrons have a NEGATIVE charge. Remember that, it's important. Now that the comb has a

negative charge, it is attracted to things that have a POSITIVE charge. It is similar to the way some magnets are attracted to certain metals.
When you bring the negatively charged comb near the faucet it is attracted to the POSITIVE force of the water. The attraction is strong enough to actually pull the water towards the comb as it is flowing! If you want to try another experiment with your comb, tear up pieces of tissue until they are as a small as you can get them...I mean really small! Then charge your comb again by brushing it through your hair, and bring it close to the tiny pieces of tissue. If the pieces are small enough they will jump off the table to the comb the same way that the water was pulled to the comb. It is all thanks to the wonders of static electricity.

The project above is a DEMONSTRATION. To make it a true experiment, you can try to answer these questions:
1. Does water temperature affect how much the water bends?
2. Does the size of the comb affect the static power?
3. Does the amount of moisture in the air affect the static power? Try it after someone has taken a shower in the room.
4. Does the material that the comb is made of affect the static power?

Retrieved from: http://www.sciencebob.com/experiments/bendwater.php

Demonstration 2: Complete a circuit

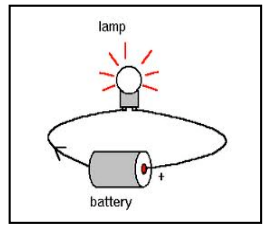
Some things to wonder about before doing this activity:

Can you make something work for you with just a small battery? What is a battery and where does the power come from?

What you need for this activity:

(materials can be found at Radio Shack)

- D-cell battery
- 1.2-volt light bulb (Radio Shack #272-1174)
- E-10 light bulb base (Radio Shack #272-356)
- 2 12-inch pieces of insulated stranded copper wire (Radio Shack #: 278-565), with one inch of insulation removed at each end
- masking tape



What to do:

1. Connect one end of each wire to the light bulb base.

2. Tape one free wire end to each end of the battery.

What's happening:

Electric current runs through a wire from the power source (battery) to a load (something that is being powered) and back to the power source. In order for electricity to travel to where we need it, there must be a complete circuit of electricity. A complete circuit is like a circle or a loop. Electricity starts at a particular place, travels around the circuit, and returns to the same place.

In this experiment, the complete circuit is something like the electrical distribution system that brings electricity to our homes. The battery produces the electricity like the generating plant does. What part of the distribution system is like the wires?

A battery is a form of chemical energy created by the acids contained inside. Here's a link so you can make a battery out of a lemon.
http://www.energyquest.ca.gov/projects/lemon.html

Other things to wonder about:

What happens if you only tape one of the wires to the battery? Why?

Can you connect more than one load to the same battery? You will need more wires prepared as the directions indicate and something else to power.

Will the lemon battery (link provided above) power the lightbulb?

Demonstration 3 -Floating Magnets

Some things to wonder about before doing this demonstration:

If two magnets are pressed together, will they attract or repel each other?
What makes magnets attract and repel?

What you need for this activity:

- Pencil
- 2 round ceramic magnets (Radio Shack- Model: 64-1888 | Catalog #: 64-1888)

What to do:

1. Put one magnet onto the pencil. You can hold the pencil in your hand or find a stand to hold it for you. This can be made of modeling clay or a piece of wood with a hole just big enough to insert the pencil.
2. Let the second magnet fall onto the first magnet.
3. Flip one of the magnet over and let it fall again. Is it a different reaction?

What's happening:

Depending on whether the magnets snapped together or seemed to "float" away from each other will help you determine how the poles of each magnet are oriented.

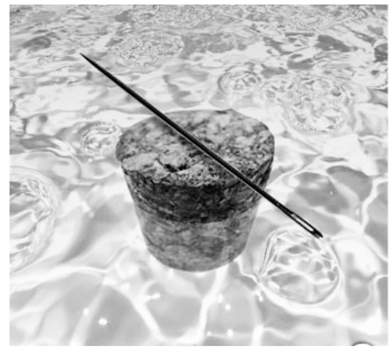
If they snapped together, you know that the north pole of one magnet is facing the south pole of the other magnet and are attracted to each other. If they seemed to "float", you know that the poles of each magnet are the same and are repelling away from each other. They are either two north poles or two south poles.

Demonstration 4: Make a floating compass

The Earth is a huge magnet and has magnetic poles. These poles influence the pointer of a compass.

Some things to wonder about before starting the experiment:

How does a compass work? Why is a compass an important tool?
When would a compass come in handy?



What you need for this activity:

- large sewing needle
- cork
- sharp knife
- permanent magnet
- glass or plastic cup full of water

What to do:

1. Rub the needle with the magnet 50 times. This will make the needle into a magnet.

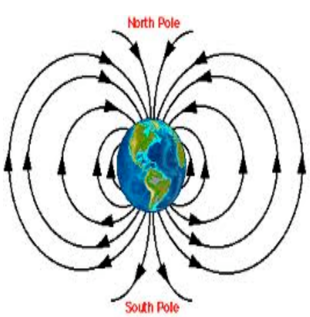
2. Cut a circle-shaped piece from the bigger end of the cork. This piece should be no thicker than 1/4 inch.

3. Lay the needle on the cork.

4. Spin the floating cork gently. When it stops, the needle will point in a North-South direction. Spin it again, and it will come back to the same place!

What's happening:

The Earth is a huge magnet and has magnetic fields. A compass is a small pivoted magnet that is affected by the Earth's magnetic field. The needle aligns itself from North to South and can help you determine direction.



Other things to wonder about:
How could you make a compass if you were lost in the wilderness? What could you use if you didn't have a needle or cork?

Here's a fun link to a compass making activity on a website for survival techniques:

http://www.survivaltopics.com/survival/make-a-floating-needle-compass/

Floating compass directions retrieved from: http://www.miamisci.org/ecolinks/activities/Geosphere/Compass/

Demonstration 5: Motor Effect

Things to wonder about before doing this activity:

How are magnetism and electricity related? How does the direction of the electric current affect the magnetic field?

What you need for this activity:
(materials can be found at Radio Shack)

- **4 to 6 small disk magnets.** (Radio Shack-Model: Ceramic magnet | Catalog #: 64-1883.)
- **One or two 1.5 volt flashlight batteries.**
- **Approximately 2 feet (60 cm) of flexible wire,** such as solid or multistranded hookup wire, or magnet wire (available at Radio Shack- Model: 278-565 | Catalog #: 278-565).
- **Masking tape.**
- **A wooden board** approximately 2 x 4 x 6 inches (5 x 10 x 15 cm).
- **A knife or sandpaper.**
- **Adult help.**

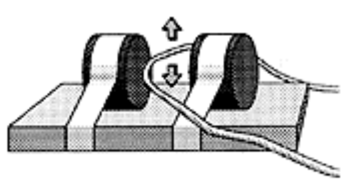
What to do:

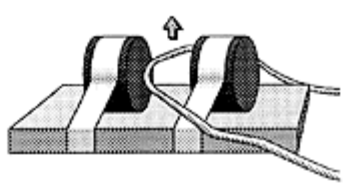
(15 minutes or less)

Group the disk magnets into a single cylindrical pile. Place the pile on the board so that it can be rolled along the board. Split the pile in the middle, leaving a gap of about 1/2 inch (1.3 cm) between the faces of the two groups. Tape the two groups to the board. A north pole will face a south pole across the gap.

Tape the battery onto the board as shown in the photo. Remove the insulation from the ends of the wire. (Use a knife for stranded wire, or use sandpaper to remove the nearly invisible insulating enamel from magnet wire.) Loop the wire through the gap between the magnets, with the ends of the wire close enough to the battery to touch it.

What to do next:





(5 minutes or more)

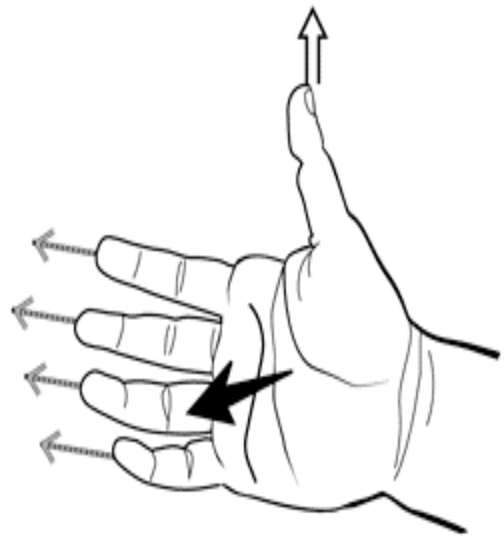
Touch one end of the wire to the positive side of the battery and simultaneously touch the other end of the wire to the negative side. The wire loop will jump either up or down.

If you reverse the direction of current flow, the wire will jump in the opposite direction. To reverse the current, attach the lead that was connected to the positive end of the battery to the negative end and vice versa.

What's happening:

The magnetic field of the disk magnets exerts a force on the electric current flowing in the wire. The wire will move up or down, depending on the direction of the current and the direction of the disks' magnetic field.

To predict the direction of movement, you can use a mathematical tool called the *right-hand rule*. Put your right hand near the section of wire that goes between the disk magnets. Make your hand flat, with your thumb sticking out to the side. (Your thumb should be at a right angle to your fingers.) Place your hand so that your thumb points along the wire in the direction that the electric current is flowing (current flows from the positive terminal of the battery to the negative terminal) and so that your fingers point from the north pole of the disk magnets toward their south pole. (You can find the north pole of the magnets by using a compass; the south end of a compass will point toward the north pole of a magnet.) Your palm will then naturally "push" in the direction of the magnetic force on the wire.



The deflecting force that a magnet exerts on a current-carrying wire is the mechanism behind the operation of most electric motors. Curiously (and happily for our sense of symmetry!), the reverse effect is also true: Move a loop of wire across the pole of a magnet, and a current will begin to flow in the wire. This, of course, is the principle of the electric generator. The electric current you generate by moving this single loop of wire through the weak magnetic field of the disk magnets is too weak to detect with all but the most sensitive of microammeters.

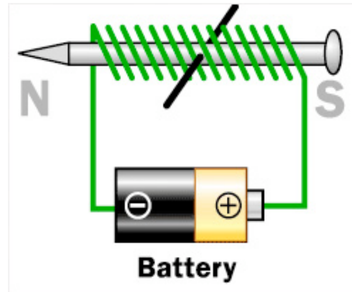
This experiment creates just a short pulse of motion. A motor requires continuous motion. This problem was solved originally in the early 1800s by the invention of commutators. A commutator is a sliding contact that not only makes electrical contact with a rotating loop of wire but also allows the current direction to reverse every half-cycle of rotation.

The first electric motors were constructed in 1821 by Michael Faraday in England and improved in 1831 by Joseph Henry in the United States.

A great explanation of how a generator works can be found at: http://www.howstuffworks.com/electricity2.htm
You can find many other explanations of how things work on this website.

Retrieved from: http://www.exploratorium.edu/snacks/motor_effect/index.html

Demonstration 6: Make an Electromagnet



Some things to wonder about before doing this activity:

Can electricity make a magnet? What are atoms?
What do they have to do with electricity and magnetism?

What you need for this activity:

- A large iron nail (about 3 inches)
- About 3 feet of THIN COATED copper wire (Radio Shack- Model: 278-501 | Catalog #: 278-501)
- A fresh D size battery
- Some paper clips or other small magnetic items.
- Electrical tape

What to do:

1. Leave about 8 inches of wire loose at one end and wrap most of the rest of the wire around the nail. Try not to overlap the wires.

2. Cut the wire (if needed) so that there is about another 8 inches loose at the other end too.

3. Now remove about an inch of the plastic coating from both ends of the wire and attach the one wire to one end of a battery and the other wire to the other end of the battery. (It is best to tape the wires to the battery - be careful though, **the wire could get very hot!**)

4. Now you have an ELECTROMAGNET! Put the point of the nail near a few paper clips and it should pick them up!

NOTE: Making an electromagnet uses up the battery somewhat quickly which is why the battery may get warm, so disconnect the wires when you are done exploring.

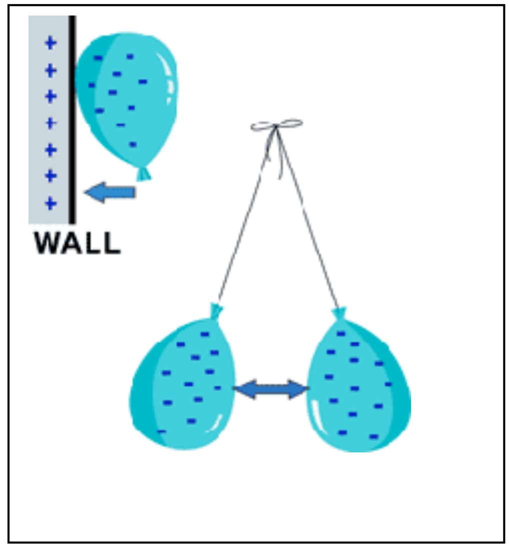
What's happening:

Most magnets, like the ones on many refrigerators, cannot be turned off, they are called permanent magnets. Magnets like the one you made that can be turned on and off are called **ELECTROMAGNETS**. They run on electricity and are only magnetic when the electricity is flowing. The electricity flowing through the wire arranges the molecules in the nail so that they are attracted to certain metals. NEVER get the wires of the electromagnet near at household outlet! Be safe - have fun!

The project above is a DEMONSTRATION. To make it a true experiment, you can try to answer these questions:

1. Does the number of times you wrap the wire around the nail affect the strength of the nail?
2. Does the thickness or length of the nail affect the electromagnets strength?
3. Does the thickness of the wire affect the power of the electromagnet?

Demonstration 7: Static Balloon



Some things to wonder about before doing this activity:

Can a balloon stick to a wall without tape or glue? How?

What you need for this activity:

- Balloon-size doesn't really matter.
  Small water balloons (no water) are nice to use for the whole class.
- Smooth wall
- String (for "Another Exploration" below)

What to do:

1. Inflate the balloon.
2. Rub the balloon on your hair vigorously.
3. Hold the balloon against a smooth wall.
4. Carefully let go of the balloon.

Did it work? Did the balloon stay on the wall?

Another Exploration:

1. Tie a string on the end of two balloons so you can dangle them.
2. Rub balloons on your hair.
3. Hang the two balloons next to each other.

Were they attracted to each other or did they repel away from each other?

What happened:

When you rubbed that balloon on your hair, tiny parts of the atoms in your hair, called ELECTRONS, collected on the balloon. These electrons have a NEGATIVE charge. Now that the balloon has a negative charge, it is attracted to things that have a POSITIVE charge. It is similar to the way some magnets are attracted to certain metals or opposite poles.
When you bring the negatively charged balloon near the wall, it is attracted to the POSITIVE force of the wall. The attraction is strong enough to actually make the balloon stick to the wall

The project above is a DEMONSTRATION. To make it a true experiment, you can try to answer these questions:

1. Can you rub the balloon on anything besides your hair? Try different fabrics.
2. Can you make the charged balloon stick to anything else?
3. How does the weather effect how static electricity behaves?
4. Does the moisture in the air matter?

Check out this website for more information on static electricity.
http://www.sciencemadesimple.com/static.html

CALIFORNIA CONTENT STANDARDS FOR DEMONSTRATIONS

***Demonstration 1- Bend Water with Static Electricity**

Grade 2
Physical Sciences:
1c. Students know the way to change how something is moving is by giving it a push or a pull. The size of the change is related to the strength, or the amount of force, of the push or pull.
1f. Students know magnets can be used to make some objects move without being touched.

Grade 3
Physical Sciences:
1h. Students know all matter is made of small particles called atoms, too small to see with the naked eye.

Investigation and Experimentation:
5a. Repeat observations to improve accuracy and know that the results of similar scientific investigations seldom turn out exactly the same because of differences in the things being investigated, methods being used, or uncertainty in the observation.

Grade 4
Physical Sciences:

1e. Students know electrically charged objects attract or repel each other.
1f. Students know that magnets have two poles (north and south) and that like poles repel each other while unlike poles attract each other.

Investigation and Experimentation:
6d. Conduct multiple trials to test a prediction and draw conclusions about the relationships between predictions and results.

***Demonstration 2- Complete a Circuit**

Grade 3
Physical Sciences:
1b. Students know sources of stored energy take many forms, such as food, fuel, and batteries.
1d. Students know energy can be carried from one place to another by waves, such as water waves and sound waves, by electric current, and by moving objects.

Investigation and Experimentation:
5a. Repeat observations to improve accuracy and know that the results of similar scientific investigations seldom turn out exactly the same because of differences in the things being investigated, methods being used, or uncertainty in the observation.

Grade 4
Physical Sciences:
1a. Students know how to design and build simple series and parallel circuits by using components such as wires, batteries, and bulbs.

***Demonstration 3: Floating Magnets**

Grade 2
Physical Sciences:

1f. Students know magnets can be used to make some objects move without being touched.

<u>Grade 3</u>
Investigation and Experimentation:
5d. Predict the outcome of a simple investigation and compare the result with the prediction.

<u>Grade 4</u>
Physical Sciences:
1f. Students know that magnets have two poles (north and south) and that like poles repel each other while unlike poles attract each other.

***Demonstration 4- Make a Floating Compass**

<u>Grade 3</u>
Investigation and Experimentation:
5a. Repeat observations to improve accuracy and know that the results of similar scientific investigations seldom turn out exactly the same because of differences in the things being investigated, methods being used, or uncertainty in the observation.

<u>Grade 4</u>
Physical Sciences
1b. Students know how to build a simple compass and use it to detect magnetic effects, including Earth's magnetic field.
1f. Students know that magnets have two poles (north and south) and that like poles repel each other while unlike poles attract each other.

***Demonstration 5- Motor Effect**

<u>Grade 3</u>
Investigation and Experimentation:
5a. Repeat observations to improve accuracy and know that the results of similar scientific investigations seldom turn out exactly the same because of differences in the things being investigated, methods being used, or uncertainty in the observation.

<u>Grade 4</u>
Physical Sciences:
1c. Students know electric currents produce magnetic fields and know how to build a simple electromagnet.
1g. Students know electrical energy can be converted to heat, light, and motion

<u>Grade 5</u>
Physical Sciences:
1c. Students know metals have properties in common, such as high electrical and thermal conductivity. Some metals, such as aluminum (Al), iron (Fe), nickel (Ni), copper (Cu), silver (Ag), and gold (Au), are pure elements; others, such as steel and brass, are composed of a combination of elemental metals.

***Demonstration 6- Make an Electromagnet**

<u>Grade 3</u>
Investigation and Experimentation:
5a. Repeat observations to improve accuracy and know that the results of similar scientific investigations seldom turn out exactly the same because of differences in the things being investigated, methods being used, or uncertainty in the observation.

<u>Grade 4</u>

Physical Sciences:

1c. Students know electric currents produce magnetic fields and know how to build a simple electromagnet.
1d. Students know the role of electromagnets in the construction of electric motors, electric generators, and simple devices, such as doorbells and earphones.
1g. Students know electrical energy can be converted to heat, light, and motion

<u>Grade 5</u>

Physical Sciences:

1c. Students know metals have properties in common, such as high electrical and thermal conductivity. Some metals, such as aluminum (Al), iron (Fe), nickel (Ni), copper (Cu), silver (Ag), and gold (Au), are pure elements; others, such as steel and brass, are composed of a combination of elemental metals.
(Au), are pure elements; others, such as steel and brass, are composed of a combination of elemental metals.