Forces and Interactions

3rd Grade Unit
Teacher Manual

NGSS Lesson Planning Template

Grade: 3rd grade	Topic: Forces and Interactions	Lesson (number/title): F 1- Forces in "Tug of War"

Brief Lesson Description:
Students will explore the impact of unbalanced and balanced forces through the game "Tug of War."

Performance Expectation(s):

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.

Specific Learning Outcomes:

Students will learn that an object will move in the direction of the largest force as well as an object will not be in motion if the forces are equal.

Narrative / Background Information

Teacher Preparation:
This activity will need to be completed in a large open space such as a field or gymnasium.

Background Knowledge:
A force is a push or pull on an object. Most of the knowledge that is known about forces was discovered by Sir Isaac Newton, a famous mathematician and scientist. He developed three laws involving forces and motion. In this activity, we will explore Newton's First Law of Motion: an object at rest tends to stay at rest and an object in motion tends to stay in motion, unless acted upon by an outside, unbalanced force.

Balanced forces occur when an object is not moving. For example, when a book is resting on a table it has balanced forces on it. (The force of gravity is pushing down on the book is equal to the force the desk is exerting to push the book up.) When unbalanced forces occur, an object will change positions or motions.

Prior Student Knowledge:
In Kindergarten through second grade, students should have learned pushes and pulls can have different strengths and directions, and can change the speed or direction of its motion or start or stop it. The concept of push and pulls may need to be reviewed.

Science & Engineering Practices:	Disciplinary Core Ideas:	Crosscutting Concepts:
☐ Asking questions (science) and defining problems (engineering) ☐ Obtaining, evaluating, and communicating information	**PS2.A: Forces and Motion** -Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative addition of forces are used at this level.) (3-PS2-1) - The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. (Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.) (3-PS2-2)	☐ Patterns ☐ Cause and effect: Mechanism and explanation

Possible Preconceptions/Misconceptions

1. An object that is not moving has no forces acting on it.

LESSON PLAN – 5-E Model

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions

1. Lead students to an area where a large rope is laying in the middle. Arrange students in a fashion so all students are able to see the rope from the same angle.
2. Pose the questions: "Is the rope moving?" (No.) "How can we make the rope move?" (Have students brainstorm ideas of how to make the rope move. They should record their ideas in their science journal.)
3. Facilitate a discussion about the ways we can move the rope. (Based on prior knowledge, the students' answers should include pull the rope and possibly push the rope.)

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions

You will begin this lesson by only using one piece of rope (normal "Tug of War" and will transition into "4 Way Tug of War.")

4. Explain that students will be exploring the concept of force using the game "Tug of War." In the game, there needs to be teams of people on each side of the rope.
5. Students will then generate three different possible teams to compete against another team be used in the game and record their ideas in their journal. Each team that they create will be used to answer a testable science question. For example, a student may want to see boys verses girls to test the question "Who is stronger, boys or girls?"
6. The teacher will randomly select students to test their questions. As the student shares the teams they have selected, focus on the question the students are trying to answer. Students may need some help wording their question into a scientific question.
7. The class will then compete in a game of tug of war to test the question. Students should record the results and possible explanation for the result in their science journal.
8. The teacher should select three different situations to have the students test out.

EXPLAIN: Concepts Explained and Vocabulary Defined

9. After the students have tested their questions (scenarios) in "Tug of War," the teacher should facilitate discussion. The main focus of the discussion should be that the rope moved in the direction that had the largest force upon it.
10. The teacher should then explain that everything has force upon it. If an object isn't moving, there are balanced forces upon it. The teacher should explain that the rope laying still has equal forces upon it. It has gravity pushing it down to earth while the ground is pushing the rope up. The forces on both ends of the rope are the same since no one is pulling on it.
11. The teacher should then demonstrate that the rope will move when forces become unbalanced. The teacher should then pick up the rope in the middle. The teacher should explain the rope has moved (changed position) because the force of gravity is less than the force exerted by picking up the rope.
12. The teacher should explain that more than one force is always acting on an object. An object will move when there are unbalanced forces.

ELABORATE: Applications and Extensions

13. To illustrate more than one force is acting on it, students will play a class game of "Four Way Tug of War." To create this game, the teacher will attach the additional rope by tying a knot in the middle of the rope. Through this activity, students could discover that the merging and combining of teams could help create unbalanced forces and allow the rope to move in the direction of the greater force.

EVALUATE:

Formative Monitoring (Questioning / Discussion):

Students will be making predictions, observations, and asking questions in their student journals. The teacher will also be asking questions and facilitating discussion throughout the entire lesson.

Summative Assessment (Quiz / Project / Report):

Students will be assessed on forces using a fixed-response assessment and a performance assessment at the end of this unit.

Elaborate Further / Reflect:

Optional: Choose an item in the classroom. Students can record what forces that are occurring on that object at that time. They should also record whether or not the object has balanced or unbalanced forces upon it.

Notes about this lesson:

Lesson 1: Forces in Tug of War

List as many ways as you can to make a rope move.

_______________ _______________ _______________

_______________ _______________ _______________

_______________ _______________ _______________

SCENARIO 1:

Team 1		Team 2
____________		____________
____________		____________
____________		____________
____________		____________

By setting up these teams, what question will you be trying to answer?

____

____

SCENARIO 2:

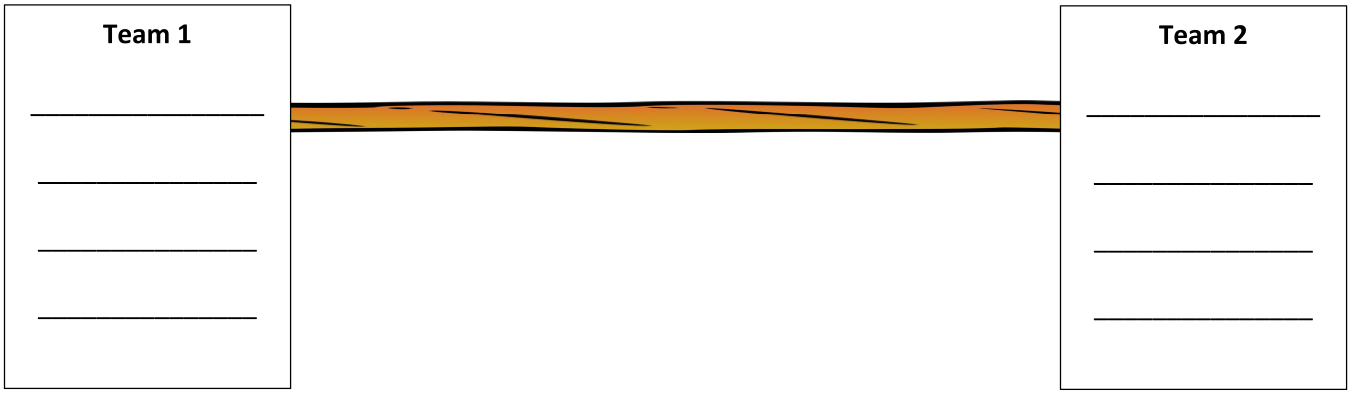
Team 1		Team 2
____________		____________
____________		____________
____________		____________
____________		____________

By setting up these teams, what question will you be trying to answer?

____

____

SCENARIO 3:



By setting up these teams, what question will you be trying to answer?

____

____

JOURNAL WRITE

Choose an object that is not moving from around the room. Draw it in the box below. Using arrows, draw a picture to illustrate the forces acting on the object. Use the lines provided to explain your picture and the arrows.

NGSS Lesson Planning Template

Grade: 3rd Grade	Topic: Forces and Interactions	Lesson (number/title): Lesson F2 - Falling Objects

Brief Lesson Description:
Children are introduced to the term, "gravity". By conducting an experiment with a ping pong ball and a golf ball, they explore what effect gravity has on weight.

Performance Expectation(s): 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.

Specific Learning Outcomes:

- Students will understand that gravitational force acts continuously on an object as it falls.
- Two objects dropped from the same height should hit the ground at the same time.
- All things fall to the ground because of the pull of gravity.

Narrative / Background Information

Prior Student Knowledge: Students have been exposed to the term "gravity."

Science & Engineering Practices:	Disciplinary Core Ideas:	Crosscutting Concepts:
☐ Asking questions (science) and defining problems (engineering) ☐ Developing and using models	**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.**	☐ Patterns ☐ Cause and effect: Mechanism and explanation

Possible Preconceptions/Misconceptions
Misconceptions: A heavier object will hit the ground before a lighter object.
Misconception: A larger object will hit the ground before a smaller object.

Falling Objects

Gravity- the force that keeps things from flying off into space. The force that pulls objects down.

1. Write a prediction for what will happen for the following situation:

If I drop a ping pong ball and golf ball at the same time from the same height, which one will hit the ground first? Why do you think that?

____

____

____

2. Drop a ping pong ball and a golf ball from the same height. Record your observations below. Which one hits the ground first?

Trials	Ping Pong Ball	Golf Ball	Same time
Trial 1			
Trial 2			
Trial 3			

3. Report your findings below. What did you discover?

____

____

____

4. Go home tonight and ask your parent the question, "If I drop a golf ball and a ping pong ball at the same time, which one will hit the ground first? Why?"

____

____

____

5. When Neil Armstrong dropped the hammer and the feather, why did they hit the moon at the same time?

____

____

NGSS Lesson Planning Template

Grade: 3rd Grade	Topic: Forces and Interactions	Lesson (number/title): Force Lesson F3 - Flicking Force

Brief Lesson Description:

Students will predict and observe what happens when force is applied to an object, and compare the relative effects of a force of the same strength on objects of different weights by flicking the ping pong ball then the golf ball *gently* with a finger and measuring the distance the ball covered with a ruler. Students will repeat this procedure using a harder flick.

This lesson was adapted from the Utah Education Network http://www.uen.org/Lessonplan/preview?LPid=14858

Performance Expectation(s):

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

Specific Learning Outcomes:

Students plan and conduct an investigation to explore forces on the motion of an object. Students make predictions on the effect of different forces on a moving object.

Narrative / Background Information

Background for Teachers
Force is anything that tends to change the state of rest or motion of an object (NY Public Library Science Desk Reference, 274). Forces cause changes in the speed or direction of the motion of an object. The greater the force placed on an object, the greater the change in motion. (Newton's Second Law of Motion) The more massive an object is, the less effect a given force will have upon the motion of the object. This activity uses *working definitions*. A working definition is a definition determined by students. It may or may not be completely correct; however, it should be used and corrected by the students as they gain more experience with and understanding of the concept. The strength of a working definition is that it is an indicator of student understanding and can be used by the teacher to guide further experiences.

Teacher Preparation:
Gather necessary materials and place them in a distribution center for student groups to gather.

Prior Student Knowledge:
Basic understanding of force and movement from to lesson one in this unit.

Science & Engineering Practices:	Disciplinary Core Ideas:	Crosscutting Concepts:
☐ Asking questions (science) and defining problems (engineering) ☐ Planning and carrying out investigations ☐ Analyzing and interpreting data ☐ Using mathematics and computational thinking ☐ Engaging in argument from evidence ☐ Obtaining, evaluating, and communicating information	PS2.A: Forces and Motion ☐ Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (3-PS2-1)	☐ Cause and effect: Mechanism and explanation

Possible Preconceptions/Misconceptions

Possible preconception is the harder you hit an object the farther it goes.

LESSON PLAN – 5-E Model

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions

Access Prior Learning:
Have students discuss different sports that are played with balls and a striking force and what they know about force and the motion and direction of the ball. e.g. baseball, badminton, tennis, ping pong, hockey

Generate Questions

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions

Materials Needed for each pair of students:

- One ping pong ball
- One golf ball
- One ruler
- Assortment of spherical objects of varying weights

Probing or Clarifying Questions:
What effect does the force of the same strength have on objects of different weights?

Instructional Procedures:

1. Instruct students to predict what will happen when an equal force is applied to objects of different weight.

2. Instruct the students to flick the ping pong ball gently with one finger and measure the distance the ball covered.

3. Record the distance on the Force Chart. Repeat for 3 trials.

4. Instruct the students to flick the ping pong ball as hard as possible with one finger and measure the distance the ball covered.

5. Record the distance the ball covered on the Force Chart. Repeat for 3 trials.

6. Repeat steps 2 through 5 using the golf ball.

EXPLAIN: Concepts Explained and Vocabulary Defined

7. Using the information recorded on their charts, have students compare data and draw conclusions about force applied to objects and it's outcome in distance and direction the object traveled.

8. Gather students together and discuss what they have discovered. The following questions may be used to guide the discussion.
   *What did you discover about the ping pong ball as a force in motion?
   *What did you discover about the golf ball as a force in motion?
   *Which ball produced the greater direction/distance and why?
   *What can you conclude about amount of force and the weight of the object? Use your data to draw conclusions.
   *How would the speed of the object and distance change if the force had increased or decreased in strength? Use your data to draw conclusions.
   *What does weight have to do with force?

9. Allow students time to explore with force applied to objects by having available other spherical objects of varying weights.

10. Guide students in creating a *working definition*.

11. Introduce Newton's Second Law of Motion – more mass needs a greater force to accelerate. The greater the force applied to an object, the greater the change in speed or direction of the object.

Vocabulary: Inertia, balanced and unbalanced forces

ELABORATE: Applications and Extensions

12. Guide students in making a list of forces they see every day and how those forces effect the motion of the objects. (examples could include batting or kicking a ball, strong winds and breezes blowing, flowing water).

EVALUATE:

Formative Monitoring (Questioning / Discussion):

- Observe the students as they apply new concepts and skills
- Look for evidence that the students have changed their thinking or behaviors.

Summative Assessment (Quiz / Project / Report): End of Unit Assessment

Elaborate Further / Reflect:

- Ask students to make a model of force applied to an object and its outcome to demonstrate for the class.
- Knowing what we now know about force and outcome, design and draw a paddle you would use to win a ping pong tournament.
- Watch Bill Nye the Science Guy The Law of Inertia: https://www.youtube.com/watch?v=ZFoG7HRF2mE

Notes for Future Reference:

Lesson 3- Flicking with Forces

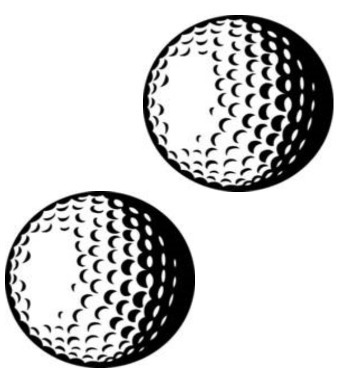
Ping Pong Ball

Trial	Soft Flick Measured in cm	Hard Flick Measured in cm
1		
2		
3		

What was the greatest distance travelled? ______________________________

This distance happened with a: ☐ **Hard Flick** ☐ **Soft Flick**

Golf Ball



Trial	Soft Flick Measured in cm	Hard Flick Measured in cm
1		
2		
3		

What was the greatest distance travelled? ______________________________

This distance happened with a: ☐ **Hard Flick** ☐ **Soft Flick**

NGSS Lesson Planning Template

Grade: 3rd Grade	Topic: Forces and Interactions	Lesson (number/title): Forces Lesson F4 - Pendulum Swing

Brief Lesson Description:

Students will plan and conduct an investigation to explore the effects of force on an object in motion.
This lesson was adapted from the Utah Education Network http://www.uen.org/Lessonplan/preview?LPid=14858

Performance Expectation(s):
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.

Specific Learning Outcomes:
Students plan and conduct an investigation to explore forces on the motion of an object. Students make predictions on the effect of different forces on a moving object. Students make observations of an object's motion to provide evidence that a pattern can be used to predict future motion.

Narrative / Background Information

Background For Teachers:

Refer to lesson one for background information on Newton's first law of motion. (An object at rest will remain at rest unless acted on by an unbalanced force. An object in motion continues in motion with the same speed and in the same direction unless acted upon by an unbalanced force. This law is often called "the law of inertia".)

This lesson plan uses a pendulum. When a pendulum is set in motion it remains in motion, thus allowing time to perform experiments on an object in motion. Many universities exhibit large pendulums (Foucault Pendulum) that actually show the rotation of the earth, hence they are important instruments having to do with force and motion.

Teacher Preparation:
- Gather materials needed
- Cut lengths of string in 2 foot sections – 1 per student pair
- Cut 2 pieces of masking tape in 6 inch sections

Prior Student Knowledge:
Basic understanding of Newton's first law of motion introduced in lesson one.

Science & Engineering Practices:	Disciplinary Core Ideas:	Crosscutting Concepts:
☐ Asking questions (science) and defining problems (engineering) ☐ Developing and using models ☐ Planning and carrying out investigations ☐ Analyzing and interpreting data ☐ Constructing explanations (science) and designing solutions (engineering) ☐ Engaging in argument from evidence ☐ Obtaining, evaluating, and communicating information	PS2.A: Forces and Motion ☐ Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion (3-PS2-1) ☐ The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it (3-PS2-2)	☐ Patterns ☐ Cause and effect: Mechanism and explanation

Possible Preconceptions/Misconceptions

A possible preconception is the predictable pattern of a child swinging in a swing.

LESSON PLAN – 5-E Model

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions

1. **Discuss/review lesson one concept/outcomes of Newton's First Law of Motion.**

2. **Watch videos on pendulums to stimulate interest and generate questions:**

   - **Foucault Pendulum at the Houston Museum of Natural Science**
     http://www.youtube.com/watch?v=nB2SXLYwKkM

   - **United Streaming: TEAMS: Force and Motion: Measuring Forces Segment 5 "How do Pendulums Work?"**
     http://app.discoveryeducation.com/search?Ntt=pendulum&N=18341&N=4294949582&N=4294939062

     The QR Code below will take you to your United Streaming Log-in page. Once you log in, it will immediately take you to the TEAMS video. Click on Segment 5 to view.

EXPLORE: Lesson Description –

Materials Needed:

For each group:

- Ruler
- 2 pieces of masking tape
- 2 feet of string
- 2" ping pong ball
- Lesson 4-Builiding a Pendulum Paper
- Large straw

Probing or Clarifying Questions

How does a force applied to an object effect the speed or direction of an object in motion?

Instructional Procedures

Explain that students will be building a machine to make observations of an object's motion to provide evidence that a pattern can be used to predict future motion and further explore the effects of force on an object in motion. Each group is responsible for building a machine and using it to experiment with applying force to an object in motion.

1. Display the materials and have the students brainstorm ways they can build a pendulum using the materials provided. Guide the children to think about how they can create a pendulum that is attached to a permanent fixture. Explain that all materials must be used and students may NOT hold their pendulum.
2. Once their pendulum is constructed have students refer to Lesson 4 in their journal.
3. Groups predict what will happen when a force acts on the pendulum and write their predictions in their student journal for lesson 4.
4. Groups are to conduct the investigation making sure to document their observations on their worksheets.

EXPLAIN: Concepts Explained and Vocabulary Defined

Teacher:

- Asks for justifications (evidence) and clarification from students to provide evidence that a pattern can be used to predict future motion.
- Formally provides definitions, explanations, and new labels
- Vocabulary: Pendulum, fulcrum point, Inertia, balanced force and unbalanced force

Students:

- Uses their recorded observations in explanations.
- Listens critically to others' explanations.

ELABORATE: Applications and Extensions

Teacher:

- Refers students to existing data and evidence and asks: What do you already know? Why do you think...?

Students:

- On a blank sheet of paper, encourage students to draw and label their pendulum creation while in motion.
- Regroup students with new partners and have students check for understanding with their peers.

EVALUATE: Formative Monitoring (Questioning / Discussion):

Teacher:

- Asks open ended questions such as: Why do you think....? How would you explain...? What evidence do you have?

Students:

- Answers open ended questions by using observations, evidence, and previously accepted explanations.
- Asks related questions that would encourage future investigations.

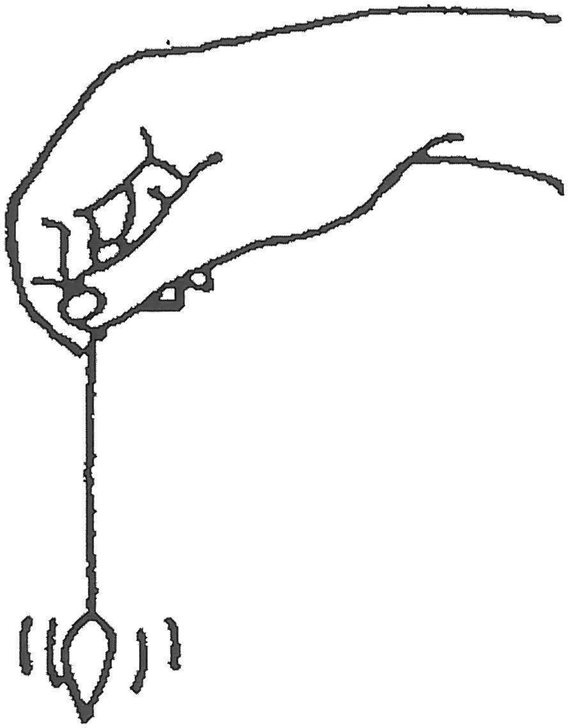
Summative Assessment (Quiz / Project / Report): End of Unit Assessment test

Elaborate Further / Reflect:

- Ask students to observe these concepts in real world applications and explain them using support from their recorded observations.

<u>Notes for Future Reference:</u>

Lesson 4-Build a Pendulum



Notes/Questions from Video Clip 1

Notes/Questions from Video Clip 2

Mission: Your group will need to build a working pendulum using ALL the materials provided: a ball, string, ruler, and tape.

Write the steps in space below to describe how to build your pendulum.

1. ______________________________

2. ______________________________

3. ______________________________

4. ______________________________

5. ______________________________

Draw a picture of your pendulum.

Force	Prediction	Results	Why?
Blowing			
Tapping with your hand			
Tapping with a paper			
No force (just watch it)			

Which method of force caused the greatest movement?

☐ Blowing ☐ Tapping with hand ☐ Tapping with paper ☐No force

Which method of force caused the least movement?

☐ Blowing ☐ Tapping with hand ☐ Tapping with paper ☐No force

Name three things that could happen when a force acts upon a moving object.

1. ______________________________

2. ______________________________

3. ______________________________

NGSS Lesson Planning Template

Grade: 3rd Grade	Topic: Forces and Interactions	Lesson (number/title): F5 Static Electricity

Brief Lesson Description:
Students will experiment with static electricity.

Performance Expectation(s):

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.

Specific Learning Outcomes:
Students will learn about and observe the effects of static electricity.

Narrative / Background Information

Prior Student Knowledge:
Students have experienced getting shocks from people when walking across the carpet.

Background Information:
Rubbing the balloons against your hair and the woolen fabric creates static electricity. This involves negatively charged particles jumping to positively charged objects. When you rub the balloons against your hair or the fabric they become negatively charged, they have taken some of the electrons from the hair/fabric and left them positively charged.

Your positively charged hair is attracted to the negatively charged balloon and it will rise up to meet it. The aluminium can is drawn to the negatively charged balloon. The area near it becomes positively charged and opposites attract.

In the first experiment both the balloons were negatively charged after rubbing them against the woolen fabric. Because of this, they were not attracted to each other.

Science & Engineering Practices:	Disciplinary Core Ideas:	Crosscutting Concepts:
Constructing explanations (science) and designing solutions (engineering)	PS2.A: Forces and Motion Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative addition of forces are used at this level.)	Patterns Cause and effect: Mechanism and explanation

Possible Preconceptions/Misconceptions
Misconceptions: That static electricity is not a form of electricity.

LESSON PLAN – 5-E Model

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions
Ask the students, "Have you ever gotten a shock from another person? What caused the shock?"
Tell them that they are experiencing static electricity when that happens. Ask children if they can think of any other ways to show the transfer of static electricity.
Ask, "What do you think would happen if you rubbed two balloons on a piece of fabric and then put them close together? Would they be attracted to each other or repelled?"

EXPLORE:
Lesson Description

Instruct the students to follow the steps below:
1. Children write a prediction down in their science journal about what will happen when you place two static electrically charged balloons
next to each other.
2. Rub the 2 balloons one by one against the woolen fabric, then try moving the balloons together. Do they want to attract or do they repel each other?
3. Children record a prediction about the effects of rubbing a balloon against their hair.
4. Rub 1 of the balloons back and forth on your hair then slowly pull it away. Have group members observe what happens.
5. Predict what will happen when you place a static electrically charged balloon next to an aluminum can.
6. Put the aluminum can on its side on a table. After rubbing the balloon on your hair again, hold the balloon close to the can and observe what happens. Does it roll towards it or away? Slowly move the balloon away from the can and see what happens.

Materials Needed: Two balloons per group
One tin can per group
One piece of woolen fabric per group

Probing or Clarifying Questions: What causes static electricity?
What evidence did you see that tells you static electricity is present?

EXPLAIN: Concepts Explained and Vocabulary Defined

Rubbing the balloons against your hair and the woolen fabric creates static electricity. This involves negatively charged particles jumping to positively charged objects. When you rub the balloons against your hair or the fabric they become negatively charged, they have taken some of the electrons from the hair/fabric and left them positively charged.

Your positively charged hair is attracted to the negatively charged balloon and it starts to rise up to meet it. The aluminum can is drawn to the negatively charged balloon. The area near it becomes positively charged and opposites attract.

In the first experiment both the balloons were negatively charged after rubbing them against the woolen fabric. Because of this, they were not attracted to each other.

ELABORATE: Applications and Extensions
Regroup and discuss any other examples of the transfer of static electricity students can think of.

EVALUATE:
Formative Monitoring (Questioning / Discussion): Monitor students working in groups and listen to whole class conversation to check for understanding.

Summative Assessment (Quiz / Project / Report): These concepts will be assessed by fixed questions on the end of the unit assessment.

Elaborate Further / Reflect:

Static Electricity!

1. What will happen if you rub two balloons on a piece of cloth and then put them next to each other?

Prediction: ____

2. Rub the 2 balloons one by one against the woolen fabric, then try moving the balloons together. Do they attract or do they repel each other?

____

____

3. Predict what will happen when you rub a balloon on your hair.

____

4. Rub one balloon back and forth on your hair, then slowly pull it away. Have your group members observe what happens. Record your findings below:

____

____

____

5. Tip your tin can over and lay it in the middle of the table. Rub one balloon on your hair and place it close to the can. (Be careful not to touch the balloon to the can.) Does the can roll towards the balloon or away from it? Slowly move the balloon away from the can and see what happens. Record your findings below:

____

____

____

____

NGSS Lesson Planning Template

Grade: 3rd grade	Topic: Forces and Interactions	Lesson (number/title): M 1- Introduction to Magnets

Brief Lesson Description:
In this lesson students work in small groups to complete four activities that serve as an introduction and review of the idea that magnets attract and repel other magnets.

Performance Expectation(s):
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.

Specific Learning Outcomes:
Students will investigate and confirm their understanding of how magnets attract and repel other magnets.

Narrative / Background Information

Background Information

1. Natural magnets are found in some rocks which contain iron. Magnets can also be made of iron, steel, nickel, cobalt, rare earth materials and the alloys of these metals.
2. Every magnet has a magnetic field which interacts with the magnetic fields of objects containing iron or other magnetic materials. Most magnetic materials that students will use are made of some form of iron.
3. Magnets usually have two poles, a north-seeking and a south-seeking pole.
4. The magnetic power of a magnet is strongest near its poles and weakest midway between the poles.
5. When two magnets are placed near one another, they react according to the poles that are near one another. Unlike poles attract and like poles repel.
6. When quantified, the magnetic powers of attraction and repulsion are mathematically equal.
7. Magnets can attract magnetic materials through all nonmagnetic and most magnetic materials.
8. Magnetic fields vary in strength.
9. Two magnets together have a single magnetic field and are considered one magnet.
10. It is possible to magnetize an iron or steel object by stroking it with a magnet.
11. Since magnetic force is greater than that of gravity, magnetism can be used to defy gravity in various ways.
12. An electromagnet can be constructed using a batter, insulated wire and a nail.
13. It is possible to measure magnetic force (attraction and repulsion) in newtons using a spring scale.

Prior Student Knowledge

In Kindergarten through second grade, students should have learned pushes and pulls can have different strengths and directions, and can change the speed or direction of its motion or start or stop it. Also, students should have previous experience in developing simple scientific questions that can be tested.

Students should be familiar with the following vocabulary: magnet, magnetism, magnetic field, poles, permanent magnet, temporary magnet.

Science & Engineering Practices:	Disciplinary Core Ideas:	Crosscutting Concepts:
☐ Asking questions (science) and defining problems (engineering) ☐ Obtaining, evaluating, and communicating information	**PS2.B: Types of Interactions** - Objects in contact exert forces on each other. (3-PS2-1) - Electric and magnetic forces between a pair of objects do not require that the objects be in contact. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other. (3-PS2-3),(3-PS2-4)	☐ Patterns

Possible Preconceptions/Misconceptions

1. A magnet will always attract to another magnet.

LESSON PLAN – 5-E Model

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions

1. Show a simple demonstration of attraction and repulsion using two bar magnets.
   - Place one magnet on the table and then a second magnet a distance from the first.
   - Ask students, "What do you think will happen as I move the magnet closer to the first magnet?" Provide students the time to write their prediction in their science journal.
   - Allow students to "turn and talk" to their neighbor and share ideas.
   - Move the magnets closer together. [The magnets will either be attracted or repelled.]
   - Ask the students, "Were you surprised? Why are the magnets behaving the way they did? Can I change how the magnets react?" Record student ideas about what they already think they know about magnets (poles and principles of repulsion/attraction) on chart paper or the board.

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions

2. Although the following activities could be done as class demonstrations, it is recommended that the teacher set up stations so that students have first-hand experience with the magnets.
3. A teacher resource guide is provided to ensure proper set up of each station.
4. Set up the stations before the lesson if possible.

Station One: (dowel, several flexible magnets, metal washers)

a. Using a wooden dowel, insert two disk magnets over the end of the pencil or dowel and see what happens to them. Do they stick together or are they forced apart?
b. Repeat the experiment by adding several disk magnets to the pencil or dowel. Have the students explain why some attract and some repel each other.
c. Have the students see if they can make each of the magnets appear to "float above each other."
d. Students can try variations of the experiment by adding metal washers between the magnets. Do the washers change what is happening to the magnets?
e. Students record information on the data sheet and include a testable question in the science journal to complete this station.

Station Two: (12-inch string, 2 bar magnets)

a. Tie a 12-inch piece of string from the middle of a bar magnet and suspend it from the side of a table with a piece of tape.
b. Hold the other bar magnet close to the end of the first magnet and see what happens. Are the two magnets attracted to each other or do they repelled? Now turn the magnet in your hand around and try the experiment again.
c. Students record information on the data sheet and include a testable question in the science journal to complete this station.

Station Three: (Tape, 2-12 inch pieces of thread, magnetic craft tape)

a. Tape the ends of a 12 inch thread or small string to opposite sides of a small piece of magnetic craft tape.
b. Tape the loop formed by the thread to a table so that the magnet strip is suspended over the edge.
c. Do the same with a second piece of magnetic craft tape of equal size. As you hang the magnetic tape, make sure it is as close as possible to the first piece, but not touching.
d. Spin one of the magnets a few times to wind the thread and then release it.
e. Using your knowledge of poles, attraction and repulsion, explain the motion of the two magnets.
f. Students record information on the data sheets and include a testable question in their science journal to complete this station.

Station Four: (Desk, ruler, magnets, yarn)

a. Using a ruler and a desk, suspend one disk magnet from a string or fishing line so that it is a free swinging pendulum. You can hang the magnet in any orientation and should hang about one inch from the ground.
b. Arrange three piles of two or three magnets stacked together in an equilateral triangle, measuring about 6 inches per side, with the suspended in the middle of the triangle.
c. Adjust the length of the pendulum so that the free-swinging magnet will come as close as possible to the magnets on the base without hitting the ground or the magnets.
d. Give the pendulum magnet a push and watch what happens.
e. Have the students record the results in their journals.
f. Vary the locations and poles of the magnets to develop other patterns. You can arrange the magnets so they all have the same pole up, or you can mix them up. Notice that a tiny change in the location of one of the fixed magnets or in the

starting position of the pendulum may cause the pendulum to develop a whole new pattern of swinging.

g. This experiment shows the force of gravity and the simple pushes and pulls of the magnets as they act together. It is difficult to predict where the pendulum is going to go next, even though you know which magnets are attracting it and which are repelling it.

h. Students record information on the data sheets and include a testable question in their science journal to complete this station.

EXPLAIN: Concepts Explained and Vocabulary Defined

Regroup as a whole class after students have rotated through each station. Facilitate a discussion about the results the students discovered in regards to magnets to ensure they are prepared for the next lessons.

During this time, please make sure the discussion includes:

a. Attract: a force that means the object is drawn towards another object

b. Repel: a force that means one object is pushing away from another object

c. Asking scientific questions: A scientific question is always testable.

HELPFUL HINT: The teacher may want to make a chart to record scientific questions so the students can visually see the questions as well.

Optional: Students may listen and dance to the song "Music Makes it Memorable: Magnets" found on Discovery Education.

- http://app.discoveryeducation.com/search?Ntt=Magnets&N=18340&N=18341

ELABORATE: Applications and Extensions

Continued in additional lessons

EVALUATE:

Formative Monitoring (Questioning / Discussion):

Students will be engaged in scientific discussions with peers. They will also be completing tasks and recording observations at different stations into a science journal.

Summative Assessment (Quiz / Project / Report):

At the end of the forces and interactions unit, students will complete a fixed-response assessment and a performance assessment to demonstrate their knowledge of forces.

Elaborate Further / Reflect:

Continued in additional lessons

This lesson is adapted from Oakland Schools.

Notes about this lesson:

Teacher's Guide to Stations

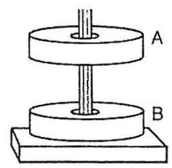
Lesson 1 Forces and Interactions: Magnets

There are four stations that will need to be arranged prior to the students beginning this lesson. If your class allows, divide students into four groups. If your class size does not accommodate groups of this size, you may want to create a fifth station for silent reading of a book about magnets or forces.

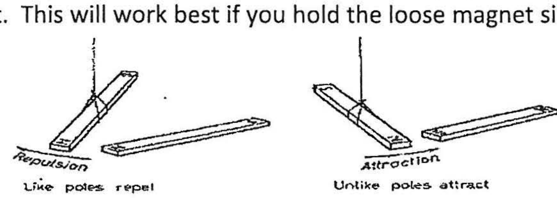
You will find a sign for each station in the packet. These should be folded and taped at the station to allow for easy transitions from one station to another.

It is also a great plan to demonstrate how students should work through each station before allowing students time to explore. Each center should take less than ten minutes and can be adjusted to meet the needs to your classroom.

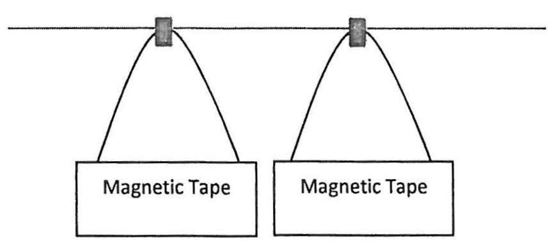
STATION 1: Students will be exploring disk magnets. They will be seeing when magnets attract and repel. Students should put their pencils with the eraser down on the desk.



STATION 2: You will need to tie a 12-inch piece of string to the center of a bar magnet. Tape the end of the string to the desk. Drape the magnet over the edge of the desk so it is hanging. A loose bar magnet will then be used to point at the hanging magnet. This will work best if you hold the loose magnet similarly to a wand.



STATION 3: Take a 12-inch piece of string and tape both ends to a piece of magnetic tape. Tape the loop on the string and hang it over the edge of table. Make another string loop using the exact same size materials. Hang the second loop as close as possible to the first but do not let it touch!!! Students will then twist one magnet and see what happens.



STATION 4: You will need to suspend a magnet from the side of a desk. Place 3 "X" with tape to form an equilateral triangle. These should be placed at a distance that the suspended magnet will come close to each "X" but will not it. Your string may need to be adjusted to reach the appropriate spot

.

Lesson 1- Introduction to Magnets

What will happen when one magnet moves closer to another?

____

____

____

STATION 1

Attempt	Results
Place 2 magnets on pencil	
Add another magnet	
Flip one magnet	
Place one washer between magnets	
Place another washer between magnets	

Think of a question that you could test at this station?

____

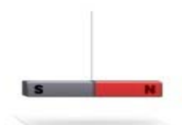
____

____

STATION 2

Hold the magnet like a wand. Point it at the hanging magnet. Move it closer.

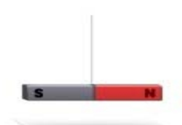
Draw an arrow to show the direction the magnet will move.



The magnets : ☐ attract ☐ repel

Hold the magnet in your hand with the other end pointing out. Point it at the hanging magnet. Move it closer.

Draw an arrow to show the direction the magnet will move.



The magnets : ☐ attract ☐ repel

Think of a question that you could test at this station?

____

____

____

Station 3

Twist one magnet 3 times.

What happens to the magnet when you let it go?

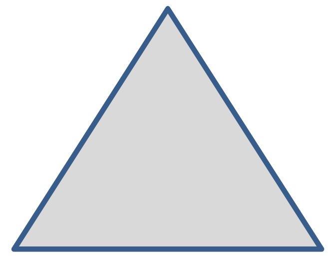
Number of Twists	Observations
1	
4	
10	

Do you think the number of twists changes the way the magnet responds?

Think of a question that you could test at this station?

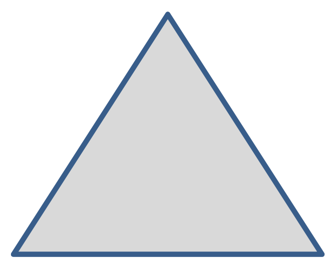
Station 4

Decide how you would like to arrange magnets on the ground. Draw and label your arrangement. Include the number of magnets in your drawing.



Where did the magnet swing to? Circle the spot with a red crayon.

Rearrange the magnets on the X's. Draw and label you new arrangement.

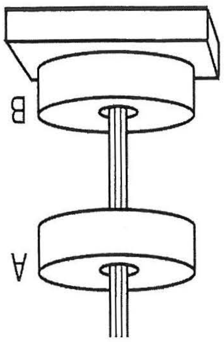


Where did the magnet swing to? Circle the spot with a red crayon.

Think of a question that you could test at this station?

Station 1

1.Put two disk magnets on a dowel.
2.Record what happens in your journal.
3.Explore what happens when you:
  -Add more magnets
  -Put washers on the dowel.
4. Can you make the magnets float?
  -Make a prediction of why.
5. Write a question that you could test at this station.



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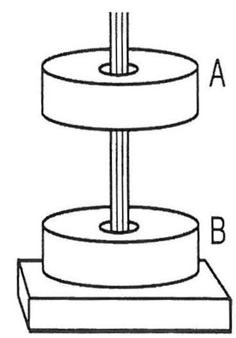
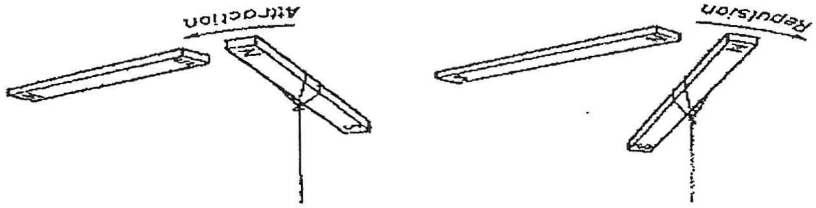


Station 2

1. There should be a bar magnet tied to a piece of String dangling from a desk.
2. Hold the tip of another bar magnet near the hanging magnet.
3. What happens? Record your answer in your journal.
4. Try touching the hanging magnet with the other tip of the magnet. What happens?



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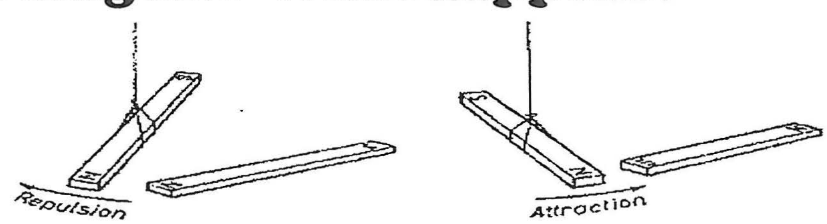

Station 3

1. There should be two magnets taped to the side of your table.
2. Take one magnet and gently twist it around.
3. Let the magnet go. Record what happens in your journal.
4. Repeat the activity. Did anything different happen?

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1. There should be two magnets taped to the side of your table.
2. Take one magnet and gently twist it around.
3. Let the magnet go. Record what happens in your journal.
4. Repeat the activity. Did anything different happen?

Station 4

1. There should be a magnet tied to a piece of string dangling from a ruler taped to a desk.
2. Make a small stack of magnets on each of the small x's on the desk.
3. Give the hanging magnet a small push or pull. What happens? Record this in your journal.
4. Rearrange the magnets on the x's.
5. Swing the magnet again. What happened?
6. Can you predict what will happen next?

Station 4

1. There should be a magnet tied to a piece of string dangling from a ruler taped to a desk.
2. Make a small stack of magnets on each of the small x's on the desk.
3. Give the hanging magnet a small push or pull. What happens? Record this in your journal.
4. Rearrange the magnets on the x's.
5. Swing the magnet again. What happened?
6. Can you predict what will happen next?

NGSS Lesson Planning Template

Grade: 3rd grade	Topic: Forces and Interactions	Lesson (number/title): M2 Lesson 2: Multiple Magnets

Brief Lesson Description:
This lesson will explore the strength of one magnet versus the strength exerted by two or more magnets.

Performance Expectation(s):

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.

Specific Learning Outcomes:
Students will begin to understand the concept of a controlled experiment.
Students will conduct an experiment in a systematic way.
Students will determine that the strength of combined magnets is stronger than that of one magnet.
Students will gain understanding that the strength of magnets does not go up exponentially when more magnets are added.

Narrative / Background Information

Teacher Prior Knowledge: Magnets have many uses- holding cabinets or refrigerator doors closed, controlling roller coasters, etc. These magnets must be strong, but not too strong. How strong does the magnet need to be? How strong is too strong? Someone had to do some experiments to find the answers to these questions.

A "fair test" is another way of doing a "controlled experiment". All things in the experiment remain the same except for the thing that you are trying to investigate.

In this experiment, students explore how the strength of a magnet changes when it is combined with other magnets. The only variable that is changed in this experiment is the number of magnets used. Make sure to ask students how to make their experiment a "fair test".

Prior Student Knowledge: Magnets can be placed on top of each other. Magnetic force can travel through wood.

Science & Engineering Practices:	Disciplinary Core Ideas:	Crosscutting Concepts:
☐ Asking questions (science) and defining problems (engineering) ☐ Developing and using models ☐ Analyzing and interpreting data ☐ Obtaining, evaluating, and communicating information	**PS2.B: Types of Interactions** • Objects in contact exert forces on each other. (3-PS2-1) • Electric and magnetic forces between a pair of objects do not require that the objects be in contact. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their	☐ Patterns ☐ Cause and effect: Mechanism and explanation

Possible Preconceptions/Misconceptions
Misconception- each time you add a magnet, the power will be doubled or follow a pattern.
Misconception- all magnets have equal strength.
Misconception- strength of magnets cannot pass through other objects.

LESSON PLAN – 5-E Model

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions

Engage the students in a discussion of how magnets are used to solve real world problems. Give the example of magnets being used on cabinet doors to help keep them closed. Have children share their knowledge of how magnets are used in our everyday world.

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions

Probing or Clarigying Questions: How does the strength of a magnet change when more than one is added together.

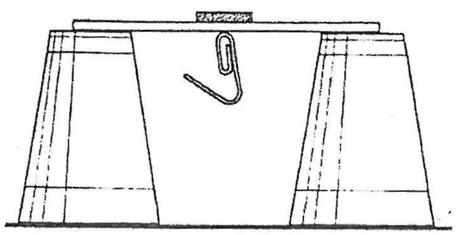
Materials Needed : Each group of 4 students will need:

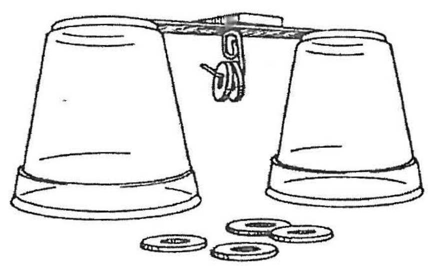
- 4 flexible magnets or disc magnets
- 2 plastic cups
- 1 tongue depressor
- 1 jumbo paper clip
- 6 washers

Lesson Description: Ask students how they think manufacturers decide how strong their magnets must be. Start by asking students if they were responsible for buying magnets to hold a cabinet closed, how would they know whether a magnet is too strong, too weak, or just right?

Have a discussion about what makes a fair test. After showing the children the materials that will be used in this experiment, ask them what they think putting two magnets together will do to the strength of the magnets. Will they cancel each other out? Will they be two times as strong? Less than that? More than that? Also ask if they think three magnets will be stronger than two. Ask them how they think we could find out the answers to these questions.

Show children the materials: magnets, cups, craft stick, jumbo paper clips, washers.
Tell them that they will be testing the concept of whether putting more than one magnet together can change the strength of the magnet.
Demonstrate the setup of the experiment:





Direct the students to the worksheet in their journal where they will be keeping track of their data.

EXPLAIN: Concepts Explained and Vocabulary Defined

Regroup: Have groups share their results with the class. Come to a class consensus about the strength of multiple magnets. Have a discussion about their findings, and talk about how that applies to real life applications with magnets.

ELABORATE: Applications and Extensions

Ask students to predict how many washers they think six magnets will hold. Have them record their predictions. Then have them test six magnets and add the data to their chart. Ask students what they think would happen if they add 12 magnets. Their predictions might assume that each time a magnet is added, magnets will keep getting stronger. This is not true. Instead, each magnet added is farther away from the hook and washers, therefore, it will contribute less strength than the combined strength of the magnets. Demonstrate this to the class to clear up any misconceptions.

EVALUATE:

Formative Monitoring (Questioning / Discussion): Monitor how each student is functioning as part of a group.
Data chart and response in student journals.

Summative Assessment (Quiz / Project / Report): Students will complete an end of unit assessment with fixed-responses as well as a performance assessment.

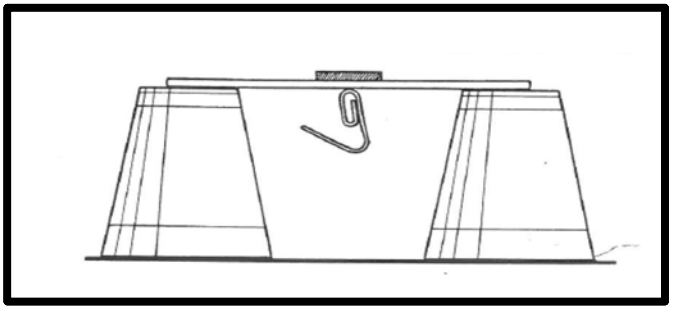
Elaborate Further / Reflect:

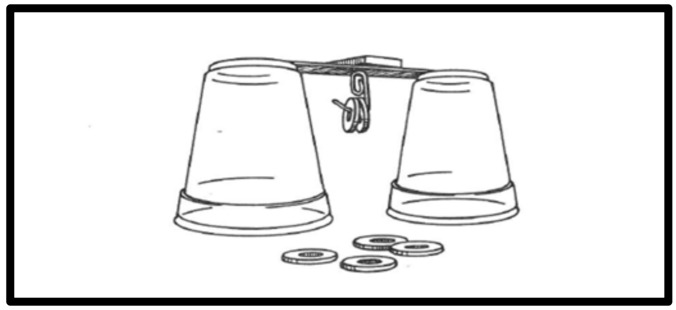
Notes for this lesson:

Multiple Magnets

Focus Question: How does the strength of a magnet change when more than one magnet is added together?

Set up your materials to look like the diagram below:





Slowly add washers to the paperclip. Record the number of washers there were on the clip before it fell off. Add a magnet and repeat the above procedure. Record your findings in the chart below:

# of Magnets	Number of Paperclips
1	
2	
3	
4	
6	

Take a close look at your data. Describe any patterns that you see in your data. Record your ideas below. ____

____

What can you conclude about the strength of multiple magnets as compared to just one magnet?

____

____

NGSS Lesson Planning Template

Grade: 3rd Grade	Topic: Forces and Interactions	Lesson (number/title): Magnet Lesson M3 – Object Sort

Brief Lesson Description:
Students make predictions, test and sort objects into magnetic and nonmagnetic sets.

Lesson adapted from Michigan Citizenship Collaborative - Oakland SCoPE Lesson Packet – Heat, Electricity and Magnetism

Performance Expectation(s):

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.

Specific Learning Outcomes:

Students make predictions and test various items for their magnetic interaction. Students observe that magnetic objects are affected by the strength of the magnet and the distance from the magnet.

Narrative / Background Information

Background for Teacher:

- All substances display magnetic properties, but most show them to a very small degree and we consider them nonmagnetic. Very sophisticated equipment is needed to detect magnetic characteristics at these low levels. On the other hand, a few metallic elements such as iron, nickel, cobalt, rare earth materials, plus some of their alloys like steel and strontium ferrite display magnetic properties strongly enough to be considered magnetic or more properly *ferromagnetic.*

Teacher Preparation:

- The teacher should test the magnets with the materials to be certain that the magnets are strong enough to complete the activities.
- Prepare small plastic bags with a mixture of paperclips, small nails, brass fasteners
- Prepare small bags of salt and iron filing mixture
- For the third activity put a magnet in a plastic bag before running the magnet through the salt/filing mixture to attract iron bits from the salt mixture.

Prior Student Knowledge:
Basic understanding about magnets from lesson one.

Science & Engineering Practices:	Disciplinary Core Ideas	Crosscutting Concepts:
☐ Asking questions (science) and defining problems (engineering) ☐ Planning and carrying out investigations ☐ Analyzing and interpreting data ☐ Using mathematics and computational thinking ☐ Constructing explanations (science) and designing solutions (engineering) ☐ Engaging in argument from evidence ☐ Obtaining, evaluating, and communicating information	PS2.B: Types of Interactions ☐ Electric and magnetic forces between a pair of objects do not require that the objects be in contact. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other. (3-PS2-3)	☐ Cause and effect: Mechanism and explanation

Possible Preconceptions/Misconceptions

A common misconception is that some believe that all metals are magnetic but this can be easily corrected by observing a magnet's effect on copper, aluminum or brass.

LESSON PLAN – 5-E Model

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions

Activity One:

1. Begin the lesson by asking, "What does magnetic mean?" [An object is magnetic when it can be magnetized or attracted by a magnet.] Allow students time to turn and talk to their buddy and discuss, "How can we tell if an object is magnetic?" [By touching an object with a magnet.]

2. In pairs, students will go on a Magnetism Scavenger Hunt in the classroom. First they will complete the scavenger hunt visually. From their seats, students will look around the room and identify and record ten objects that might be attracted to a magnet and ten items that they believe are not attracted to a magnet.

3. Students will record their predictions about which items are magnetic and nonmagnetic.

4. After completing the prediction portion, give each pair of students a magnet. They will test the items to discover if they are correct.

EXPLORE: Lesson Description –

Probing or Clarifying Questions

How do magnets interact with various materials? What effect does distance, medium, and magnets have on the ability of objects to interact with magnets?

Materials

- Magnets
- Collection of objects
- Plastic bag with a mixture of paper clips, brass (nonmagnetic) fasteners, small iron nails, tacks, large iron nail
- Classroom clock with a second hand
- Bag with a mixture of salt and iron filings or bits
- Snack size baggie for the magnets for second activity
- Toothpicks

Activity Two:

1. Ask, "In your predictions, how did you determine whether an object was magnetic or nonmagnetic? What surprised you? What does this activity tell us about metallic objects?" (Not all metallic objects are magnetic. Magnets do not attract most other materials). Ask, "Can we tell just by looking at a metal whether it is magnetic or nonmagnetic
2. Then ask, "How can we sort items into magnetic and nonmagnetic sets"? [manually or by using magnets] "Which method would be more efficient? By hand? Or using a magnet? How could we measure efficiency?" Guide students to realize that they could time the two strategies to find out which is more efficient.
3. Students will work in pairs with one student being the sorter and one student being the timer. Distribute small bags of assorted items paper clips and paper fasteners. Have the students empty their bags on the desk. At the signal, the sorters begin sorting the magnetic and nonmagnetic items. When finished the timers will record the time.
4. Continue sorting for the second and third trials.
5. Distribute magnets. Discuss how the results may differ using magnets.
6. Time the activity using magnets the same way; doing three trials.

EXPLAIN: Concepts Explained and Vocabulary Defined

Teacher:

Encourage the students to explain their findings using evidence from the investigation.
Provide a formal explanation that magnets attract metals containing iron, cobalt, and nickel or alloys containing these metals such as steel. For example, copper, brass and aluminum are not magnetic and would not be attracted to a magnet.

Student:

Explain possible solutions using recorded observations and explanations.
Listens critically to others' explanations

ELABORATE: Applications and Extensions

__Activity Three:__

1. Distribute bags of salt and iron filings or bits. Tell students what is in the bag.
2. Repeat the question: "How can we sort items into magnetic and nonmagnetic sets?" Present toothpicks as one strategy; have students try to sort manually.
3. Encourage students to think of other strategies such as dissolving the salt in water and filtering out the iron bits. Discuss the pros and cons of each suggestion; including the use of magnets.
4. Pour salt mixture on to a paper plate or large piece of paper. Give each group a magnet which has been placed in a baggie. Use the magnets to pick up the iron bits. Be careful not to let the iron filings to come in contact with the magnets.
5. Discuss: "Which method of sorting was faster? Why do you think magnets helped sort more efficiently? What were some problems you encountered? How do you think a factory would utilize magnets?"
6. Explain that in industry, magnets are often used to sort magnetic materials from nonmagnetic materials because of the increased efficiency. They are used to sort scrap metal, coins, etc.
7. Record ideas and observations.

EVALUATE:
Formative Monitoring (Questioning / Discussion):

- Observe the students as they apply new concepts and skills
- Look for evidence that the students have changed their thinking or behaviors.

Summative Assessment (Quiz / Project / Report): End of Unit Assessment

Elaborate Further / Reflect:

Notes for Future Reference:

Lesson 3- Magnetic Object Sort

Magnetic Scavenger Hunt

Name of Object (What are you going to test?)	**Prediction** (Magnetic or not Magnetic)	**Was the Object Magnetic?** (Yes or No)	**Was Your Prediction Correct?** (Yes or No)

Looking over your results, do you notice anything in common about all the items that are magnetic? ☐ **YES** ☐ **NO**

EXPLAIN:

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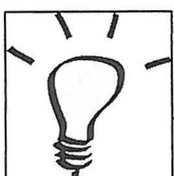
Sort Using Hands

Trial	Time
1	
2	
3	

Sort Using Magnet

Trial	Time
1	
2	
3	

Which way is more efficient (faster) to sort materials? ☐ **Hand** ☐**Magnet**



Brainstorm as many ways as possible to separate salt from iron filings.

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Real life connection:

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NGSS Lesson Planning Template

Grade:	Topic:	Lesson (number/title):
3rd Grade	Forces and Interactions	M4: Paper Clip Walk (Magnets)

Brief Lesson Description:
Students will use a magnet to make a paperclip "walk" on a paper plate. Students investigate how many paper plates through which the magnetic field will pass.

Performance Expectation(s):
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.

Specific Learning Outcomes:
Students will demonstrate that magnetic objects are affected by the distance from the magnet.

Narrative / Background Information

Teacher Preparation:

1. Students should work in groups of two to five. The teacher should test the magnets with the materials to be certain that the magnets are strong enough to complete the activities.

Background Knowledge:

2. As students test the strength of the magnet by stacking their paper plates together to see how many paper plates a paper clip is still attracted through, make sure that students understand that the paper plates are not blocking the magnetic field when the magnet will no longer hold the paper clip. The thickness of the paper plates has moved the magnet and paper clip far enough apart that the magnetic attraction is no longer strong enough to hold the paper clip, but it is still passing through the paper.
3. Magnetism will pass through materials that are not magnetic, such as glass, plastic and water (as demonstrated in the previous activity) and also, paper plates. When students are allowed to manipulate magnets and objects, they discover that they can make the objects move without actually touching the objects.

Prior Student Knowledge:
Students will have a basic understanding of magnets from previous lessons within this unit.

Science & Engineering Practices:	Disciplinary Core Ideas:	Crosscutting Concepts:
☐ Asking questions (science) and defining problems (engineering) ☐ Developing and using models ☐ Planning and carrying out investigations ☐ Constructing explanations (science) and designing solutions (engineering)	**PS2.B: Types of Interactions** Electric and magnetic forces between a pair of objects do not require that the objects be in contact. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other. (3-PS2-3),(3-PS2-4)	☐ Patterns ☐ Cause and effect: Mechanism and explanation ☐ Scale, proportion, and quantity ☐ Systems and system models

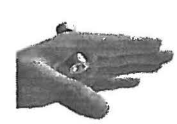
Possible Preconceptions/Misconceptions

1) A magnet needs to touch another object to attract it.
2) Paper plates block magnetic fields as opposed to increasing the distance between the magnet and the object.

LESSON PLAN – 5-E Model

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions

1. Ask, "What is magnetic force? What is a magnetic field?" *[A magnetic force is the push or pull that a magnet exerts. In other words, it is the force in which a magnet attracts or repels a metal. A Magnetic field is the area around a magnet that exerts a magnetic force. Magnetic fields are strongest at the poles of a magnet.]*
2. "Can you feel magnetic force in the air?" *[If you move a magnetic object close to a magnet, you can feel the magnetic force or attraction of the magnet.]* "Can you feel magnetic force if you place a magnet on each side of your finger? Your hand? Can you feel a magnetic field pass through your hand?" *[Yes, if the magnets are strong enough.]*



EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions

3. Working in groups, place a metric ruler on the table and position several paper clips on the table next to 0cm on the ruler. Place a magnet on the table next to the 20cm mark. Slowly move the magnet toward the paper clips. Observe what happens as the magnet is

slowly moved toward the paper clips. Record the measurement at which the paper clips begin to move. Repeat this activity three times. Challenge students, "What does this demonstrate about the magnetic field of the magnet?"

4. Distribute a paper plate to each student. Instruct students to place a paper clip on the paper plate. Ask students to pick up the paper clip with the magnet.
5. Predict whether the magnetic force or field will pass through the paper plate if they put the magnet under the plate instead of over it. From the previous activity, students learned that a magnetic field can pass through nonmagnetic materials. Allow students to test their prediction. Observe the paper clip as it moves around the plate.
6. As a class, predict how many paper plates can be stacked together before the force of the magnetic field will no longer affect the paper clip.
7. Test the prediction by adding one student's paper plate at a time. As each student adds his/her plate to the stack, continue testing until the paper clip can no longer be held or moved by the magnet.
8. Challenge students, "What do you observe? Why is the paper clip no longer attracted to the magnet?" [The thickness of the paper plates has moved the paper clip and the magnet far enough apart that the magnetic attraction is no longer strong enough to hold the paper clip, but it is still passing through the paper plates.] Repeat two more times.
9. Measure the thickness of the paper plates. How does the thickness of the paper plates compare to the distance at which the paper clips began to move toward the magnet when we measured them at the beginning of this lesson?

EXPLAIN: Concepts Explained and Vocabulary Defined

MAGNETIC FIELD: the area around a magnet that exhibits a magnetic force. The magnetic force is the strongest near the poles.

Teacher should facilitate the discussion of magnetic fields and its impact on this experiment. The discussion should include that the magnet was able to attract items despite its distance or objects blocking its contact due to the magnetic field surrounding it.

ELABORATE: Applications and Extensions

To continue this experiment, students could be allowed to repeat the above procedure using objects other than paper plates. Additional objects could include cardboard, books, tissue paper, or other various items in your classroom.

EVALUATE:

Formative Monitoring (Questioning / Discussion):

Students will be recording observations and data into their student journal during this activity. They are also required to respond to the open-ended questions in their journal.

Summative Assessment (Quiz / Project / Report):

Students will be completing a fixed-response assessment as well as a performance assessment at the end of this unit.

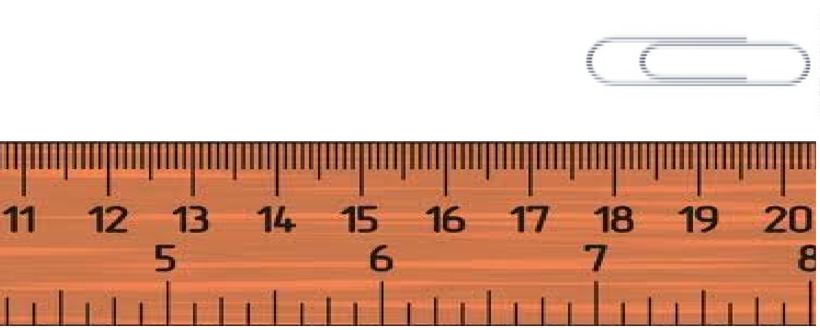
Elaborate Further / Reflect:

At the end of the lesson, please regroup as an entire class to discuss and debrief observations and discoveries from the lessons activities. Students should be able to share from their student journals.

This lesson is adapted from Oakland Schools.

Notes about this lesson:

Lesson 4- Paperclip Walk



Trial	Distance
1	
2	
3	
4	

Why do you think the paperclip moved? Do you think that it will always move?

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Predict: Will a magnetic field pass through or over a paper plate?

☐ **Through** ☐ **Over**

Class Prediction

How does the thickness of the plates compare to the distance at which the paper plate began to move?

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NGSS Lesson Planning Template

Grade: 3rd Grade	Topic: Forces and Interactions	Lesson (number/title): Magnet Lesson M5 - Electromagnet

Brief Lesson Description:

The students will build a simple electromagnet and explore its properties.

Lesson adapted from Magnetism Unit, K-STATE RESEARCH AND EXTENSION- SEDGWICK COUNTY, Wichita, KS http://www.sedgwickcountyextension.org

Performance Expectation(s):

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.

Specific Learning Outcomes:

Students observe that the strength of the electromagnet can be increased by increasing the number of coils wrapped around the iron bolt. Students observe that wrapping the coils tightly together also increases the strength of the electromagnet. Students will also observe that the electromagnet can be turned on and off.

Narrative / Background Information

Background Information:
When an electric current flows through a wire, a magnetic field is produced around it. The magnetic field produced by a single wire (not coiled on the iron bolt) is very weak. By coiling the wire, the magnetic field is made proportionally larger. By wrapping the coils around a magnetic core, such as the iron bolt, we can concentrate and strengthen the magnetic field even more. The magnetic field is strongest near the poles. The magnetic poles of the electromagnet are located at the ends of the bolt.

The strength of an electromagnet can be increased in two ways. One way is by adding more coils around the bolt. The other way is by increasing the amount of electricity flowing through the wire. This can be accomplished by putting more batteries in the electromagnet circuit. By increasing both the amount of electricity passing through a wire and the number of coils, engineers have developed very powerful electromagnets, such as the ones used to lift large piles of metal in scrap yards or to lilt cargo in metal containers from ships. Much smaller electromagnets are used in everyday things such as in telephones, clocks, doorbells, and appliances. The main advantage of electromagnets over permanent magnets is that their magnetic power can be turned on and off by simply turning the electricity on and off.

Teacher Preparation:

- Strip 3-5 cm (1-2 in.) of the varnish coating from both ends of a 30 inch section of wire (one section per group). It may be rubbed off with an emery board or bolt file. Do not rub the wire too hard or it will break.
- Prepare materials for groups of 3-4 in a distribution center.
- Make sure the batteries have a good charge.

Prior Student Knowledge:
Basic knowledge of batteries and what they are used for.
Basic knowledge of magnets and magnetic field.

Science & Engineering Practices:	Disciplinary Core Ideas:	Crosscutting Concepts:
☐ Asking questions (science) and defining problems (engineering) ☐ Developing and using models ☐ Planning and carrying out investigations ☐ Analyzing and interpreting data ☐ Constructing explanations (science) and designing solutions (engineering) ☐ Engaging in argument from evidence ☐ Obtaining, evaluating, and communicating information	PS2.B: Types of Interactions Electric and magnetic forces between a pair of objects do not require that the objects be in contact. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other. (3-PS2-3),(3-PS2-4)	☐ Cause and effect: Mechanism and explanation ☐ Energy and matter: Flows, cycles, and conservation

Possible Preconceptions/Misconceptions

Common misconceptions:
Magnetism and electricity are two different forces.

LESSON PLAN – 5-E Model

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions

Access Prior Learning through class discussion:

- What have you learned about magnets?
- What can magnets do?
- What are magnets used for?
- What questions do you have about magnets?
- Where do magnets come from?
- Do you think magnetic force and electricity are related?

Stimulate interest

Show Video of Crane Car with an electromagnet at work: **http://www.youtube.com/watch?v=nvyL5s6hLjk**

Generate question:

- Have students brainstorm questions about the video.
- How are magnets made?

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions

Materials Needed:

- One iron or steel bolt, about 5 to 8 cm (2-3 in.) long for each activity group
- 30 inches of 22-gauge varnish-insulated copper wire for each activity group
- 2 D-cell (1.5 volt) batteries for each activity group
- 20 small metal paper clips for each activity group (#1 size)
- 2 battery holders that can be clipped together OR masking tape for each activity group
- One wire cutter or stripper for teacher use.
- One emery board or bolt file for teacher use.

Activity:
Sometimes we need magnets whose strength can be more easily regulated and/or can be turned on and off when needed. Use the activity below to help students build a simple electromagnet and explore its properties.

1. Divide the class into activity groups of three to four students each.

2. Distribute one set of activity materials to each group and direct students to the Electromagnet Data Sheet in their journal. This activity works best on tables that are large enough for the entire activity group to work around.

3. Have the students wrap the wire in tight, even coils around the bolt. Tell them to be sure to leave at least 3 or 4 in. loose at each end of the coil so that they can connect the wires to the batteries. There may be 3 or 4 layers of wire all the way along the bolt.

4. Direct the students to put batteries into the battery holders OR tape them together with masking tape. Remind them to match the positive terminal (+) on one battery with the negative terminal (-) on the other battery. Depending on their dexterity, some students may need assistance with this step.

5. Connect one end of one wire to the positive (+) end of one of the batteries, and then connect the other wire end to the negative (-) end of the other battery. If the electromagnet is working, it will be magnetic and able to attract and hold a paper clip.

   If it does not work, they might want to check:
   - Make sure all the connections are tight
   - That the batteries are not dead
   - That the coils are wrapped tightly around the bolt.

6. Ask the students how they will know if their electromagnet is working. Tell them to test their electromagnets by trying to pick up one of the paper clips with the wire-wrapped bolt.

7. Have students try to pick up one of the paper clips with their electromagnet.

8. Have students unhook one of the wires from the battery. Does your bolt still pick up a paper clip? How many paper clips can your bolt pick up?

9. Using only the insulated copper wire, coil it loosely around a pencil. Carefully pull the pencil out of the coil and connect the ends of the wire to the battery. Can you pick up a paper clip with the coil? *(Possibly – but loosely coiled wire will make a weak magnet)* Can you pick up more then one paper clip? *(Probably not.)*

10. Next, straighten out the wire and connect both ends to the battery. Can you pick up a paper clip? *(Probably not.)*

EXPLAIN: Concepts Explained and Vocabulary Defined

Teacher:
Encourage the students to explain their findings using evidence from the investigation.
Vocabulary: electromagnet, coil, insulated copper wire, positive terminal, negative terminal, circuit

Student:
Explain possible solutions using recorded observations and explanations.
Listens critically to others' explanations

ELABORATE: Applications and Extensions

11. Ask the groups how they might be able to make their electromagnets even stronger. Challenge each group to come up with two ways and then to test them. Encourage them to work with other groups to try out their ideas.

12. Have a class discussion about electromagnets using the following question as a guide. The students should refer to their recorded observations in their explanations:

    How many paper clips did your electromagnet hold?
    The number of paper clips that the electromagnet can hold will depend on the strength of the electromagnet.

    How did you test the strength of your magnet?
    As we have seen in the previous activities about magnetism, we know that the magnet is stronger if it can pick up more paper clips or if it can pick up the paper clips from a greater distance.

    Were you able to make your electromagnet stronger? How? Why do you think this worked/didn't work? What evidence so you have that supports that you magnet is stronger?
    The strength of the electromagnet can be increased by increasing the number of coils wrapped around the bolt (additional lengths of wire may be needed). Wrapping the coils tightly together also increases the strength of the electromagnet because that concentrates the magnetic field produced by the electrical current.

    Would you use an electromagnet or a permanent magnet to do the following and why? To hold a picture to your refrigerator? To lift large piles of scrap iron from junkyards? To pick up pins that have spilled?
    The weight of the objects and the distance they need to be moved by the magnet are important considerations in determining whether a temporary or permanent magnet would do the job better. Either a temporary or a permanent magnet could hold a picture to a refrigerator door. However, the opening and closing of the refrigerator door may eventually knock the magnetic domains of the temporary magnet out of alignment and the magnetism would be lost, so a permanent magnet may be better for holding a picture to the refrigerator door. A very strong magnet would be required to lift heavy piles of scrap iron! temporary magnet would work well to pick up those small, light weight pins.

EVALUATE:
Formative Monitoring (Questioning / Discussion): • Observe the students as they apply new concepts and skills • Look for evidence that the students have changed their thinking or behaviors. **Summative Assessment (Quiz / Project / Report):** End of Unit Assessment
Elaborate Further / Reflect: Explore more of the properties of an electromagnet by trying the following experiments: 1. Disconnect one end of the wire from the battery and straighten it. Reconnect the ends of the wire to the battery and test how many paper clips the straightened wire will pick up. Does the length of straightened wire affect the number of paperclips the magnet will pick up? How? 2. Teacher can share real life applications of electromagnets. Engineers have developed very powerful electromagnets, such as the ones used to lift large piles of metal in scrap yards or to lilt cargo in metal containers from ships. Much smaller electromagnets are used in everyday things such as in telephones, clocks, doorbells, and appliances. The main advantage of electromagnets over permanent magnets is that their magnetic power can be turned on and off by simply turning the electricity on and off.

Notes for Future Reference:

Lesson 5: Electromagnets

During the movie:

List least three wonderings you have about the video:

1. ____

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2. ____

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3. ____

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Making an Electromagnet:

Can you pick up a paperclip with your electromagnet? ☐ Yes ☐ No

Unhook one of the wires. Can you pick up a paperclip? ☐ Yes ☐ No

With your group, brainstorm two different ways to make your electromagnet stronger.	Was it successful? How do you know?
1.	
2.	

Use you data to explain one way that magnets can be made stronger.

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