CAPE COD REGIONAL
STEM NETWORK

Motion Stability: Forces and Interactions

Science Grade 3

This unit is designed to introduce students to forces of friction, magnets, science, and engineering. Students will be able to conduct investigations regarding how forces change the motion of an object and how magnets are influenced by direction and distance. At the end of the unit, students will be able to design a tool to solve a problem using their knowledge of forces and motion. Students will be able to demonstrate an understanding and application of these NGSS 3-PS2-1, 3-PS2-3, 3-PS2-4, 3.5-5-ETS1-1.

A collaboration with Cape Cod Regional STEM Network, Terri O'Hara, and Shannon Waldron.. © 2016
 This material is based upon work supported by the Natural Science Foundation under Grant No. 134760. Any opinions, findings, and conclusions or recommendations expressed in this material are those author(s) and do not necessarily reflect the views of the National Science Foundation.

CAPE COD REGIONAL STEM NETWORK

Background information on the unit development. *In order to help others who are interested in this topic understand a bit more about what you created, we will write a short introduction to each unit and provide some images, in addition to posting the completed units on the Cape Cod Regional STEM Network website (www.capecodstemnetwork.org). Please help us by answering the questions below after you have completed your unit.*

1. Please provide us some background informations on the unit development

Who helped to create this unit?

Names	School (Grade/course taught)
Terri O'Hara	Hyannis West Elementary Grade 3
Shannon Waldron	Centerville Elementary Grade 3

What were some sources of inspiration for this unit?

- Discovery Works
- Foss Magnetism and Electricity Module
- Colleague Input
- sample units from DESE

What's the most important lesson you learned as you created this?

It is most important to do hands on exploration and modeling in science.

2. Please also provide information about the unit that will help us write a brief introduction to your unit:

- In your own words, what are you hoping students learn - big picture - through this unit?

  Students will gain knowledge of multiple forces, including friction, on an object. They will know that balanced forces do not change the motion of the object and unbalanced forces do change the motion of the object. Students will learn about the nature of the forces between two magnets on their orientations and distance relative to each other.

- What real world experiences did you incorporate? What science standards or requirements were you trying to emphasize?

  The real world experience was the design problem that the students had to solve. They needed to construct a tool that would keep their pencil from falling off their desk or table. We used evidence, creation, and design standards to solve a design problem.

- How would you say that this unit "matters" to the STEM community? Or to our community on Cape Cod? Or to the larger community?

  It shows real world experiences through the use of accessible materials and concepts.

- What will students be most excited about at the end? (Will they have completed something, created something, etc.?)

  It shows real world experiences through the use of accessible materials and concepts.

3. Anything else you would like fellow teachers or others to know about this unit?

You will need many materials to make this unit successful.

Table of Contents

CAPE COD REGIONAL STEM NETWORK

Stage 1 Desired Results

<table>
<tr>
<td rowspan="3">

MA STE Standards
3-PS2-1 Provide evidence to explain the effect of multiple forces, including friction, on an object. Include balances forces that do not change the motion of the object an unbalanced forces that do change the motion of the object.

3-PS2-3 Conduct an investigation to determine the nature of forces between two magnets based on their orientations and distance relative to each other.

3-PS2-4 Define a simple design problem that can be solved by using interactions with magnets.

3.3-5-ETS1-1 Define a simple design problem that reflects a need or want. Include criteria for success and constraints on materials, time, or cost that a potential solution must meet.
</td>
<td>

ESSENTIAL QUESTIONS
Why do forces change the motion of an object?
How are forces created by magnets affected by direction and distance?
How can a problem be solved by using magnets?
</td>
</tr>
<tr>
<td>

UNDERSTANDINGS
Students will understand that…
● *Balances and unbalanced forces, as well as friction can change the motion of an object.*
● *Magnetic fields can be influenced by direction, distance, and size of the magnet.*

Students will be skilled at…..
● *Using their knowledge of magnets and forces to design tools to solve real-world problems.*
● *Using scientific terminology in writing and speaking.*
● *Analyzing and interpreting categorical data.*
● *Make a bar graph using data collected from an activity.*
● *Using relevant evidence to make and justify a scientific argument.*
</td>
</tr>
<tr>
<td>

TRANSFER
Students will be able to independently use their learning to…
● *Build a tool using magnets to solve a problem.*
● *Use appropriate evidence and reasoning to develop scientific claims and engage in discussions of scientific and technical topics.*
● *Analyzing and interpreting categorical data.*
</td>
</tr>
</table>

	Cross-Curricular Connections Mathematics ● **3.MD.B.3** Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one - and - two - step “how many more” and “how many less” problems using information presented in scaled bar graphs. English - Language Arts ● **W3.2** Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

Stage 2 Evidence

Formative Assessment Ideas:

- Students will collect data on the speed of a matchbox car on 3 different surfaces, using 3 different forces. Students will compare the speed of the car on 3 surfaces and 3 forces (push, breath, and fan). Students will present their data and finding to the class.
- Students will explore and investigate how different strengths of magnets will affect the range of the magnetic field. Students will record the data of how far a magnetic field can affect the object.

Summative Assessment Ideas:

Students will construct a tool using magnets to solve a problem. Students will design a magnetic tool to hold their pencil to their desk or table. Students will be given magnets and a variety of materials to construct their tool.

Introductory Lesson	**Constructing Lesson**	**Practice Lesson**	**Assessment Lesson**
Lesson that introduces the content. More teacher directed	Lessons that engage students in building and linking together understanding. Guided/collaborative. Student/teacher or partners/small group	Lessons or activities that students can complete relatively independently	Formative: Check-ins along the way to see if students “get it” Summative: Students showing what they know, when you feel they are ready

Stage 3 Learning Plan

Summary of Key Learning Events and Instruction

- Newton's 1st Law: An object will either remain at rest or continue to move at a constant velocity, unless acted upon by a force.
- Newton's 2nd Law: When an object is in motion, an opposing force of the object will slow or stop the motion of the object (friction).
- Magnetic objects are influenced by direction and distance of a magnetic field.

Lesson Name	Type	Content Addressed	Standards Included
1. What are Forces?	Introductory	Push, pull, balanced, unbalanced, force, gravity, and motion	3-PS2-1
2. What is friction? Make it stop!	Introductory	Friction, opposing forces, and motion	3-PS2-1
3. Forces in Motion - Start your engines!	Constructing	Friction, balances, unbalanced, motion, gravity, and car movements	3-PS2-1
4. Magic or magnets? Magnetic Attraction	Introductory/Constructing	Iron, cobalt, nickel Magnets - a piece of metal that can pull certain metallic objects towards itself and hold them	3-PS2-3
5. Opposites Attract - North and South Poles	Constructing	Magnets have two poles, and those poles repel each other and attract	3-PS2-3
6. Magnetic Fields	Constructing	Distance, direction, and strength of magnets - making predictions on the strength of magnets Magnetic Field - the space around which the force of a magnet is felt	3-PS2-3
7. Magnets in Action	Assessment	Students will design and build a tool using magnets that will solve the problem of their pencil rolling off the desk or table.	3-PS2-3, 3-PS2-4, 3.3-5-ETS1-1

CAPE COD REGIONAL STEM NETWORK

Lesson 1: What are Forces?

Overview of the Lesson: Students will complete a KWL Chart focusing on motion. Students will be prompted with key vocabulary words such as **balanced, unbalanced, gravity, push,** and **pull** to discuss and clarify their prior understanding. After completing the chart, the teacher will lead a mini-lesson illustrating balanced and unbalanced forces with a textbook and table. Then, teams of 3 students will show how a "tug of war" rope can show balanced and unbalanced forces. **Time (40 minutes):** KWL (20 min), Textbook (5 min), Tug of War (10 min), Closing (5 min)
Standard(s): • **3-PS2-1** Provide evidence to explain the effect of multiple forces, including frictions, on an object. Include balanced forces that do not change the motion of the object and unbalanced forces that do change the motion of the object.
Essential Question(s): • What are balanced and unbalanced forces?
Science Objectives • Students will be able to explain the effect of balanced and unbalanced forces on the motion of an object.
Language Objectives and/or Targeted Academic Language • Force, push, pull, balance, unbalanced, and gravity
Anticipated Student Preconceptions/Misconceptions • Students may have knowledge of push and pull from first grade. Clarify any preconceptions or misconceptions they may have.
Instructional Materials/Resources/Tools • Chart paper • Markers • Textbook • Rope with a flag taped to the middle (enough rope for a group of three on each side of the flag) • Tape rolls - 2 colors • Index cards
Assessment:

- Exit ticket: Explain what happens to an object when it is balanced and when it is unbalanced.

Science and Engineering Practices included (put the included ones in bold):

1. **Asking questions (for science) and defining problems (for engineering)**
2. **Developing and using models**
3. **Planning and carrying out investigations**
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Opening/Engagement Strategy/Pre - Assessment:

- (20 min) KWL: *What makes an object move? How can you make certain objects in the classroom move?* Record and discuss responses and vocabulary of discussion. When mentioning push and pull, remind them that it is called a force.

During the Lesson:

- (10 min)
  - Ask: *What does the word **balance** mean to you?* - Expect answers regarding the word **equal**, explanations or experience of being balanced. Ask students to look at the textbook sitting at the table. *How does that move?* It needs a force to move. When an object is at rest, then is is experiencing **balanced forces**. Put **balanced forces** on the word wall or chart. Then ask, *what would the word **unbalanced** mean?* Responses should include words like **uneven, not equal**, and **falling**.
  - Then redirect their attention to the book. *How can we put an **unbalanced force** on the book?* Students should suggest pushing or pulling the book. Push the book off the table. Explain that the book is experiencing an **unbalanced force**, meaning that the book is only experiencing a force from one side. Put **unbalanced force** on the word wall or chart. Invite two students to come to the table and push the book equal from opposite sides. Ask students to turn to a partner and discuss what happened to the book. *Did the book move? Why or why not?*
- (10 min)
  - Next, break the class into groups of three. Give each group a rope and a piece of duct tape. Ask the students to put the piece to duct tape on the floor.
  - Then select two students to pull the rope equally on both sides (like tug of war) so that the flag hangs above the duct tape, and the rope is taut, showing balanced force of a pull. Have the third student observe the **equilibrium of balanced forces**. Then rotate within groups so that each child will be an observer and pull the rope.
- Then, give students 2 other pieces of different color duct tape. Have students place tape one foot on either side of the original duct tape. have students use **unbalanced force** to move the flag on their rope to each duct tape line. Rotate turns within groups.

Lesson Closing

● (5 min) Bring class back as a group to discuss what happened to the rope when you had **balanced** and **unbalanced forces** acting upon it. Have students complete an Exit Ticket on a index card answering: ○ *Draw and write what happens to an object when it is balanced, and when it is unbalanced.*
Instructional Tips/Strategies/Suggestions for Teacher: ● Word Walls with definitions for key vocabulary for ELLs with visual examples. ● BrainPopJr Video Push and Pull - to help reactivate information - https://jr.brainpop.com/science/forces/pushesandpulls/

CAPE COD REGIONAL
STEM NETWORK

Lesson 2: What is friction? Make it stop!

Overview of the Lesson: Students will learn that **friction** opposes the force of an object when two surfaces touch, it will slow or stop the motion - Newton's 2nd Law. **Time (20 minutes):** Free - write/ Type (5 min), Class discussion and example (10 min), Closing - type 2 writing (5 min)
Standard(s): • **3-PS2-1** Provide evidence to explain the effect of multiple forces, including frictions, on an object. Include balanced forces that do not change the motion of the object and unbalanced forces that do change the motion of the object.
Essential Question(s): ● How does friction change the motion of an object?
Science Objectives • Students will be able to explain how friction changes the motion of an object.
Language Objectives and/or Targeted Academic Language • Friction, balanced, unbalanced, motion, forces, and explain
Anticipated Student Preconceptions/Misconceptions • Students may believe that "magic" could stop the ball, or strength behind an object can stop a ball. Clarify that when another object such as a wall (unbalanced force), stops a ball, that is from the interference and not friction. Gravity can also play a part in the pace of the ball slowing.
Instructional Materials/Resources/Tools • Ball • Chart paper • White-lined paper or composition notebook • Sandpaper • Rug • Table • Markers and pencils
Assessment: ● Students will correctly respond to the Type 2 scenario explaining why a skateboard would travel faster on a certain surface using the word

friction.
Science and Engineering Practices included (put the included ones in bold): **1. Asking questions (for science)** and defining problems (for engineering) **2. Developing and using models** **3. Planning and carrying out investigations** **4. Analyzing and interpreting data** 5. Using mathematics and computational thinking **6. Constructing explanations (for science)** and designing solutions (for engineering) 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information
Opening/Engagement Strategy/Pre-Assessment: ● (5 min) Free-write (Type 1 *Writing John Collins*) - Give each student a piece of paper. Tells students that they have one minute and 20 seconds (1:20) to write anything they know or think they know about **friction**. After the time is up, have a few students share what they wrote.
During the Lesson: ● (10 min) After students share, remind students of yesterday's lesson about **balanced** and **unbalanced** forces. Ask *what happens to an object when its forces are **balanced** and what happens to an object when its forces are **unbalance***d. ● Bring out a ball, tell students that you are going to put an **unbalanced force** on it to make it move. Ask students *if they think it will keep rolling forever, or if it will stop on its own*. Record predictions on chart paper. ● ***Lightly*** roll the ball on the classroom floor. When it stops, ask students *what caused the ball to stop*. Record their responses on chart paper. Explain that **friction** caused the ball to stop. **Friction is when two surfaces give opposing forces, to stop or slow the motion of an object**. ● Then, ask the students to make predictions about what would happen if we rolled the ball on different surfaces. *Would it go faster or slower? Would it change direction? Why did this happen on this particular surface?* ● Roll the ball on a rug, table, sandpaper - pausing to prompt students to observe the behavior of the ball.
Lesson Closing ● (5 min) Have students return to their Free-Write (Type 1) paper. Have them draw a line below their original writing. Pose a scenario: o *You and a friend are skateboarding. You are skateboarding on the sidewalk and your friend is skateboarding on the grass. You each take 3 equal pushes. Who would go the faster and why?* (Type 2 *Writing John Collins*). - Students must use the work friction correctly in their response.
Instructional Tips/Strategies/Suggestions for Teacher: ● Word Walls with definitions for key vocabulary for ELLs with visual examples.

Lesson 3: Forces in Motion - Start your engines!

Overview of the Lesson: Students will be testing the speed of a matchbox car on different surfaces with different forces. **Time:** 30 minutes
Standard(s): • **3-PS2-1** Provide evidence to explain the effect of multiple forces, including frictions, on an object. Include balanced forces that do not change the motion of the object and unbalanced forces that do change the motion of the object.
Essential Question(s): • How does the motion of an object change based on different forces and surfaces?
Science Objectives • Students will be able to determine how types of unbalanced forces and friction change the motion of an object.
Language Objectives and/or Targeted Academic Language • Friction, balanced, unbalanced, motion, force, and analyze
Anticipated Student Preconceptions/Misconceptions • Students will analyze their data and respond in writing as to why a matchbox car traveled faster using key vocabulary words.
Instructional Materials/Resources/Tools • Matchbox cars • Sandpaper • Rug • Tile floor • Fan • Recording sheet (Attached) • Pencils • Stopwatch • Rulers
Assessment:

CAPE COD REGIONAL
STEM NETWORK

- Students will analyze their data and respond in writing as to why a matchbox car traveled fastest using key vocabulary words.

Science and Engineering Practices included (put the included ones in bold):

1. **Asking questions (for science)** and defining problems (for engineering)
2. **Developing and using models**
3. **Planning and carrying out investigations**
4. **Analyzing and interpreting data**
5. Using mathematics and computational thinking
6. **Constructing explanations (for science)** and designing solutions (for engineering)
7. **Engaging in argument from evidence**
8. **Obtaining, evaluating, and communicating information**

Opening/Engagement Strategy/Pre - Assessment:

- (15 min)
  - Remind students of the last two lessons regarding forces and friction. Explain that today we will be experimenting with different surfaces and forces to see how quickly a matchbox car can travel in a 1 foot distance.
  - Pass out recording sheets. Show students the materials and how to set up their “track”. Ask them to make prediction on which surface and with which force would make the matchbox car travel the fastest. Remind students that the push is a LIGHT push. Teacher will demonstrate that that looks like. Model how to use a stopwatch.
  - Send students in groups of three to experiment with their “tracks”, stopwatches, and forces - Test and record.

During the Lesson:

- (15 min) Students will be experimenting with their surfaces and forces in groups of three. Students should be recording the time it takes for their matchbox car to reach the end of their ruler. Walk around and check on groups to make sure they are on task and using the materials correctly.

Lesson Closing

- When recording is completed, have students analyze their data to determine which matchbox car traveled fastest and why (response question at the bottom of sheet). Encourage them to use key vocabulary words. After students have finished their responses, ask students to share their results with the class. Collect recordings for teacher use.

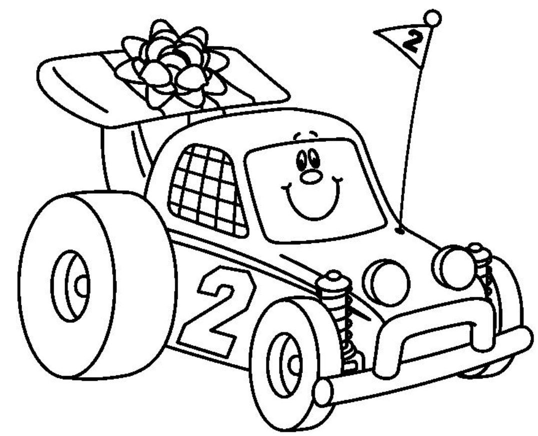
Instructional Tips/Strategies/Suggestions for Teacher:

- Word Walls with definitions for key vocabulary for ELLs with visual examples.

CAPE COD REGIONAL STEM NETWORK

Name______________________________ **Date**____________________

Force in Motion - Start your engines!



Predict: On what surface and with what force will your matchbox car travel fastest? Answer in a complete sentence.

____

____

____

Record the speed of your matchbox car for each surface and force

Surface	**Force**	**Force**	**Force**
	Light Push	Breath	Fan on Low
Tile Floor			
Rug			
Sandpaper			

Analyze: What matchbox car traveled the fastest? Explain why using key vocabulary words such as **balanced, unbalanced,** and **friction.**

____

____

____

Lesson 4: Magnets or magic? - Magnetic Attraction

Overview of the Lesson:
Students will learn that a magnet is a piece of metal that can pull certain metallic objects toward itself and hold them. Students will experiment with different magnets throughout the room to test classroom objects to see if they're magnetized.

Time: 30 minutes

Standard(s):

- **3-PS2-3** Conduct an investigation to determine the nature of the forces between two magnets based on their orientations and distance relative to each other.

Essential Question(s):

- Why do magnets attract certain metals?
- What is a magnet?

Science Objectives

- Students will be able to classify what objects are attracted by magnets and which are not. They will know that magnets are made of metallic alloys that contain either iron, cobalt, or nickel.

Language Objectives and/or Targeted Academic Language

- Magnet, metal, iron, cobalt, nickel, and attraction

Anticipated Student Preconceptions/Misconceptions

- Students may equate magnetism with magic. Provide time for students to see and feel the pull of the magnet. Make sure that children know that although a magnet may be covered with plastic or wood, it can still attract of magnetic objects.

Instructional Materials/Resources/Tools

- Wand magnets
- Paper clips
- Nails
- Examples of magnetic objects
- Recording sheet (attached)
- *Fantastic Magnet Facts* article
- Beach Sand
- Homework sheet (attached)

Assessment:

- Students will respond to the analyzing question at the end of their recording sheet.
    - *What materials must a metallic object contain in order to be a magnet?*

Science and Engineering Practices included (put the included ones in bold):

1. **Asking questions (for science)** and defining problems (for engineering)
2. **Developing and using models**
3. **Planning and carrying out investigations**
4. **Analyzing and interpreting data**
5. Using mathematics and computational thinking
6. **Constructing explanations (for science)** and designing solutions (for engineering)
7. Engaging in argument from evidence
8. **Obtaining, evaluating, and communicating information**

Opening/Engagement Strategy/Pre - Assessment:

- Invite students to the front of the room to form a class discussion. Tell students that we are moving to another kind of force, magnetic force. Ask students *to share what they know about magnets.* Record their responses on chart paper.
- Place students into partners are pass out *Fantastic Magnet Facts* article (attached). Have students partner read the article. Have children record two facts on an index card about what they learned. Call class back to form a discussion. Have students shark what they have learned. Record points on chart paper.
- Teacher talk: Explain to students that a magnet is a piece of metal that can pull certain metallic objects toward itself and hold them. A magnet can pull another magnet toward itself, or push it away without actually touching it. Explain that magnets contain either iron, cobalt, or nickel. Hold a magnet over a tub of beach sand. Show that some of the grain of sand are attracted to the magnet. This means that the minerals in the sand could contain iron, cobalt, or nickel.

During the Lesson:

- Give each student a recording sheet. Explain that each student (partners or individually) must find at least 10 classroom objects that are magnetized. When they are done, have them describe what happens when two magnets come together, magnetized, on the recording sheet.

Lesson Closing

- When students are done, have them share what classroom objects were magnetized. Ask them collectively why objects attract each other. In unison they should respond that they should contain iron, cobalt, or nickel. Give students a homework recording sheet and magnet to take home. Students will complete the same activity at home for homework.

Instructional Tips/Strategies/Suggestions for Teacher:

- Word Walls with definitions for key vocabulary for ELLs with visual examples.

Fantastic Magnet Facts

Until the 13th Century people believed that magnets were magical. Then a Frenchman, Petrus de Maricourt, discovered (in 1269) that magnets have two poles and the mysteries of magnetism started to be unraveled. In 1600 an English physician name William Gilbert discovered the Earth's magnetism.

Why does the Earth behave like a giant magnet with a magnetic field surrounding it? Scientist have found out that the magnetic field is produced by the molten metal which is found deep beneath the Earth's surface. As the Earth spins, electric currents are created in molten metal and theses currents produce the Earth's magnetic field.

The world's heaviest magnet is in the Joint Institute for Nuclear Research near Moscow, Russia. It measures 196 feet in diameter and weighs a massive 42,000 tons. The amazingly fast Maglev trains use magnetic force to help them reach speeds of over 217 miles an hour. The Japanese MLU system uses electromagnets that repel each other so the train floats above the rails.

The largest electromagnet is higher than a four-story building and has an enormous aluminum coil weighing 1,000 tons. The magnet was built by a team of Russian and Swiss scientists and it is made out of more metal than the Eiffel Tower in Paris!

Did you know that some animals have a built-in magnet that acts like a compass and helps them to find their way? Whales and dolphins use the Earth's magnetic field to navigate. Scientists have discovered that if a magnet is fixed to a pigeon's back it cannot find its way on cloudy days. In Australia there are insects called Compass Termites which build their nests facing north. It is thought they use the Earth's magnetism to get the position of their nests right.

CAPE COD REGIONAL
STEM NETWORK

Name____________________________________ **Date:**__________________

Magnetic or Not? Classroom

Travel around the classroom with your magnet. Test 10 items to see if they are magnetic or not.

Object	Magnetic	Not Magnetic

Describe what happens when two magnets come together.

____

____

CAPE COD REGIONAL STEM NETWORK

Name______________________________________ **Date:___________________**

Magnetic or Not? Homework

Travel around your home with your magnet. Test 6 items to see if they are magnetic or not.

Object	**Magnetic**	**Not Magnetic**

CAPE COD REGIONAL STEM NETWORK

Lesson 5: Opposites Attract - North and South Poles

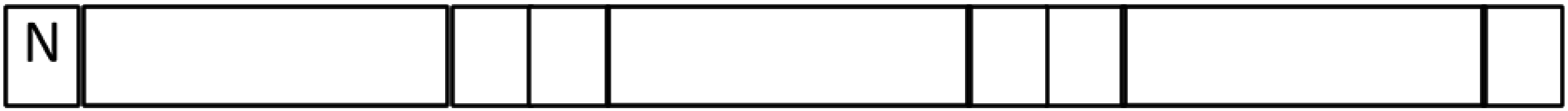
Overview of the Lesson: Students will recognize that a magnet has two poles, and that like poles of magnets repel each other and that unlike poles of magnets attract each other. **Time (minutes):**
Standard(s): • **3-PS2-3** Conduct an investigation to determine the nature of the forces between two magnets based on their orientations and distance relative to each other.
Essential Question(s): • How will students recognize that a magnet has two poles and that like poles of magnets repel each other and that unlike poles of magnets attract each other?
Science Objectives • Students will be able to conduct an experiment to determine that a magnet has two poles and that like poles repel each other and that unlike poles attract each other.
Language Objectives and/or Targeted Academic Language • Repel, attract, poles, north, and south
Anticipated Student Preconceptions/Misconceptions • Students will think that north/north will go together and south/south would go together. They will need to know the concepts of repel and attract.
Instructional Materials/Resources/Tools • Various Magnets for exploring how magnets interact with one another • Bar magnets labeled north and south • Exit ticket
Assessment: ● Students will show through a drawing how like poles repel and unlike poles attract.
Science and Engineering Practices included (put the included ones in bold): 1. Asking questions (for science) and defining problems (for engineering) **2. Developing and using models**

3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations (for science) and designing solutions (for engineering) **7. Engaging in argument from evidence** **8. Obtaining, evaluating, and communicating information**
Opening/Engagement Strategy/Pre-Assessment: ● Teacher Talk: Ask students how they think magnets stick to each other. Record their responses on chart paper. Then give them various magnets and have them observe what happens. Then give them bar magnets. Have them observe what happens when they try to put them together. What do they notice? Record responses on chart paper.
During the Lesson: ● They will make a train using the bar magnets. See how many they can put together.
Lesson Closing ● North and south exit ticket.
Instructional Tips/Strategies/Suggestions for Teacher: ● Word Walls with definitions for key vocabulary for ELLs with visual examples.

North and South- Exit Ticket

Name____ **Date:**____________________

1. Where are the north and south poles on the magnets?



2. How would each train connect to the next train?

CAPE COD REGIONAL STEM NETWORK

Lesson 6: Magnetic Fields

Overview of the Lesson:
Students will investigate magnetic fields, and discover that magnets have magnetic fields around them. The fields explain the strength and direction of magnets' attraction for objects. Students will do this by attaching string to their magnet and lifting their magnet a certain distance to see if it will attract other magnetic objects.

Time (minutes):

Standard(s):
- **3-PS2-3** Conduct an investigation to determine the nature of the forces between two magnets based on their orientations and distance relative to each other.

Essential Question(s):
- How does the distance of a magnet to an object determine the strength or pull of a magnetic field?

Science Objectives
- Students will be able to compare the various strengths and distances of magnetic fields.

Language Objectives and/or Targeted Academic Language
- Magnetic field, strength, attract, force, and recording sheet (attached)

Anticipated Student Preconceptions/Misconceptions
- Students may think that the size of the magnet correlates to the strength of the magnet. For example, the larger magnet, the stronger the magnet.

Instructional Materials/Resources/Tools
- Magnets of varying strengths (5): bar magnets, horseshoe magnets, wand magnets, ring magnets, refrigerator magnets
- String
- Paper clips
- Aluminum tray
- Ruler
- Chart paper
- Markers
- Recording sheet (attached)

Assessment:

- Students will complete a recording sheet and analyze what happens to the magnetic field as the magnet moves farther away from a magnetic object.

Science and Engineering Practices included (put the included ones in bold):

1. **Asking questions (for science)** and defining problems (for engineering)
2. **Developing and using models**
3. **Planning and carrying out investigations**
4. **Analyzing and interpreting data**
5. Using mathematics and computational thinking
6. **Constructing explanations (for science)** and designing solutions (for engineering)
7. **Engaging in argument from evidence**
8. **Obtaining, evaluating, and communicating information**

Opening/Engagement Strategy/Pre-Assessment:

- Explain to students that they will be conducting an experiment to see the strength of a magnetic field. Ask students to turn and talk to a partner about what they think a magnetic field is. Have students share their ideas, writing them on chart paper.
- Teacher Talk: Explain that a magnetic field is the invisible force surrounding the magnet that can attract objects. Explain that the stronger the magnet, the larger the field and the farther reaching will a magnet is able to attract objects.
- Show students the magnets that they will have available to them to test, as well as paper clips. Students will check each magnet to see how many paper clips it can collect at varying distances using a ruler. Demonstrate how a students would pull the string up at a distance of 2 inches, using the ruler as a guide. Then, record how many paper clips it would collect. Then, show how you would move the string up another 2 inches to see how many paper clips the magnet would collect. After the demonstration, separate students into groups of 3 and give them the supplies. Explain that everyone will take a turn to record, lift the magnet, and monitor the height. Before beginning the experiment, ask the students to make a prediction on what magnet will have the greatest magnetic field (or collect the most paper clips) on their recording sheet.

During the Lesson:

- Students will experiment with different magnets and at different distances. Students will first place the magnet against the paper clips to see how many paper clips it will attract. Then, students will lift the magnet 2 inches from the tray and record the number of paper clips it collects. One student should be holding a ruler for students to monitor the height of the string. They will repeat these steps at a distance of 4'', 6'', and 8''. They will experiment with the same distances for the other 4 magnets.

Lesson Closing

- Students will analyze their data to see which magnet was the strongest. They will acknowledge if their prediction was incorrect or correct.

Instructional Tips/Strategies/Suggestions for Teacher:

- Written definitions with pictures and Word Walls with definitions for key vocabulary for ELLs with visual examples.

CAPE COD REGIONAL STEM NETWORK

Name:________________________________ **Date:**______________

Magnetic Field Experiment

Predict: Which magnet do you think will have the greatest strength or magnetic field?

____

____

Recording Sheet: Number of Paper Clips Attracted by Each Magnet

	Horseshoe Magnet	**Bar Magnet**	**Ring Magnet**	**Wand Magnet**	**Fridge Magnet**
0 Inches					
2 Inches					
4 Inches					
6 Inches					
8 Inches					

Analyze: Which magnet attracted the most paper clips at the farthest distance and why?

____

____

Was your original prediction correct or incorrect? If it was incorrect, what do you now know about magnets that explains why your answer was wrong?

____

____

CAPE COD REGIONAL STEM NETWORK

Lesson 7: Magnets in Action

Overview of the Lesson:

- Students will develop a tool to magnetically attach a pencil to their desk.

Time (90 minutes): Activity can be done over a 1-2 day period

Standard(s):

- **3-PS2-3** Conduct an investigation to determine the nature of the forces between two magnets based on their orientations and distance relative to each other.
- **3-PS2-4** Define a simple design problem that can be solved by using interactions between magnets.
- **3.3-5-ETS1-1** Define a simple design problem that reflects a need or want. Include criteria for success and constraints on materials, time, or cost that a potential solution must meet.

Essential Question(s):

- How can you design and construct a tool to solve a problem using magnets?

Science Objectives

- Students will be able to design and construct a tool to keep their pencil magnetically attached to their desk.

Language Objectives and/or Targeted Academic Language

- Magnets, attract, repel, design, construct, magnetic field, force, balanced, unbalanced, gravity, push, and pull

Anticipated Student Preconceptions/Misconceptions

- Students may thank that a tool can only be on in a hardware box, but a tool can be anything make to solve a problem Students may think that they are making their pencils magnetic, but they are actually making a magnetic HOLDER for their pencil.

Instructional Materials/Resources/Tools

- Tape (scotch, duct, masking, ect.)
- Adhesive magnetic rolls
- Refrigerator magnet squares
- Scissors
- String
- Glue
- Pencils

- Paper
- Cardboard egg trays
- Cardboard
- Markers
- Stickers
- Empty yogurt cups
- Empty milk cartons
- Additional recyclable materials that you see fit to provide

Assessment:

- Students will construct a pencil holder using magnets.

Science and Engineering Practices included (put the included ones in bold):

1. Asking questions (for science) and **defining problems (for engineering)**
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and **designing solutions (for engineering)**
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Opening/Engagement Strategy/ Pre - Assessment:

- (20 min)
    - Tell students that today we will use our knowledge of magnets to be engineers. Invite students to turn and talk to discuss what an engineer is. After students discuss, have them share their ideas. Tell students that an engineer is someone who designs and builds tools to solve problems.
    - Explain that a big problem in classrooms is that pencils always fall on the floor. Students keep losing them and are always picking them up. Tell students that since we are so knowledgeable about magnets and forces, that we can use magnets to help solve this problem. Invite students to look at the materials available. Tell them that today we will begin designing and constructing a way for pencils to magnetically attach to the desks. Tell them that they can use any of the materials, but it must magnetically connect to the desk in some way. Remind them that is might be a good idea to design something that can be used again on other pencils, and can be easily removed when their pencil need sharpening.
- (10 min) Give students a Design Planning Worksheet to start. When they complete their plain, they may begin to construct and test their magnetic pencil.

During the Lesson (40 min):

- (10 min) Once students have completed their Design and Planning Worksheet, have them meet in groups of 5 to get feedback on their designs. Students should present their plan to their classmates, and then record other ideas that may come up during this feedback session from other students.
- (30 min) Once the conference is completed, students should make any adjustments necessary to their design, and begin to construct their pencil holder. The teacher should be circulating around the classroom as an extra set of hands, or to help students consider other ideas. Students should be testing their design as they build it to make sure it works successfully.

Lesson Closing (30 min):

- Students will complete an Engineering Conclusion Sheet describing what materials they used, the process of how they built their design, why the design works, or if there are any changes they would make. Students will present their reports and their holders in front of the class.

Instructional Tips/Strategies/Suggestions for Teacher:

- Students should design and construct their pencil holders individually, but be able to work in groups to receive feedback and bounce ideas off of eachother. Teachers should be collecting recyclables to help create the holder, or encourage students to bring materials from home.

Name______________________________________ **Date**____________________

Design and Planning Sheet

List the materials that you will be using to build your magnetic pencil holder (You don't need to fill every line!)

In the space below, draw what you would like your pencil holder to look like.

- ________________________
- ________________________
- ________________________
- ________________________
- ________________________
- ________________________
- ________________________
- ________________________

Describe how you are going to use the materials to help you construct your pencil holder.

____

____

Feedback Page

Record any notes or new ideas that you got from your classmates in the space below:

Name_______________________________ **Date**_______________

Pencil Holder Thoughts

What materials did you end up using for your pencil holder?

____

____

Describe the process of how you built your pencil holder?

____

____

____

____

Describe why your design works? Would you change anything about your design? Explain why.

____

____

____

____

Unit Resources

Lesson 1: What are forces?

- BrainPopJr Video Push and Pull - to help reactivate information - https://jr.brainpop.com/science/forces/pushesandpulls/

Lesson 2: What is friction? Make it stop!

Lesson 3: Forces in Motion - Start your engines!

- Funny music video that reviews vocabulary and concepts up to start of Unit 3

Lesson 4: Magic or magnets? - Magnetic Attraction

Lesson 5: Opposites Attract - North and South Poles

Lesson 6: Magnetic Fields

Lesson 7: Magnets in Action

Unit Materials List

Lesson 1: What are forces?

- Chart paper
- Markers
- Textbook
- Rope with a flag taped to the middle (enough rope for a group of three on each side of the flag)
- Tape rolls - 2 colors
- Index cards

Lesson 2: What is friction? Make it stop!

- Ball
- Chart paper
- White-lined paper or composition notebook
- Sandpaper
- Rug
- Table
- Markers and pencils

Lesson 3: Forces in Motion - Start your engines!

- Matchbox cars
- Sandpaper
- Rug
- Tile floor
- Fan
- Force in Motion-Start your engines! Recording sheet (pg 36)
- Pencils
- Stopwatch
- Rulers

Lesson 4: Magic or magnets? - Magnetic Attraction

- Wand magnets
- Paper clips
- Nails

- Examples of magnetic objects
- Recording sheet (attached)
- *Fantastic Magnet Facts* article (pg 37)
- Beach Sand
- Magnetic or Not? Classroom Data sheet (pg 38)
- Magnetic or Not? Homework Data sheet (pg 39)

Lesson 5: Opposites Attract - North and South Poles

- Various Magnets for exploring how magnets interact with one another
- Bar magnets labeled north and south
- Exit ticket (pg 40)

Lesson 6: Magnetic Fields

- Magnets of varying strengths (5): bar magnets, horseshoe magnets, wand magnets, ring magnets, refrigerator magnets
- String
- Paper clips
- Aluminum tray
- Ruler
- Chart paper
- Markers
- Magnetic Fields Experiment Data sheet (pg 41)

Lesson 7: Magnets in Action

- Tape (scotch, duct, masking, ect.)
- Adhesive magnetic rolls
- Refrigerator magnet squares
- Scissors
- String
- Glue
- Pencils
- Paper
- Cardboard egg trays
- Cardboard
- Markers

- Stickers
- Empty yogurt cups
- Empty milk cartons
- Additional recyclable materials that you see fit to provide
- Design and Planning Pages (pgs 42, 43)
- Design Review Page "Pencil Holder Thoughts" (pg 44)

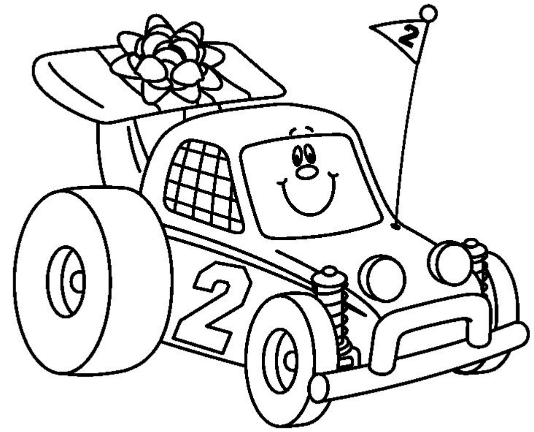
CAPE COD REGIONAL
STEM NETWORK

Activity Pages/Worksheets/Handout Masters for Units

CAPE COD REGIONAL STEM NETWORK

Name____ **Date**______________________

Force in Motion - Start your engines!



Predict: On what surface and with what force will your matchbox car travel fastest?
Answer in a complete sentence.

____

____

____

Record the speed of your matchbox car for each surface and force

Surface	**Force**	**Force**	**Force**
	Light Push	Breath	Fan on Low
Tile Floor			
Rug			
Sandpaper			

Analyze: What matchbox car traveled the fastest? Explain why using key vocabulary words such as **balanced, unbalanced,** and **friction.**

____

____

Fantastic Magnet Facts

Until the 13th Century people believed that magnets were magical. Then a Frenchman, Petrus de Maricourt, discovered (in 1269) that magnets have two poles and the mysteries of magnetism started to be unraveled. In 1600 an English physician name William Gilbert discovered the Earth's magnetism.

Why does the Earth behave like a giant magnet with a magnetic field surrounding it? Scientist have found out that the magnetic field is produced by the molten metal which is found deep beneath the Earth's surface. As the Earth spins, electric currents are created in molten metal and theses currents produce the Earth's magnetic field.

The world's heaviest magnet is in the Joint Institute for Nuclear Research near Moscow, Russia. It measures 196 feet in diameter and weighs a massive 42,000 tons. The amazingly fast Maglev trains use magnetic force to help them reach speeds of over 217 miles an hour. The Japanese MLU system uses electromagnets that repel each other so the train floats above the rails.

The largest electromagnet is higher than a four-story building and has an enormous aluminum coil weighing 1,000 tons. The magnet was built by a team of Russian and Swiss scientists and it is made out of more metal than the Eiffel Tower in Paris!

Did you know that some animals have a built-in magnet that acts like a compass and helps them to find their way? Whales and dolphins use the Earth's magnetic field to navigate. Scientists have discovered that if a magnet is fixed to a pigeon's back it cannot find its way on cloudy days. In Australia there are insects called Compass Termites which build their nests facing north. It is thought they use the Earth's magnetism to get the position of their nests right.

CAPE COD REGIONAL
STEM NETWORK

Name____________________________________ **Date:**__________________

Magnetic or Not? Classroom

Travel around the classroom with your magnet. Test 10 items to see if they are magnetic or not.

Object	**Magnetic**	**Not Magnetic**

Describe what happens when two magnets come together.

____

____

CAPE COD REGIONAL STEM NETWORK

Name______________________________________ **Date:**___________________

Magnetic or Not? Homework

Travel around your home with your magnet. Test 6 items to see if they are magnetic or not.

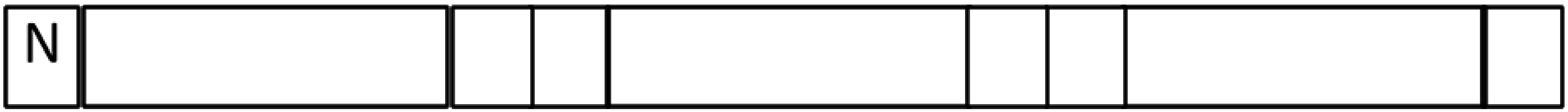
Object	Magnetic	Not Magnetic

CAPE COD REGIONAL STEM NETWORK

Exit Ticket North South Poles

Name____ **Date:**______________________

1. Where are the north and south poles on the magnets?



2. How would each train connect to the next train?

CAPE COD REGIONAL STEM NETWORK

Name:____ **Date:**__________________

Magnetic Field Experiment

Predict: Which magnet do you think will have the greatest strength or magnetic field?

____

____

Recording Sheet: Number of Paper Clips Attracted by Each Magnet

	Horseshoe Magnet	**Bar Magnet**	**Ring Magnet**	**Wand Magnet**	**Fridge Magnet**
0 Inches					
2 Inches					
4 Inches					
6 Inches					
8 Inches					

Analyze: Which magnet attracted the most paper clips at the farthest distance and why?

____

____

Was your original prediction correct or incorrect? If it was incorrect, what do you now know about magnets that explains why your answer was wrong?

____

____

Name_________________________________ Date___________________

Design and Planning Sheet

List the materials that you will be using to build your magnetic pencil holder (You don't need to fill every line!)

- ______________________
- ______________________
- ______________________
- ______________________
- ______________________
- ______________________
- ______________________
- ______________________
- ______________________
- ______________________

In the space below, draw what you would like your pencil holder to look like.

Describe how you are going to use the materials to help you construct your pencil holder.

____

____

____

CAPE COD REGIONAL STEM NETWORK

Feedback Page

Record any notes or new ideas that you got from your classmates in the space below:

Name_______________________________ Date_______________

Pencil Holder Thoughts

What materials did you end up using for your pencil holder?

____

____

Describe the process of how you built your pencil holder?

____

____

____

____

Describe why your design works? Would you change anything about your design? Explain why.

____

____

____

____