The Evolution of the T2L Science Curriculum

Over the last four years, the Teach to Learn program created 20 NGSS-aligned science units in grades K-5 during our summer sessions. True to our plan, we piloted the units in North Adams Public Schools, and asked and received feedback from our science fellows and our participating teachers. This feedback served as a starting point for our revisions of the units. During year 2 (Summer of 2015), we revised units from year 1 (Summer/Fall 2014) and created new units to pilot. In year 3, we revised units from years 1 and 2 and created new units of curricula, using the same model for year 4. Our understanding of how to create rich and robust science curriculum grew, so by the summer of 2018, our final summer of curriculum development, we had created five exemplar units and established an exemplar unit template which is available in the T2L Toolkit.

We made a concerted effort to upgrade all the existing units with exemplar components. We were able to do much, but not all. So, as you explore different units, you will notice that some contain all elements of our exemplar units, while others contain only some. The fully realized exemplar units are noted on the cover page. We did revise all 20 units and brought them to a baseline of "exemplar" by including the Lessons-At-A-Glance and Science Talk elements.

Grade 3

Forces and Magnets

MCLA NAPS Williams

Teach To Learn

A collaboration between MCLA, Williams College, and North Adams Public Schools

Funded by NSF DUE-IUSE Award #1432591

T2L Curriculum Unit

Teach To Learn
A collaboration between MCLA, Williams College, and North Adams Public Schools
Funded by NSF DUE-IUSE Award #1432591

Forces and Magnets

Physical Science/Grade 3

Students will learn about how forces affect the world around them. They will also learn about the laws of physics, invisible forces, and how forces can be balanced. Students will use their knowledge about forces and the laws of physics to understand how magnets and the Earth's magnetic field function.

Authors
Lori Parrino, Grade 3 Teacher, Colegrove Park Elementary School
Diego Gonzalez, Computer Science Major, Williams College
Lindsay Osterhoudt, Science Coordinator, North Adams Public Schools

Major Revisions, Summer 2018
Stephanie Nguyen, Elementary Education and Interdisciplinary Studies, MCLA
Matthew Roychowdhury, Physics major, Williams College

License/Copyright Information

This unit was developed with funding from the National Science Foundation DOE-IUSE Award No. 1432591.

This unit is downloadable at http://mcla.edu/teach-to-learn

Translations:
If you create translated versions of this material (in compliance with this license), please notify principal investigator, Nick Stroud at n.stroud@mcla.edu. The project may choose to distribute and/or link to such translated versions (either as is, or as further modified by Teach to Learn).

Table of Contents

This unit was developed with National Science Foundation funding (Grant #1432591). It is a DRAFT document that will be revised as the unit is piloted and feedback received.

Unit Plan

<table>
<tr><th colspan="3">Stage 1 Desired Results</th></tr>
<tr><td rowspan="2">

- **3-PS2-3**. Investigate to determine the nature of the forces between two magnets based on their orientations and distance relative to each other. **Clarification Statement:** Focus should be on forces produced by magnetic objects that are easily manipulated.
- **3-PS2-1**. Provide evidence to explain the effect of multiple forces, including friction, 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. [**Clarification Statements:** Descriptions of force magnitude should be qualitative and relative. Force due to gravity is appropriate but only as a force that pulls objects down. **State Assessment Boundaries**: Quantitative force magnitude is not expected in state assessment. State assessment will be limited to one variable at a time: number, size, or direction of forces.]

</td><td colspan="2">

- ***Meaning***

</td></tr>
<tr><td>

UNDERSTANDINGS
Students will understand that…

- Each force acts on one particular object and has both strength and direction. An object at rest typically has multiple forces acting on it, but they equal to zero net force on the object. Forces that do not sum up 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.)
- 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
- Objects in contact exert forces on each other. Electric and magnetic forces between objects do not require that the objects be in contact. The size of the

</td><td>

ESSENTIAL QUESTIONS

- How do forces affect the world around us?
- How do magnets and their properties influence everyday life?

</td></tr>
</table>

This unit was developed with National Science Foundation funding (Grant #1432591). It is a DRAFT document that will be revised as the unit is piloted and feedback received.

MCLA NAPS Williams
Teach To Learn
A collaboration between MCLA, Williams College, and North Adams Public Schools
Funded by NSF DUE-IUSE Award #1432591

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

3.3-5-ETS1-2. Generate several possible solutions to a given design problem. Compare each solution based on how well each is likely to meet the criteria and constraints of the design problem. [Clarification Statement: Examples of design problems can include adapting a switch on a toy for children who have a motor coordination disability, designing a way to clear or collect debris or trash from a storm drain, or creating safe moveable playground equipment for a new recess game.]
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.
2006- PS- 9 Recognize that magnets have poles that repel and attract each other.
3-PS2-4 Define a simple design problem that can be solved by applying scientific ideas about magnets. (Clarification statement: Examples could include constructing a latch to keep a door shut and creating a device to

</td>
<td>
force in each situation depend on the properties of the objects and their distances apart

Magnets have certain characteristics and attract specific types of metals
Magnets can be used to solve design problems
Magnets have poles that attract and repel
Magnets will work through non-magnetic surfaces
A magnet will attract some objects and materials and there are some objects and materials that a magnet will not attract

</td>
<td></td>
</tr>
<tr>
<td colspan="2">Student Learning Targets</td>
</tr>
<tr>
<td colspan="2">
Students will be able to
Correctly predict whether or not an object is magnetic.
Categorize objects by whether or not they are magnetic.
Indicate whether or not an object will move.
Answer questions to demonstrate understanding.
Label the north and south poles of a magnet.
Predict whether or not two poles will attract or repel each other.
Predict the direction an object will move based on the strength and direction of the force on an object.
</td>
</tr>
</table>

MCLA NAPS Williams
Teach To Learn
A collaboration between MCLA, Williams College, and North Adams Public Schools
Funded by NSF DUE-IUSE Award #1432591

keep two moving objects from touching each other.)	Determine the strength of a magnet based on the number of paperclips the magnet held. Explain how a magnet works through a non-magnetic surface. Predict whether or not an object will stop due to friction. Demonstrate that the higher an object is placed on a ramp the faster it will be once it comes off the ramp. Create a design to fix an everyday problem using magnets and materials supplied.

Stage 2 – Evidence

Evaluative Criteria	Assessment Evidence
Pre-unit Assessment (if any)	1. The end of the year science test. 2. Individual lesson worksheets 3. **Show What You Know!** Many lessons contain MCAS style multiple choice and open response questions to assess student understanding of the concepts presented in the lesson. The classroom teacher should administer the questions sometime after the completion of the lesson. The results can be used to plan additional lessons on concepts that students need help mastering.

Stage 3 – Learning Plan

3.R.1. Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.

PreK-PS2-1(MA). Using evidence, discussing ideas about what makes something move the way it does and how some movements can be controlled.

PreK-PS2-2(MA). Develop awareness of the factors that influence whether things stand or fall. Clarification Statement: Examples of factors in children's construction play include using a broad foundation when building, considering the strength of materials, and using balanced weight distribution in a block building.

K-PS2-1. Compare the impacts of different strengths and directions of pushes and pulls on the motion of an object. Clarification Statements: Examples of pushes or pulls could include a string attached to an object being pulled, a person pushing an object, a person stopping a rolling ball, and two objects colliding and pushing on each other. Non-contact pushes or pulls such as those produced by magnets are not expected.

Lesson Overview

Lesson 1 - Students will discuss magnets, what they are, and where they've seen them. They will then do two activities; first exploring which objects around them are magnetic and which aren't magnetic. Then, they will predict and test the magnetic nature of objects.

Lesson 2 - Students will investigate that objects at rest stay at rest unless acted upon by an outside force. Students will watch a video regarding forces and motion. Then, they will brainstorm different ways to move an object. Afterwards, the students will learn (through examples) that in order to alter the speed of an object, you must apply force to that object. Students will practice their engineering and design skills as they test their airplanes.

Lesson 3 - Students will experiment with a variety of magnets and explore the properties of the north and south poles. They will have the opportunity to manipulate magnets and discuss how "like" poles repel and "different" poles attract one another. The students will extend these properties to the concept of a compass. They will manipulate a magnet and compass. They will see that the compass works by magnetic forces and that the introduction of a magnet will attract the compass' needle.

Lesson 4 - Students will learn about balance and observe various demonstrations showing them how forces act on an object. Students will then participate in an activity using ping pong balls and straws where they will learn how forces interact. Finally, students will make mobiles to further their understanding of balance.

Lesson 5 - Students will work with paper clips and magnets to determine the strength of various magnets. **Lesson 6 -** Students will learn about friction and will experiment with different materials to see how much friction they can produce. The students will also learn about gravity and air pressure and how it keeps planes afloat. **Lesson 7 -** Students take on the role of engineers. They will be given an everyday problem to solve using magnets and a variety of craft materials. Students will reflect on their knowledge of magnets and will work in groups to analyze the problem. Then, they will discuss the design of a gadget to solve the problem after much testing and revising.
Adapted from Massachusetts Department of Elementary and Secondary Education's Model Curriculum Unit Template. Originally based on Understanding by Design 2.0 © 2011 Grant Wiggins and Jay McTighe. Used with Permission July 2012

Lessons at a Glance

Key

Independent online student research	Tech integration	YouTube video (or other video site)	Kinesthetic learning	Outdoor education	Lab work

Lesson	Core Activities	Extensions	Aspects of Lesson
1. Introduction to Magnets	• Magnet scavenger hunt • Magnet discovery basket		Outdoor education
2. Investigating Forces and Motion	• Do objects stop and start moving on their own? • Bill Nye video • Scooter think-pair-share • Paper airplane activity	• “Famous Scientists–Isaac Newton” reading	Kinesthetic learning, YouTube video, Outdoor education
3. Pole to Pole	• Guided magnet exploration • Free magnet exploration • Compass exploration	• Virtual compass	Tech integration
4. Balanced and Unbalanced Forces	• Rope Pulling • Force Diagrams • Ping-pong ball activity • Mobile Making	• Ping-pong maze	Outdoor education, Kinesthetic learning

5. Magnetic Applications	• Magnet Plate Car • Testing magnetic strength	• Temporary magnets	
6. Unseen Forces	• Friction Investigation • Air Resistance Investigation • Ramp Lab • Airplane Review	• Bill Nye flight video	
7.Magnetic Engineers	• Paperclip contraption demo • Engineers creating gadgets		

Teach To Learn
A collaboration between MCLA, Williams College, and North Adams Public Schools
Funded by NSF DUE-IUSE Award #1432591

Lesson Feature Key

Lessons in this unit include several features to help instructors. This key is a quick guide to help identify and understand the most important features.

Icons

Talk science icon: Look for this icon to let you know when to use some of the talk science strategies (found in the unit resources of this unit).

Anchor phenomenon icon: Indicates a time when an anchoring scientific phenomenon is introduced or when an activity connects back to this important idea.

Text Formatting:

[SP#: ….] Any time you see a set of brackets like this, it indicates that students should be engaged in a specific science or engineering practice.

Underlined text in the lesson:

This formatting indicates important connections back to the central scientific concepts and is useful to note these connections as an instructor, as well as for students.

Callouts

Teaching Tip

In these call-out boxes, you'll find tips for teaching strategies or background information on the topic

Student Thinking Alert

Look out for common student answers, ways in which students may think about a phenomenon, or typical misconceptions.

Tiered Vocabulary List

Tier 1	Tier 2	Tier 3
Push	Force	Scale
Pull	Trial	Force components
Magnet	Research	Newton (unit)
Metal	Speed	Friction
Nonmetal	Diagram	Gravity
Problem	Balance	Air resistance
	Experiment	Magnetic Field
	Laws of physics	Magnetism
	Attract	Design
	Repel	Gadget
	North	Contraption
	East	Collaborate
	West	Aerodynamics
	South	Thrust
	Pole	Lift
	Strength	Drag
	Create	
	Engineer	
	Practical	

Science Content Background

Please read through the explanation provided over the next few pages and jot down any questions or uncertainties. Consult internet resources to answer your questions, ask colleagues, and work together as a team to grow your own understanding of the science content and the central phenomena in this unit. This knowledge will prime you to better listen and respond to student ideas in productive ways. Please feel free to revisit this explanation throughout the unit to revise and improve your own understanding of the science content.

Essential Questions:

How do forces affect the world around us?

Forces are crucial to the functioning of every part of the universe, and can be thought of as an "push" or "pull." Without forces the speed and direction of travel of objects would never change, and the temperature of matter would never change. Forces can, and do, change all these variables and affect where objects end up and how they form; from the buoyancy of a leaf floating on a pond to the growth and steady decline of mountain ranges.

How do magnets and their properties influence everyday life?

Magnets influence our everyday life both in nature and in human-made tools. The Earth's magnetic field helps us navigate via compass and creates the northern and southern lights; humans use magnets to attract magnetic objects and generate electricity.

Anchoring Phenomena:

In this unit we use the concept of engineering and design to connect the following lessons and the concepts of forces and magnetism. Students are encouraged to use their understanding of forces and magnetism to come up with innovative ways to build paper airplanes and use magnets.

This unit was developed with National Science Foundation funding (Grant #1432591). It is a DRAFT document that will be revised as the unit is piloted and feedback received.

Key Science Ideas:

1. Newton's First Law:
    a. Objects will always have the same speed (even if that speed is zero) and travel in the same direction unless acted upon by a force.
    b. A force is a push or pull; this push and pull can be caused not only by physical collisions (when two objects hit each other), but also by special types of attractions and repulsions such magnetic, electric, chemical, and gravitational forces.
2. Forces can combine or cancel each other out:
    a. A force changes an object's speed and/or the direction of the object's path. The object's travel path changes direction based on the direction of the force.
    b. The larger the force the larger the change in speed and/or direction an object experiences.
    c. When two or more forces act upon the same object from the same direction, they combine together and act like one large force; when two or more forces act upon the same object from opposite directions, they subtract from each other and may cancel each other out.
    d. Every force can be looked at as the combination of two, smaller forces that are at right angles to each other.
3. Newton's Third Law:
    a. Every time an object applies a force on another object, an equally large force is applied on the first object in the opposite direction.
4. Friction:
    a. Friction is a force that opposes motion.
    b. Friction is caused by the resistance of bumps on the surface an object touches while it moves. The rougher and bumpier the surface, the stronger the force of friction.

5. Gravity:
    a. Gravity is a force that pulls any two objects with mass towards each other. For example, gravity pulls objects down towards the Earth, and that object also pulls up the Earth.

b. Larger objects experience stronger forces of gravity and therefore feel heavier. Weight is simply a measure of the gravitational pull on an object, and can change (e.g., your weight is different on the Moon than on the surface of the Earth).

6. Magnetism
   a. Magnetic force is a special type of force that acts on certain types of materials, such as metals like iron, nickel, and cobalt. Magnetic forces can push and pull an object.
   b. Magnetic fields exert magnetic forces on objects. When an object is close to the center of a magnetic field, it feels a strong magnetic force; when it is far away from a magnetic field, it experiences a weaker magnetic force.
   c. Every magnetic field has two poles: a north pole and a south pole. Opposite poles attract and identical poles repel.
   d. A magnet is an object that has a magnetic field, and therefore produces magnetic forces.
   e. Some magnets are permanent, meaning they always have a magnetic field, and others are temporary, meaning they only become magnets when they are near other magnets or are magnetized for a short time.

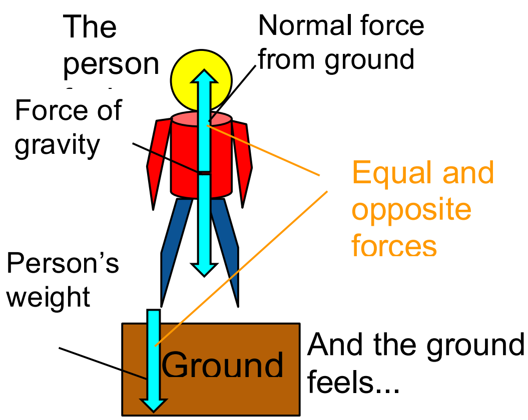
Explanation:

Newton's First Law states that an object at rest will always stay at rest and an object in motion will always stay in motion unless acted on by an unbalanced force. This means that all objects will travel at the same speed and in the same direction indefinitely unless they experience a force. Therefore, whenever an object speeds up it has experienced a force, whenever a moving objects slows down it has experienced a force, and whenever an object changes direction it has experienced a force. **Forces don't *move* objects; they only change *how* they move.**

Every force has a direction, and the larger the force, the more quickly it changes the speed and/or direction of the object it acts on. Forces come in units called newtons, just like time comes in units of hours. A newton is defined as the amount of force needed to speed up one kilogram of mass so that its speed increases by 1 meter/sec every second that the force is applied. When more than one force affects the same object, they can combine together. If two forces pointing in the same direction are applied together, they act like one large force on the object. That's why two or more people pushing a car (or anything else) speed it up faster than one person pushing it alone. Forces can also subtract from each other. If two forces act on the object from opposite directions, they subtract from each other and the object speeds up more slowly in the direction of the greater force; if both forces are equal in size and opposite in direction, they actually cancel each other out and the object acts as if there aren't any forces on it at all (it keeps its original speed, even if that speed was zero).

When an object is affected by two forces that are at right angles to each other, the two forces combine into one larger force that points at an angle diagonally in between the two original forces (see the lower right image in the figure below). So if two right-angle (perpendicular) forces are interchangeable with one larger, diagonal force, it follows that any force is interchangeable with two smaller, perpendicular forces. In other words, just as two perpendicular forces combine to form a larger force, forces can be "broken up" into little perpendicular forces (this happens to Force 1 in the upper right part of the image on the left). These perpendicular forces are called the **components** of the force. This comes in handy when an investigator is trying to figure out how several forces, including diagonal forces, will combine together. In the images on the left, four different combinations of forces act upon the yellow object, but the effect of each combo on the object is exactly the same. Rearranging the forces in the upper left image so that they look like the forces in the lower left image can help an investigator figure out what their combined force is going to look like (the combined force is the white arrow in the lower right image).

The concept of resisting forces is often difficult for students to understand. Every time an object exerts a force on another object, it undergoes an equally large force pointing in the opposite direction. For example, when a player kicks a soccer ball, the player applies a force to the ball and the ball applies an equally large force on the player. The force that player receives from the ball explains why it sometimes hurts to kick a ball, or why a bowling ball rolls more slowly after it has stuck a pin. **The two opposing forces are *not* both applied to the soccer ball.** These "equal and opposite" forces are called normal forces, and can come from soccer balls, air, and the ground; anything that is pushed or pulled applies a normal force against the thing pushing and pulling on it. This is why a motorboat moves forward by pushing water backwards with its engines, or a rocket propels itself forward by pushing fuel backwards. Both these machines are sped up by the normal force of the water or fuel. Sometimes the two opposing forces are harder to see. When a person stands on the ground, they are pushed down by the force of gravity. They apply the force of their weight on the ground, and the ground applies an equal force back on them. The person is held in place by the pull of gravity and the ground does not move due to its solid nature, but the opposing forces the two objects apply to each other are still there.



Normal force also helps explain the phenomena of friction and air resistance. Pretty much every surface, no matter how smooth it seems, is covered in bumps and pieces of debris. When an object slides across that surface, it runs into the bumps, pushes them out of the way, and pulls around the debris. In other words, the object is applying force to the surface. The surface therefore applies an equal and opposite force on the object and slows it down. This normal force is what we call friction. Rolling objects don't apply as much force to the surface as sliding objects do, so they travel a bit further before coming to a stop. This explanation also explains why objects with bumpier surfaces exert more friction. The force that air applies on moving objects, called air resistance, works in a very similar way; instead of smoothing out bumps, however, the object forces air molecules out of its way.

This unit does not require that students know anything more about magnets than what is outlined in the key science ideas above. But students are bound to have more questions about magnets, and it will be helpful to the teacher to know the answers to those questions before deciding how into depth they want to go with their explanations. Below are answers to two commonly asked questions. These answers are meant to provide a full understanding to the teacher, but not necessarily to be easily grasped by the student.

Why do some objects stick to magnets and others don't?

Electrons are the tiny particles that make up electric currents, and they also exist in every material on the planet. Each electron spins on its axis (like the Earth), and that spinning creates a tiny magnetic field, turning the electron into an incredibly small magnet. When an electron spins clockwise, its north pole points in one direction (let's call it "up") and its south pole points in the other ("down"); if it spins counterclockwise instead, the north pole points down and the south pole points up. Most materials, including some metals like copper and aluminum, have the same amount of electrons spinning clockwise as they have spinning counterclockwise. Therefore, the magnetic forces cancel each other out and the object can't create or be affected by a magnetic field. But metals like iron, cobalt, and nickel have more electrons spinning one direction than they do the other, so the combined magnetic forces of all their electrons *can* add up to a magnetic field.

Why aren't the metals that stick to magnets* always *magnetic?

Even if most of a metal's electrons are all spinning one way, that doesn't mean that its electron-magnets are all pointed in the same direction! In most pieces of magnetic metal, each tiny magnet is pointed in a different direction and all the forces cancel out. But when the metal is brought near a strong magnet, every one of the electron-magnets starts pointing the same direction, and their forces add together to turn the piece of metal into one big magnet. Electrons naturally move around inside the metal though, so once the first magnet goes away, the metal's electrons go back to pointing in every direction; this is why a paperclip is magnetic only as long as it is near another magnet. Permanent magnets contain special structures so that the electrons are all trapped pointing in the same direction and can't move; therefore, they stay magnetic even without another magnet around. Even a permanent magnet will stop having a magnetic field, however, if the magnet is hammered or heated so that its electrons are jostled around again.

This unit was developed with National Science Foundation funding (Grant #1432591). It is a DRAFT document that will be revised as the unit is piloted and feedback received.

Lesson 1: Introduction to Magnets

BACKGROUND

Overview of the Lesson

Students will discuss magnets, what they are, and where they've seen them. They will then do two activities; first exploring which objects around them are magnetic and which aren't magnetic. Then, they will predict and test the magnetic nature of objects.

Focus Standard

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. **Clarification Statement:** Focus should be on forces produced by magnetic objects that are easily manipulated.

Learning Targets

I can correctly predict whether or not an object is magnetic
I can categorize objects by whether or not they are magnetic

Assessment

Have students complete the two provided worksheets.

WIDA Language Objectives

Dependent on the needs of your ELL students

This unit was developed with National Science Foundation funding (Grant #1432591). It is a DRAFT document that will be revised as the unit is piloted and feedback received.

Key Vocabulary

Tier 1: Magnet, metal, nonmetal

RESOURCES AND MATERIALS

Quantity	Item	Source
1	**Large demonstration magnet**	**Bin**
1 per student	**Handheld bar magnets**	**Bin**
1 per group	**Plastic tray**	**Bin**
1 of each per group	**Paper clips, wood block, paper, plastic toy, pennies/coins, jar of iron filings, pipe cleaners, novelty fridge magnets, plastic bingo chips**	**Bin**
1 per student	Scavenger Hunt Worksheet	Binder
1 per student	Discovery Worksheet	Binder

****Items in bold should be returned for use next year****

LESSON DETAILS

Lesson Opening/ Activator

Show a large magnet to the class, then ask the students questions like "who knows what this is?" or "does anyone know what this might be/be used for?" Students will identify this as a magnet. The teacher should also ask students if they have encountered magnets at home or in other places. The teacher should demonstrate the magnet sticking to various surfaces in the front of the classroom as the students may suggest that they have seen this before.

During the Lesson

Magnet Scavenger Hunt: Be sure to explain this activity to the students before handing them their materials. Students will each be given a magnet and a scavenger hunt worksheet. They will take their bar magnet around the room to find 6 different things that the magnet sticks to, and that don't stick to the magnet. To incorporate outdoor education, the teacher should bring the class outside, so students can find objects outside as well.

Science Talk (Small Groups): If teachers choose to have students work in small groups, students will support each other through a discussion about the worksheet.

1. The teacher may choose to do this activity in small groups or have each student do this individually.
2. Give students an adequate amount of time to fill in their worksheets. Then, bring them all back to a whole group and start the discussion about what objects the students found to be magnetic. Encourage students to use these sentence starters to help frame their thinking:
   I think _____ was magnetic because it _____ when I held the magnet to it.
   I don't think_____ was magnetic because it _____ when I held the magnet to it.
3. Ask students what material the objects were made of. Were the objects metal or nonmetal? Write down the objects students name in two columns (magnetic and nonmagnetic) on the board. Students should eventually conclude that all the objects that the magnets stuck to were made of metal, but the magnet didn't stick to all metal objects.

The teacher will now explain to the students that they will be predicting whether or not an object is magnetic based on what they just learned. The teacher will split students into groups of 3-4 students and have the students in each group sit together around a table or central desk.

Magnet discovery basket: Each group will be given a tray full of the various objects, and each student will be given a worksheet. The worksheet has a prediction column and an experiment column.

Science Talk: Support student thinking by having students make predictions about the magnetic quality of the objects:

1. Students will first predict whether or not the object is magnetic and note that in the prediction column, either by writing the name of the object or drawing a quick sketch of it.

This unit was developed with National Science Foundation funding (Grant #1432591). It is a DRAFT document that will be revised as the unit is piloted and feedback received.

2. Once the whole group has all of their objects classified as magnetic or not magnetic, the teacher should now give each group a few bar magnets to test their predictions. They will record their findings in the experiment column of their worksheet, either by writing the name of the object or drawing a quick sketch of it.

Probing Questions: What assumptions did you make beforehand about the magnetic properties of objects?
Why do you think your predictions were incorrect?
What did you learn from this activity that will help you predict if an object is magnetic/not magnetic?

Lesson Closing

Students will recap what they learned during the lesson by reviewing what they learned about magnetic properties.

At the end of the lesson, ask students if all the objects were magnetic. The students should tell the teacher that some of the objects they explored were not magnetic. Therefore, based on this fact, the teacher should ask students what exactly makes an object magnetic. Remind the students that they do not need to know the answer, but they should keep this question keep this in mind for the next lesson which focuses on the forces, the concepts behind magnets.

Assessment: Have students complete the two provided worksheets.

Lesson 2: Investigating Forces and Motion

BACKGROUND

Overview of the Lesson

Students will investigate that objects at rest stay at rest unless acted upon by an outside force. Students will watch a video regarding forces and motion. Then, they will brainstorm different ways to move an object. Afterwards, the students will learn (through examples) that in order to alter the speed of an object, you must apply force to that object. Students will practice their engineering and design skills as they test their airplanes.

Focus Standard(s)

3-PS2-1. Provide evidence to explain the effect of multiple forces, including friction, 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. [**Clarification Statements:** Descriptions of force magnitude should be qualitative and relative. Force due to gravity is appropriate but only as a force that pulls objects down. **State Assessment Boundaries**: Quantitative force magnitude is not expected in state assessment. State assessment will be limited to one variable at a time: number, size, or direction of forces.]

3.3-5-ETS1-2. Generate several possible solutions to a given design problem. Compare each solution based on how well each is likely to meet the criteria and constraints of the design problem. [**Clarification Statement:** Examples of design problems can include adapting a switch on a toy for children who have a motor coordination disability, designing a way to clear or collect debris or trash from a storm drain, or creating safe moveable playground equipment for a new recess game.]

3. R. 1. Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.

Learning Targets

I can indicate whether or not an object will move
I can generate a solution to a problem
I can answer questions to demonstrate understanding

Assessment

Students will be assessed on their participation in discussions. A worksheet will also assess their knowledge of the core concepts.

Key Vocabulary

Tier 1: push, pull

Tier 2: force, trial, research, speed

RESOURCES AND MATERIALS

Quantity	Item	Source
1 piece per student	White paper	Classroom Teacher
1 per group	Ipad	Classroom Teacher
1	Scooter	Gym Teacher
	Bill Nye "Force and Motion" Video	CMC Website
1 per student	Bill Nye Video Worksheet	Binder
1 per student	Airplane Test Flights Worksheet	Binder
1 per student	Isaac Newton Reading and Questions	Binder
1 roll	**Masking Tape**	**Bin**

****Items in bold should be returned for use next year****

LESSON DETAILS

Lesson Opening/ Activator

Teachers should make a paper airplane before the lesson begins- this will be used for demonstration purposes. (A link to a tutorial is provided below.) Ask the students if any of them have ever flown in an airplane. Allow the students to share their experiences. Throw the paper airplane across the room and time how long it stays in the air. Then, ask the students to share what they observed. How long did the plane stay afloat? Why did it fall to the ground? How can we predict whether the plane will fly in a straight or curved path?

Video on how to make an airplane: https://www.youtube.com/watch?v=veyZNyurlwU
Website with step by step instructions on how to make an airplane: http://www.foldnfly.com/1.html#Basic-Dart

During the Lesson

1. **Do Objects Start and Stop Moving on Their Own?**
   a. The teacher or science fellow should pretend to be an inanimate object. Ask a volunteer or the fellow instructor to lightly push on the person who is acting as an inanimate object. Ask the students to share what the observed. When did the movement happen? Could the object move on its own?
   b. Move the class to the hallway. Bring out a scooter. Ask the students to encourage the scooter to move by saying things like "*Please move over here! I have cake!"* Ask the class for ideas on what they can say to the "object" to get it to move. This should last for no more than two minutes.
   c. After some failed attempts, ask the class "*Is there anything else we can do to move the scooter?"* Guide the discussion, so that the students realize that someone needs to apply a push or a pull to the scooter to make it move. Push and pull the scooter and explain that this shows that a still object, or an object "at rest", will stay at rest unless you apply a force, which you can first explain as a push or pull.

   Probing Questions:
   - How do you usually move scooters? (Answer: you push it)

- What if you couldn't push a scooter? Is there another way to move it? What will happen if you do not push or pull the scooter at all?

d. Stack some books on the scooter, and get it moving slowly. Then have a volunteer stop the scooter suddenly with their foot and observe how the books fly off. Help the students come to the conclusion that the books flew off because they kept moving and were never stopped by an opposing push. Explain that this shows that a moving object or an object "in motion" will stay in motion unless acted upon by a force.

2. **Science Talk: Force Discussion [SP6 - Constructing Explanations]** For this activity, students should be seated in the classroom so they can watch the Bill Nye video "Force and Motion". Before showing the video, tell the students to pay attention to what happens to an object at rest and an object in motion. Once the video is over, go over the concepts with the students. Ask them; "*Do objects at rest ever move on their own? Did the boxes move on the truck by themselves?*" "*Do objects in motion ever stop on their own? What would happen if an object in motion had no forces affecting it?*" Now pass out the Bill Nye video worksheet for the students to complete.

Write the following two sentences on the board; "*Objects in motion stay in motion unless acted upon by an outside force. Objects at rest stay at rest unless acted upon by an outside force*.**"** Ask students whether they think these sentences are true or false and to explain their reasoning. Remind them to think back to the scooter activity and video they just watched. Tell the students that this is the first law of physics by Sir Isaac Newton that they will learn about during this unit.

Scooter Think-Pair-Share: **[SP 8 - Obtaining, evaluating, and communicating information]** Tell the students that they will brainstorm different ways to apply a force to an object. If you wish to relate this to your previous hands-on example, you can have the students imagine that they're applying force to the scooter. Now, put the students in pairs and ask them to think of examples of how they could apply a force to an object, either directly or indirectly. Give the students 5-10 minutes to brainstorm and then have each of the pairs share their examples. The teacher should split the whiteboard into four columns for each type of force. For each example a student shares, the teacher should write it down in the corresponding category. The columns shouldn't be labeled.

Teaching Tip
For visual learners, draw a brief picture next to each category. For push, draw a person pushing a shopping cart. For pull, draw a person pulling something heavy. For collision, draw a bowling ball crashing into pins. For friction, draw someone slipping on ice to show them that this is a lack of friction.

Then, lead the conversation to the conclusion that every way of moving an object is either a:

1. Push
2. Pull
3. Collision
4. Friction

Have students guess how you grouped their ideas.

(Science Talk: Class Discussion): Bring the students outside and tell them that when you put a force on an object, you affect that object's speed. Ask the students if they have ever seen someone skateboard. Allow a student to discuss the concept of skateboarding to the class. Ask the students "*What happens when someone pushes on the ground while on a skateboard?*" To help students visualize what happens when someone skateboards, the teacher should select a student volunteer to demonstrate on a scooter. However, remind the student instead of standing, they should be fully seated on the scooter. Then, lead the discussion to the conclusion that when someone skateboards, they push the ground to gain speed. Ask students: how could they get the scooter to go faster? Then, tell the students, "*Each push has the same amount of strength behind it, but the skateboard keeps going faster and faster because the speed increases with every push.*"

Airplane Activity: (This part of the lesson was adapted from: [http://betterlesson.com/lesson/641889/flying-into-a-problem-1-3]

The students will remain outside for this activity.

1. Put the students into groups of 2-4. Tell the students that they are going to use what they know about forces to become airplane engineers. Ask the students if they think they can make a paper airplane that flies for at least 5 feet.

2. Give each group a few sheets of paper and have the students discuss their airplane designs with their group. Once they have agreed on a design, they will make their airplane. **Note: The students should not use paper clips in their designs.**

3. *Initial Testing:* Once every group has made their airplane, each group will take turns testing their airplane on the grass. Make sure that all students are behind the student throwing the airplane. Each group will test their airplane three times. The teacher should hand out a worksheet with three columns labeled Trial 1, Trial 2, Trial 3 for students to fill out. Tell the students to jot down any observations from their test flights in the column for that trial. Once a student's paper airplane hits the ground, put a piece of masking tape on the ground where the plane landed. Write down the names of the students on the piece of masking tape followed by the trial number. Students should measure the distance their airplanes traveled with a tape measurer and record the measurements in their worksheet.
4. Each group should write their names on their airplane. The teacher should then collect the airplanes and save them for lesson 6 in this unit.

(Science Talk: Class Discussion): Ask the students to list the forces they think are working on the airplane. Ask them what sorts of forces were involved in flight. Ask them, "*Are there any pushes? Any pulls? Any collisions?*"

Assessment

Students will be assessed on their participation in discussions. A worksheet will also assess their knowledge of the core concepts.

Lesson 3: Pole to Pole

BACKGROUND

Overview of the Lesson

Students will experiment with a variety of magnets and explore the properties of the north and south poles. They will have the opportunity to manipulate magnets and discuss how “like” poles repel and “different” poles attract one another. The students will extend these properties to the concept of a compass. They will manipulate a magnet and compass. They will see that the compass works by magnetic forces and that the introduction of a magnet will attract the compass’ needle.

Focus 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.

2006- PS- 9 Recognize that magnets have poles that repel and attract each other.

Learning Targets

I can label the north and south poles of a magnet

I can predict whether or not two poles will attract or repel each other

Assessment

The students will be assessed on their participation and how well they respond to questions during the discussions.

- What can you say about magnetic poles?
- When will magnets attract?
- When will magnets repel?
- What is a compass?
- How does a compass work?
- What could affect a compass and its ability to work properly?

WIDA Language Objectives
Dependent on the needs of your ELL students

Key Vocabulary
Tier 1: magnet, force
Tier 2: poles**,** attract, repel, north, south (east, west).
Tier 3: magnetism, magnetic field.

RESOURCES AND MATERIALS

Quantity	Item	Source
5 of each	Bar magnet, block magnet, horseshoe magnet, ring magnet, button magnet, plastic-encased block magnet, magnet wand, North/South bar magnet	Classroom Attractions Kit (Dowling Magnets)
1	**Demo Alnico bar magnet**	**Bin**
8	**Compass**	**Bin**
1 per student	Science Journal	Classroom Teacher
6	**Plastic bowls**	**Bin**
6	**Sewing needles**	**Bin**
6	**Pieces of cork or Styrofoam**	**Bin**

****Items in bold should be returned for use next year****

LESSON DETAILS

Lesson Opening/ Activator

Remind the students: "*Last lesson, we learned about forces. A couple of lessons ago, you were able to experiment with bar magnets. Could anyone explain what happens when magnets attract other objects? Did the objects move? How did they move?*" The teacher should remind students that objects cannot move on their own. Then, the teacher should have students brainstorm possible explanations of how the magnet attracted the objects. The teacher should then explain briefly how a magnet exerts an unseen force on the object; this is call magnetic force. Have the students brainstorm what type of force magnets use to attract objects (is it a push, pull, collision, or friction?). Then, tell the class: *"Today, we will learn about the forces behind magnets and see if you are correct."*

During the Lesson:

Student Thinking Alert:
Some students might think that a magnet has two ends because each end is made of a different material. The teacher should explain that both ends are made of the same material. You can prove this with the following answer:
If the magnet was to be broken in half along the north-south divide, each piece would become its own little magnet with a north and south pole. A magnet always has two poles, just like a coin always has two sides.

1. Guided Exploration: Tell students: "Magnets have two ends; these ends are called poles. One is called the north pole. The other is called the south pole." Now form groups of students so they can experiment with the magnets.

a. Show the students the demo bar magnet, pointing to the ends marked N and S. Give the students two "like" magnets (two horseshoe, two bar or block magnets). Ask: "Why do you think they are labeled N (North) and S (South) for you?"

b. Have the students move the magnets so that the opposite/different poles are facing one another. Then have the students move the magnets so that the same poles are facing one another.

c. Ask the students what type of force is exerted when the magnets have opposite/different poles facing and when they have the same poles facing. Discuss the pulling and pushing that the students feel. Explain that these pushes and pulls are special forces that magnets give off called magnetic forces. Clarify that when opposite poles face each other, the magnets attract each other and pull each other. When like poles face each other, the magnets repel each other or they push away.

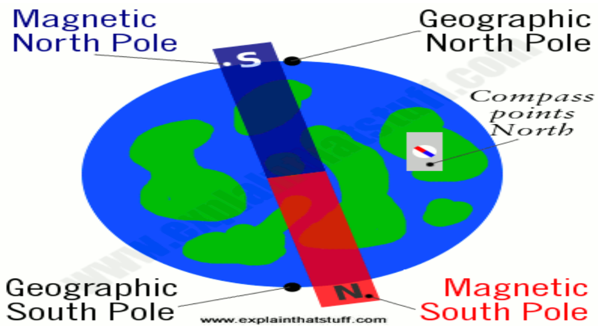
2. **Free Exploration:**
   Allow students to explore with all the other types of magnets. Have the students remain in their groups and investigate and record their findings in their science journals. Guide the students to explore with the different kinds of magnets. Give the students time to work through their investigations. Bring the class back together to discuss their findings. Have the students share their observations and any notes they made in their science journal. The teacher should write the students' observations on the whiteboard.

3. **Compass Exploration**
   a. Tell students: The Earth acts like a magnet and has a North and South pole just like the magnets we've explored in class.

   b. The Earth is filled with magnetic materials such as iron.

   c. Does anyone know what a compass is? What is it used for? A compass has a magnetized needle with a north and south pole just like other magnets. Ask students what they know about Earth's poles; North at the top and South at the bottom.
   d. A compass is simple: the red pointer in a compass (or the magnetized needle on your homemade compass) is a magnet. Therefore, the needle/red pointer is attracted by Earth's own magnetism (sometimes called the ***geomagnetic*** field—"***geo***" simply means Earth). As English scientist William Gilbert explained 400 years ago, that the Earth behaves like a giant bar magnet with one pole up in the Arctic (near the north pole) and another pole down in Antarctica (near the south pole).

Figure A



e. The teacher will show a compass via a projector/Elmo and wait for the needle to stop moving. The teacher will turn the compass around so that the arrow on the needle lines up with the "N" for North. Decide where north and south are in the room you are in. Then, have the children predict where their needle will point.

Optional Extension: Teachers can use a virtual compass in place of an actual compass. Found here: http://digitalarena.co.uk/teach/virtual_compass/virtual_compass_interactive.htm#.WywT76czrIV

Investigation 1: Have each group conduct an investigation with a needle, cork/styrofoam, a bowl of water, and compass. Float the needle on top of the cork/styrofoam and set it in the water within the bowl. The students should record which way the compass needle points. Set your bowl on the desk and your compass beside it and compare. The needle should line up just as the compass did. After the students have completed the activity discuss what happened and what they observed.

Investigation 2: (Science Talk: Class Discussion):
Ask students if anyone can predict what will happen when you place a magnet next to a compass? A compass in the presence of other metals or magnets will throw off the true reading of a compass. Allow students to test out the magnet next to the compass and discuss the results.

- Have the students to write down in their science journals what kind of force the magnet will exert on the compass (will it push or pull the compass?) and how this will affect the compass' needle (will it move the magnet?).
- Ask students why they think that the needle moved. Prompt students so they think about their prior experiences with magnets; specifically, what makes an object magnetic and how magnets work.

Lesson Closing

Be sure to review the first activity, reinforcing what students learned about the poles of magnets. Ask students to share what they discovered about the different kinds of magnets.

Assessment

The students will be assessed on their participation and how well they respond to questions during the discussions.

- What can you say about magnetic poles?
- When will magnets attract?
- When will magnets repel?
- What is a compass?
- How does a compass work?
- What could affect a compass and its ability to work properly?

Lesson 4: Balanced and Unbalanced Forces

BACKGROUND

Overview of the Lesson

Students will learn about balance and observe various demonstrations showing them how forces act on an object. Students will then participate in an activity using ping pong balls and straws where they will learn how forces interact. Finally, students will make mobiles to further their understanding of balance.

Focus Standard

3-PS2-1. Provide evidence to explain the effect of multiple forces, including friction, 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. [**Clarification Statements:** Descriptions of force magnitude should be qualitative and relative. Force due to gravity is appropriate but only as a force that pulls objects down. **State Assessment Boundaries**: Quantitative force magnitude is not expected in state assessment. State assessment will be limited to one variable at a time: number, size, or direction of forces.]

Learning Target

I can predict the direction an object will move based on the strength and direction of the force on an object

Assessment

Students will be assessed on their participation in class discussions. At the end of the lesson, have students draw force diagrams of different scenarios. These can include: objects in free fall, a person standing on the ground, a rising elevator, etc. The students should include in the pictures arrows representing the forces acting on the object and labels identifying the force.

WIDA Language Objectives

[Dependent on the needs of your ELL students]

This unit was developed with National Science Foundation funding (Grant #1432591). It is a DRAFT document that will be revised as the unit is piloted and feedback received.

Key Vocabulary
Tier 2: diagram, balance
Tier 3: scale, Newton

RESOURCES AND MATERIALS

Quantity	Item	Source
1	**Rope**	**Bin**
1	**Balance Scale**	**Bin**
15	**Marbles**	**Bin**
1	**Ball with strings attached**	**Bin**
3 boxes	Straw	Bin
15	**Ping pong balls**	**Bin**
1 per student pair	Ping Pong ball handout	Binder
2 packets	**Index Cards**	**Bin**
	Paper clips	Classroom Teacher
1 per student	Ruler	Classroom Teacher
	Mobile Poster	Binder
	Craft supplies for decorating mobiles	**Bin**
1	Roll of masking/colored tape (optional)	Classroom Teacher

****Items in bold should be returned for use next year****

LESSON DETAILS

Lesson Opening/ Activator

(Science Talk: Class Discussion):

Remind the students: *"Last lesson, we discovered that when you put a magnet next to a compass it attracts the compass' needle. Why would the needle be attracted to the magnet when it is usually attracted to the Earth's North Pole? How did the tiny magnet make the compass' needle move when the needle is usually pulled by the huge magnet in the North Pole."* Have students think about the questions for a minute and share their thoughts. Then, tell them: *"To answer these questions, today, we will learn how different amounts of force affects the movement of objects. By the end of this lesson, you will know how the tiny magnet was able to pull the compass' needle."*

Review the two laws of of physics with students and write them on the board.

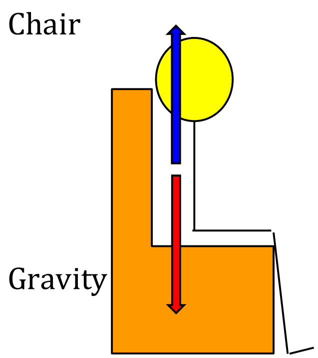
- An object at rest stays at rest unless affected by a force
- An object in motion stays in motion unless affected by a force

Split the students into small groups and hand out a balance scale and marbles to each group. Let the students know that right now the scale is balanced because both sides of the scale are in the middle. Now, have each group put 5 marbles onto one side of the scale. Explain to the students that the scale is now unbalanced because one side is lower than the other. Ask the students "*Does anyone know how we can balance the scale again without removing any marbles?"* The students need to find the correct number of marbles to place on the empty side of the scale to balance it out. Ask the students "*How many marbles did it take to balance the scale?"* Lead the discussion to the conclusion that the scale was balanced when both sides had the same number of marbles pushing down. Ask the students "*Is it important to have the same amount of marbles on each side of the balance?"*

This unit was developed with National Science Foundation funding (Grant #1432591). It is a DRAFT document that will be revised as the unit is piloted and feedback received.

During the Lesson

1. **(Science Talk: Class Discussion):** Explain to the students that **all forces have directions.** Demonstrate on the board that these forces can be shown in pictures as little arrows coming towards or out from the objects they act on, and tell the students that these kinds of pictures are called diagrams.



2. Ask the students *"Are you moving or still?" "If you are still are there any forces affecting you right now?"* Allow the students to share any answers. *"Actually, there are forces pulling on you at all times!"* Point out that gravity, a constant force, pulls us towards the ground. Draw a picture of person sitting on a chair, and then have a student come up and help them draw the proper gravity arrow pointing down.

Then, ask the students *"So if gravity is pulling you down, why do you think you're not moving?"* Allow the students to try to answer this with their own theories. The correct answer is that the chair they are sitting on is actually pushing them upwards. Lead the discussion to this conclusion.

Student Thinking Alert:
Students may be confused about how an inanimate object like a chair is able to exert a force. Every time an object experiences a force, it applies an equally large force in the opposite direction on the object that gave it that force.
So whenever a chair gets pushed down on, it pushes back the other way.

Ask the students *"So if there's a force pulling you down, and a force pushing you up, why are you still? Why aren't you moving all over the place?"* Allow the students to answer. Lead the discussion to the conclusion that the force pushing you up and the force pulling you down cancel each other out. Draw the second force on the diagram. Tell the students that the forces are balanced just like the scale. Therefore, when the forces on an object are balanced, the object is at rest.

2. **Rope pulling: (This part of the lesson can and should be done outside if possible)** Ask the students if they have ever played the game "Tug of War". If they have, ask for a volunteer to explain the rules of the game. If none of the students can explain the rules, then the teacher or science fellow should explain them.

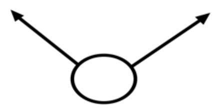
a. Ask for three volunteers. Tell the students that they are going to be forces acting on an object. Try to pick students who have similar strengths. Take out the rope and tell the students that two of the volunteers will be on one side of the rope and the third will be on the other side of the rope. Share with the students that the unit of measurement scientists use to measure forces are **Newtons** which is named after Isaac Newton. Explain to the class that each volunteer is one newton. Ask the students how many newtons are on the side with two students (two newtons). Ask the students how many newtons are on the side with one student (one newton).

b. Have these students play tug of war and ask the students "*Imagine that there's a ball glued to the middle of the rope, which direction will the ball move? Why?"* Allow the students to answer. Lead the discussion to the conclusion that the ball moved towards the side with more people since they had more newtons of force.

c. Now ask for two more volunteers. Add these students to the side of the rope with only one student. Ask the students "*What will happen this time? Which side will potentially win? Why?"* Allow the students to answer. Have the students play tug of war again. Now finally ask for one last volunteer. Add this student to the side with two students. Each side should have three students now. Ask the class "*What will happen this time?"* Allow the students to answer. Lead the discussion to the conclusion that it will be a closer game because each side has an equal amount of people or newtons. The sides are balanced. Connect the discussion to the previous lesson on magnets. Ask students when the magnets were attracted to each other, why didn't they move? Provide students with the hint that what they learned in tug of war also applies to magnets (even though the magnets were both pulling each other, the forces were balanced, so they didn't move).

3. **Force Diagram**: Draw a circle which represents a ball on the board. Draw two arrows out from the circle; these arrows should form a right angle (see image below). Remind the students that this is a force diagram which is a helpful tool scientists use to visualize how forces affect an object. Ask the students to imagine there are two strings where the arrows are, and that we pull on both the strings at the same time the ball will move. Ask the students how they think the ball will move?" Allow the students to share their predictions.

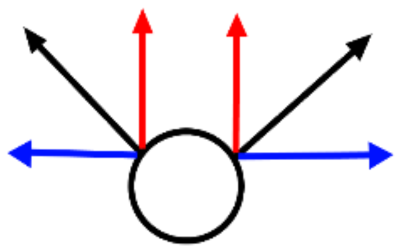
4. Now take out the ball which has two strings attached to it. Hold it in the same way as depicted in the image below.



   a. **(Science Talk: Turn and Talk):** Ask the students to make predictions of what will happen when you pull on the strings. Students should write down their predictions in their science journals. Then, they will turn and talk to their classmates about their predictions. The teacher should then pull on each string separately. In other words, pull on one string and then pull the other string.

   b. Now, pull on both the strings at the same time. The ball should move straight up.. Allow the students to share their theories and explain what they observed.
   c. Explain to the students that the string on the left pulled the ball up and to the left, while the string on the right pulled the ball up and to the right. Since one string pulled to the left and the other pulled to the right, those two parts of the force were balanced and canceled each other out, similar to the tug of war. As a result, there was an upwards force from both strings, so the ball moved upwards. **Note: this concept takes some time to fully understand. If the students ask for better explanation, refer to description below to help solidify the concept.**

Figure 2



Every force has a x component, indicated by the blue arrows and a y component, indicated by the red arrows

The x components, the blue arrows, are balanced. This means the object will not move left to right.

The y components however are not balanced. They are both pulling the object upwards.

Since the object is balanced in the x components but not in the y components, the object will move upwards.

4. **Ping pong ball activity: [SP 3 - Planning and Carrying out investigations]** Partner up the students and give each pair a ping-pong ball, two straws, and the ping pong ball handout. The handout has a circle labeled **start**. This is where the students should initially place the ping pong ball. Next to each **start** circle, there are two arrows pointing towards the circle. This is where the students are allowed to blow on the ball with their straws. The handout also has 3 circles labeled **end.** This is where the students are trying to roll the ball towards. The **ends** are numbered 1, 2, and 3. The teacher should model how to complete this activity, so students are not confused.

    a. Each group will need to get the ball to roll over the first end circle (labeled with a 1) only by blowing on the ball along the arrows. Have the students discuss in their groups what their plan is before going ahead and blowing on the ball.

    b. Walk around and help the students when necessary. Ask the students "*Do you think you need both the straws to blow at the same time?* Once a group has succeeded in getting the ball to roll over the end circle, tell them to try to get the ball to roll over the next end circle.

    c. **Optional Extension:** The teacher can tape out two or three simple mazes on the floor/tables (templates for mazes can be found at https://www.shutterstock.com/search/simple+maze) with masking tape. Once groups have finished the ping pong activity, they will try to blow their ping pong ball through one of the mazes without going over the lines.

***** If time is a concern, the lesson can be broken up here*****

5. **Mobile Making: [SP 2 - Developing and using models]** Tell the students that they will be making mobiles. Give the students paperclips, index cards, straws, rulers, and any other craft materials you may have in the classroom. Go over the following steps with the students and model them.

    a. Tape a ruler off the edge of the desk so that half the ruler hangs over the edge of the desk.

    b. Unbend a paperclip so that it has a hook on either end. The top hook will hook onto the ruler. The bottom hook will hook onto the middle of a straw.

    c. The students will then make their mobiles by adding index cards or other craft materials to either side of the straw, keeping everything in balance while doing so. Students can also add more straws to the ends of straws to make a larger mobile. Students can add objects to the ends of straws by making another paper clip hook. These can be used to then attach the objects to the straws.

    d. As the students are making their mobiles, walk around and help them balance their mobiles if necessary.

Note: Refer to the Mobile Poster in the binder to see example of mobiles. In the examples, rubber bands are used with the paper clips to hold objects. You may do this as well if you have rubber bands.

Lesson Closing

(Science Talk: Class Discussion):

Ask the students what happened when their mobiles were unbalanced. Lead the discussion to the conclusion that when their mobiles were unbalanced, the mobile would fall towards the heavier side. Compare this to the game of tug of war, so that students understand that force affects an object. When one side has more force, the object will move with that force. Now tell the students that when their mobiles were balanced, the mobile would not move.

Probing Questions: What happened when you had too many materials on one side of your mobile?
How did you balance your mobiles?
How are your mobiles similar to tug of war?

Ask the students to compare what they learned today to what they learned about magnets and north and south poles. Ask the students, "*When were the magnetic forces balanced? When were they unbalanced?*" With direction from the students, draw a force diagram of two magnets interacting on the board.

Assessment

Students will be assessed on their participation in class discussions. At the end of the lesson, have students draw force diagrams of different scenarios. These can include: objects in free fall, a person standing on the ground, a rising elevator, etc. The students should include in the pictures arrows representing the forces acting on the object and labels identifying the force.

Lesson 5: Magnetic Applications

BACKGROUND

Overview of the Lesson

Students will work with paper clips and magnets to determine the strength of various magnets.

Focus Standard

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. **Clarification Statement:** Focus should be on forces produced by magnetic objects that are easily manipulated.

Learning Targets

I can determine the strength of a magnet based on the number of paperclips the magnet held
I can explain how a magnet works through a non-magnetic surface

Assessment

Continue the discussion on the usefulness of magnets. Discuss other uses magnets have and ask for examples. Depending upon the amount of depth the teacher wishes to go into, these uses can include moving scrap metal, sealing fridge doors, generating electricity when the magnets are rotated, and driving motors in speakers and electric power tools.

WIDA Language Objectives

Dependent on the needs of your ELL students

Key Vocabulary

Tier 2: Strength

RESOURCES AND MATERIALS

Quantity	Item	Source
1 package	Matte finish paper plates	Bin
	Craft supplies	Classroom Teacher
1 package	**Coin Magnets**	**Bin**
	Various types of magnets	**Bin**
1	**Box of paper clips**	**Bin**

****Items in bold should be returned for use next year****

LESSON DETAILS

Lesson Opening/ Activator

Ask the students what they know about the strength of magnets:

- Does the strength of the magnet matter?
- What are the different strength magnets used for? (Weak magnets might be fridge decorations, stronger ones may hold pictures up on the fridge, and very strong ones may be used in workplaces like the crane in a junkyard).

During the Lesson

Discussion/Demo

1. The teacher will first discuss that one of the ways people use magnets is by using them through surfaces. Some examples would be hanging pictures on the fridge at home, the magnetic whiteboard eraser, and other things you might find around your home. Ask the students if they can think of some other places in their homes that magnets are used to help them.

2. Briefly explain to students that the more strength a magnet has, the more force it exerts on other objects, so it will attract objects even through surfaces.

Teach To Learn
A collaboration between MCLA, Williams College, and North Adams Public Schools
Funded by NSF DUE-IUSE Award #1432591

***Teachers are encouraged to move this activity outside if the weather permits them to do so.**

Magnet plate car: In this activity students will be decorating paper plates to resemble a racetrack style road so their car can drive in a circle on their paper plate.

1. Each student should be given a matte finish paper plate, crayons, colored pencils, markers, , scissors, 2 coin magnets, and glue.
2. Students will first color their plate and draw a small car to cut out of paper. Then, they will glue their paper car to one of the coin magnets (liquid glue or gel glue is preferable for this activity). Once the glue has dried the students should put the car magnet on one side of the plate, and their second coin magnet on the back of the plate underneath the car magnet.
3. The students will move their magnet on the back of the plate and watch the car magnet move on their road/plate.

Magnet Strength:

(**Science Talk: Small Group Discussion**):

The class should be divided up into groups of 2-5 students, depending on class size. Explain to students that magnets have different strengths depending on how they are made. For instance, the magnet in a compass is weaker than the magnet that sticks to your fridge.

1. Each group will each be given a box of paperclips and several different kinds of magnets. Students will test each magnet for strength by testing the number of paperclips each magnet can hold.
2. One student will hold up the magnet while the other students attach paper clips one at a time to the magnet until no more paper clips will hold without falling. Students should record the amount of paperclips in their science journals. Then, students should discuss and compare the different magnet strengths. If there is enough time, students can repeat the test to see if the number changes for each type of magnet.

Assessment

Continue the discussion on the usefulness of magnets. Discuss other uses magnets have and ask for examples. Depending upon the amount of depth the teacher wishes to go into, these uses can include moving scrap metal, sealing fridge doors, generating electricity when the magnets are rotated, and driving motors in speakers and electric power tools.

Lesson 6: Unseen Forces

BACKGROUND

Overview of the Lesson

Students will learn about friction and will experiment with different materials to see how much friction they can produce. The students will also learn about gravity and air pressure and how it keeps planes afloat.

Focus Standard

3-PS2-1. Provide evidence to explain the effect of multiple forces, including friction, 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. [**Clarification Statements:** Descriptions of force magnitude should be qualitative and relative. Force due to gravity is appropriate but only as a force that pulls objects down. **State Assessment Boundaries**: Quantitative force magnitude is not expected in state assessment. State assessment will be limited to one variable at a time: number, size, or direction of forces.]

Learning Targets

I can predict whether or not an object will stop due to friction
I can demonstrate that the higher an object is placed on a ramp the faster it will be once it comes off the ramp

Assessment

Students will be assessed on their participation in class discussions.

WIDA Language Objectives

[Dependent on the needs of your ELL students]

Key Vocabulary

Tier 2: Experiment, laws of physics
Tier 3: Friction, gravity, air resistance

RESOURCES AND MATERIALS

Quantity	Item	Source
1 per group	**Wooden ramp**	**Bin**
1 per group	**Small ball**	**Bin**
1 per group	**Milk Carton (or similar hollow box)**	**Bin**
1 per group	Ruler	Classroom Teacher
1 per group	**Block of wood**	**Bin**
1 per group	**Square of carpet**	**Bin**
1 per group	**Square of Sandpaper**	**Bin**
1 per group	**Square of Felt**	**Bin**
1 per group	**Square of Laminated paper**	**Bin**
1 per two students	A sheet of tissue paper	Classroom Teacher
1 per student	Vocabulary Worksheet	Binder
1 per student	Ramp Lab Worksheet	Binder

****Items in bold should be returned for use next year****

LESSON DETAILS

Lesson Opening/ Activator

Explain to the students that up until now they've been learning about the forces they can see. Ask for examples of forces that they've seen in the past few lessons. Some examples may include pushing, pulling, and collisions. Once the students have named examples of forces, tell them that there are also invisible forces everywhere. Ask the students "*If we can't see these forces, how can we tell if they're there?*" Lead this discussion to the conclusion that we can look at how objects move.

This unit was developed with National Science Foundation funding (Grant #1432591). It is a DRAFT document that will be revised as the unit is piloted and feedback received.

Write the following on the board "*1. An object in motion will stay in motion unless acted upon by an outside force*" and "*2. An object at rest will stay at rest unless acted upon by an outside force.*" Tell the students that these are two laws of physics that they are going to use them to find invisible forces.

During the Lesson

1. **(Science Talk: Class Discussion):** Ask the students to describe what happens when you roll a ball. When the students state the fact that the ball will eventually stop moving, say "*That's strange, doesn't law number 1 say that an object will stay in motion unless acted upon by an outside force? What's happening there?*" Allow the students to share any ideas they may have. Tell the students "*There must be an unseen force stopping the ball from moving! Let's think about this with another example. Has anyone ever seen a game of hockey? In hockey, players push a small puck, a flat circle, over ice and try to make goals. Does anyone know why they play on ice? What would happen if you pushed the hockey puck over pavement?*" Lead the discussion to the conclusion that hockey is played on ice because ice is "slippery" (or something similar to that). Tell the students that sometimes when you try pushing an object over a surface, the object collides with the bumps on the surface, causing the surface to push back against the object just like a chair pushes up against your weight when you sit on it. This resistance is called friction. Some materials, like ice, have less friction than others. Tell the students that friction is an unseen force that pushes on an object opposite the direction it is moving in. Draw Figure 1 on the board to help explain this concept.

Teaching Tip:
This lesson has some difficult vocabulary. The teachers should be sure to reinforce the vocabulary and ensure understanding.

Figure 1

The car is moving towards the right
Friction is pushing the car to the left

If the car is turned off, there is no force pushing it to the right. That means that the car will start to slow down due to the force of friction pushing it to the left.

2. **Friction investigation: [SP 3 – Planning and Carrying out investigations]**
    a. Divide the students into groups of four. Tell the students that they are going to explore how different materials can produce different amounts of friction. Give each group a block of wood, a square of carpet, a square of sandpaper, a square of felt, and a square of laminated paper.

    b. Tell the students to predict in their science journals which material they think will produce the least amount of *friction*. Tell the students to draw four columns in their science journals. Put the following labels on the columns:
        i. Carpet
        ii. Sandpaper
        iii. Felt
        iv. Laminated paper

This unit was developed with National Science Foundation funding (Grant #1432591). It is a DRAFT document that will be revised as the unit is piloted and feedback received.

c. Now, tell the students to slide the block of wood across each of the materials, writing down observations in their science journals. For each material, ask the students to use words such as "fast, slow, rough, smooth, slippery" regarding how the materials impact the speed of the block of wood as it is being pushed across.

d. The students should give the block of wood a push and then they will see how much resistance the block encounters. If necessary, provide a demonstration of a proper push prior to the students beginning the activity.

e. Tell the students to number the different materials in terms of how much friction they produced. Number 1 will be the material with the least friction and 4 should be the material with the most friction. This should be written down in their science journals. Ask each group to share their results and then discuss which material produced the least friction and which material produced the most friction?

***** If time is a concern, the lesson can be broken up here.*****

Air Resistance Investigation:

1. **(Class Discussion):** Drop a piece of paper/tissue paper onto the ground. Tell the students to watch as it floats downwards. Ask the students "*Why the paper does not just fall straight to the ground, why does it float a little?*" Lead the discussion to the conclusion that there is air which hits the paper in a certain way. Tell the students that there is air all around them that is constantly pushing on them from every direction. Tell them this is another invisible force called air resistance that works against objects moving through the air.

This unit was developed with National Science Foundation funding (Grant #1432591). It is a DRAFT document that will be revised as the unit is piloted and feedback received.

2. Think-pair-share: Break the students into groups of two or three and give them each a piece of tissue paper. Give the students about five minutes to figure out how to drop the tissue paper from the air in the shortest amount of time (they can fold it anyway they want). Regroup as a class and have each group describe what worked. Come to the conclusion that the force of air resistance increases the wider the surface of the object that moves through it.

> **Teaching Tip:**
> Students might say that the tissue doesn't fall very quickly just because it's light. Bunch up the tissue and show that it falls faster even though it's the same weight, showing that the force of air resistance *is* slowing the tissue down.

3. **Ramp Lab: [SP 3 – Planning and Carrying out investigations]**
   a. Now have each group clean up their materials from the last activity and then give them a ramp, a milk carton, a ruler, a ball, and the ramp lab worksheet. Go over the following instructions with the groups. Each group will put the milk carton at the base of the ramp. They will then put the ball at three positions on the ramp, at the top, in the middle, and at the base. They will release the ball and it will roll down the ramp and hit the milk carton. They will then measure how far the milk carton goes using the ruler. They will write down the distance onto the worksheet using centimeters.

   b. However, before the students start the lab, tell the students to write down their hypothesis, a scientific guess. Tell the students to predict which position of the ball will make the milk carton go the furthest and to write these down on the ramp lab worksheet.

   c. **(Class Discussion):** Once all the students have experimented with the balls on the ramp, have the students individually draw a force diagram of the ball rolling down the ramp. Bring the class together for a

> **Teaching Tip:**
> Try relating this to the scooter activity in lesson 2. Help the students understand that just as the scooter moved faster the longer it was pushed, the ball rolls faster the longer it was on the ramp.

discussion. Discuss their results and ask the students if their predictions were correct. Ask the students "*Why was the top of the ramp the best position for the ball? Did the ball gain speed over time? How did the ball's speed affect the distance the milk carton traveled?*" Lead the discussion to the conclusion that the longer the ball was able to roll, the faster it went. Come to the conclusion that this shows that gravity is a type of force.

Lesson Closing:

1.) ***Research and Revision:*** Take out the airplanes that the students created in lesson 1. Tell the students that they are now going to fix/change their designs based on what they have learned in the unit. Tell the students that engineers often research their topics to improve their designs.

2. Give each group an iPad (or more if the supply allows for it) and write the following websites on the board. If possible, provide students with QR codes for the websites, so they can access the websites easily. **The teacher should screen the best websites ahead of time, but the following websites are recommended:**
    i. http://www.scholastic.com/teachers/article/what-makes-paper-airplanes-fly
    ii. https://www.sciencebuddies.org/science-fair-projects/project-ideas/Aero_p046/aerodynamics-hydrodynamics/how-far-will-paper-planes-fly#makeityourown
    iii. http://www.10paperairplanes.com/ (there are visual animations for the arrow, dart, stealth, and moth planes)
    iv. http://www.origami-instructions.com/paper-airplanes.html (it's highly recommended that the teacher make the students choose only among the first three designs.)

3. Tell the students that they should use the links to research how they can fix any issues with their designs.

4. Walk around the room and ask the students what they are thinking about their designs. Allow the students around 10-20 minutes to research and design. Encourage the students to draw their design in their science journal. **Note: Allow the students to struggle with their design problems. This is meant to get them thinking like an engineer.**

5. Gather all the students once again to test their designs (outside if possible) and then have them write down any observations in the science journal under a heading titled Trial 2. Make sure that all students are behind the student throwing the paper airplane.

Optional Extensions:

2.) If the students are interested in learning more about flight, show them the Bill Nye "Forces of Flight" video (~23 minutes) [https://vimeo.com/83625163]. Screen the video to find a section specific to their interests.

Assessment

Students will be assessed on their participation in class discussions.

This unit was developed with National Science Foundation funding (Grant #1432591). It is a DRAFT document that will be revised as the unit is piloted and feedback received.

Lesson 7: Magnetic Engineers

BACKGROUND

Overview of the Lesson

Students take on the role of engineers. They will be given an everyday problem to solve using magnets and a variety of craft materials. Students will reflect on their knowledge of magnets and will work in groups to analyze the problem. Then, they will discuss the design of a gadget to solve the problem after much testing and revising.
Parts of this lesson were adapted from a lesson by Karen Ostlund and Sheryl Mercier at Teacherspayteachers.com

Focus Standard

3-PS2-4 Define a simple design problem that can be solved by applying scientific ideas about magnets. (Clarification statement: Examples could include constructing a latch to keep a door shut and creating a device to keep two moving objects from touching each other.)

Learning Target

I can create a design to fix an everyday problem using magnets and materials supplied

Assessment

Use the following questions to assess student learning:

- Did the students build a design that would potentially solve the problem they were given?
- Did the students test their design?
- Can the students describe how their design works?
- Can the students state the problem that it solves?
- Did the students use the magnets and understand why they worked?

WIDA Language Objectives

Dependent on the needs of your ELL students

This unit was developed with National Science Foundation funding (Grant #1432591). It is a DRAFT document that will be revised as the unit is piloted and feedback received.

Key Vocabulary

Tier 1: problem

Tier 2: create, engineer, practical.

Tier 3: design, gadget, contraption, collaborate

RESOURCES AND MATERIALS

Quantity	Item	Source
1	**Steel can**	**Bin**
30 cm	String	Bin
1-2	Piece tape	Bin
6 each	**Magnets (different types)**	**Bin**
1 Package	**Feathers**	**Bin**
1 each	Box Paper clips (small and large)	Bin
1	**Roll string**	**Bin**
1	**Package of craft Foam sheets**	**Bin**
1	**Package of popsicle sticks**	**Bin**
1	**Package of pom poms**	**Bin**
1	**Package of clothespins**	**Bin**
1	List of design problems	Binder
1 per child	Science Journals	Classroom Teacher

****Items in bold should be returned for use next year****

LESSON DETAILS

Lesson Opening/ Activator

1. "*Let the students know that today they are going to be engineers and solve a problem using magnets. What is an engineer? What does it mean to design something?*" See if there is anyone in the class who understands the terms engineer or design. Discuss that when you design something, you decide what it will look like and how it will function (work) in the

best way that it can. When you design something, you use what you know and you imagine what it could be. "*Generally, engineers come up with ideas and design something to make something better. Engineers figure out problems that need to be solved, test their design, discover their mistakes, and find the best solution to the problem. Today, you are the engineers creating a design to solve a problem.*

During the Lesson

1. **Paperclip Contraption:**
    a. Explain that before you begin designing, that you'd like to share a demonstration. It's called the *Paperclip Contraption."*
    b. Have the experiment already set up in the front of the class. Place a magnet inside the steel can, close to the top. Turn the can upside down. Tie a paperclip to a string and tape it to one end of a table/desk.
    c. Ask students to observe what is happening to the paperclip in relation to the can and why.
    d. Lead a discussion addressing what is causing the paperclip to be drawn to the can. "*What materials must each item in our contraption be made of? Knowing what we do about magnets, why is there an attraction? What is causing the paperclip to levitate/hover?*" (hang in the air unsupported)
    e. Instruct the students to draw the "contraption" in their science notebooks and show what is making it work.
    f. Let students know that now we're going to take the "contraption" apart and see how it actually works.
    g. Now, ask the students to brainstorm possible ways they could change the contraption.
    h. Ask the students if they think there is a practical use for the paperclip contraption. Have the students brainstorm some possible uses for what they observed and write these on the board.

2. **Engineers creating Gadgets**

(Science Talk: Small Group Discussion):

    a. Tell the students they are going to design their own contraption or gadget using magnets and that their design needs to solve a problem.

b. The Third Grade Engineers, will now be given a problem to solve and some materials to use. Ask students to take what they know and create a gadget to solve a problem.

c. The teacher will place students in groups of 2-4. The slips of paper with a design problem will be in a container **(Note: These slips of paper should be cut out from the design problems sheet in the binder)**. Each group will choose a problem to work on and will have a packet to complete as they go.. Once students have chosen a team name, they will
   i. Identify the problem
   ii. Brainstorm solutions
   iii. Draw/design their prototypes (new designs)
   iv. Build their prototypes
   v. Test their designs
   vi. Answer the conclusion questions at the end of the packet to complete the activity.

   Optional Extension: Students may use computers to research contraptions that can help them find solutions to their problems.

d. While the students are designing their contraptions, organize the table with the materials they can use. The teacher may choose to familiarize the children with what is available and limit how many of each item they choose, depending on availability. Every team is given a variety of magnets to choose from. Let every team know that the rule is: every team must use a magnet/magnets in their design, but the other materials are up to them.

e. The teacher should give the students a designated amount of time to complete their project. (Perhaps an hour).

Lesson Closing

(Science Talk: Small Group Discussion): Each team will present their "gadget" and explain how it works and answer the following:

- Does your gadget solve the problem you were given?
- What did you find challenging about this activity?
- What would you change about your gadget if you could do this again?

After everyone has shared their own contraptions, discuss with the class how they felt about the activities. Were there challenges? Ask the students to argue from evidence in answering these questions: Are magnets useful? How can they make our lives easier to manage? [**SP 2 – Arguing from Evidence**]

Assessment

Use the following questions to assess student learning:

- Did the students build a design that would potentially solve the problem they were given?
- Did the students test their design?
- Can the students describe how their design works?
- Can the students state the problem that it solves?
- Did the students use the magnets and understand why they worked?

Science Talk and Oracy in T2L Units

Teach To Learn
A collaboration between MCLA, Williams College, and North Adams Public Schools
Funded by NSF DUE-IUSE Award #1432591

Science talk is much more than talking about science. In line with the science and engineering practices, students are expected to make a claim that can be supported by scientific evidence. The MA STE Standards (and the NGSS) value the importance of engaging in an argument from evidence. NGSS defines how this practice takes form in the real world: *"In science, reasoning and argument are essential for identifying the strengths and weaknesses of a line of reasoning and for finding the best explanation for a natural phenomenon. Scientists must defend their explanations, formulate evidence based on a solid foundation of data, examine their own understanding in light of the evidence and comments offered by others, and collaborate with peers in searching for the best explanation for the phenomenon being investigated."*

Students are asked to participate in articulate and sensible conversations in which they are able to communicate their ideas effectively, listen to others to understand, clarify and elaborate ideas, and reflect upon their understanding. These forms of talk can be developed using scaffolds such as the A/B Talk protocol (below) and strategies for class discussions (from the Talk Science Primer, link below). Oracy is developed in the physical, linguistic, cognitive, and social-emotional realms; each of these realms can be expanded upon over time in order to develop a thoughtful speaker. Being able to display appropriate body language, use proper tone and grammar, be thoughtful and considerate thinkers, and allow space for other thoughts and opinions are all important facets of oracy to work on and through with students. Incorporating the appropriate scaffolding is an important aspect of fostering these skills. Techniques for teaching effective science talk often include modeling, discussion guidelines, sentence-starters, and generating roles, while gradually putting more responsibility on students to own their thinking and learning.

Part of creating a safe school environment for students is allowing them a space that is comfortable enough for them to express ideas and ask questions, while being validated for their thoughts and questions; students should be feel comfortable and confident when speaking and listening for understanding. Effective talk is an important part of being an active, intelligent member of a community and society. Successful development in oracy is important for future employability and general well-being of adults.

The following resources should be helpful examples of how to employ effective use of progressive oracy and science talk in your classrooms.

- Oracy in the Classroom: https://www.edutopia.org/practice/oracy-classroom-strategies-effective-talk
- Science Talk Primer: https://inquiryproject.terc.edu/shared/pd/TalkScience_Primer.pdf

This unit was developed with National Science Foundation funding (Grant #1432591). It is a DRAFT document that will be revised as the unit is piloted and feedback received.

A/B Talk Protocol

Adapted from https://ambitiousscienceteaching.org/ab-partner-talk-protocol/

Teach To Learn
A collaboration between MCLA, Williams College, and North Adams Public Schools
Funded by NSF DUE-IUSE Award #1432591

1. Share your ideas

Partner A

- I think ______ happened because…
- Evidence that supports my idea is…
- The activity we did with ______ helps me know more about ______ because…
- One thing I'm wondering about is…

2. Listen to Understand

Partner B

- I heard you say ______. What makes you think that?
- I heard you say ______. What if ______?
- Can you explain the part about ______ again?
- What do you mean when you say ______?

3. Clarify and elaborate

Partner A

Answer partner's questions or ask for clarification in order to understand a question.

4. Repeat steps 2 & 3 until all questions are answered

5. Switch roles and repeat steps 1-4

6. Reflect on your understanding in writing

- My idea about ______ changed when my partner said ______.
- I will add ______ to my idea about ______ because…
- I still have questions about…
- I may be able to answer my question(s) if I could investigate ______.

List of Unit Resources

Lesson 1

1	**Large demonstration magnet**	**Bin**
1 per student	**Handheld bar magnets**	**Bin**
1 per group	**Plastic tray**	**Bin**
1 of each per group	**Paper clips, wood block, paper, plastic toy, pennies/coins, jar of iron filings, pipe cleaners, novelty fridge magnets, plastic bingo chips**	**Bin**
1 per student	Scavenger Hunt Worksheet	Binder
1 per student	Discovery Worksheet	Binder

Lesson 2

Quantity	Item	Source
1 piece per student	White paper	Classroom Teacher
1 per group	Ipad	Classroom Teacher
1	Scooter	Gym Teacher
	Bill Nye "Force and Motion" Video	CMC Website
1 per student	Bill Nye Video Worksheet	Binder
1 per student	Airplane Test Flights Worksheet	Binder
1 per student	Isaac Newton Reading and Questions	Binder
1 roll	**Masking Tape**	**Bin**

This unit was developed with National Science Foundation funding (Grant #1432591). It is a DRAFT document that will be revised as the unit is piloted and feedback received.

Lesson 3

Quantity	Item	Source
5 of each	Bar magnet, block magnet, horseshoe magnet, ring magnet, button magnet, plastic-encased block magnet, magnet wand, North/South bar magnet	Classroom Attractions Kit (Dowling Magnets)
1	**Demo Alnico bar magnet**	**Bin**
8	**Compass**	**Bin**
1 per student	Science Journal	Classroom Teacher
6	**Plastic bowls**	**Bin**
6	**Sewing needles**	**Bin**
6	**Pieces of cork or Styrofoam**	**Bin**

Lesson 4

Quantity	Item	Source
1	**Rope**	**Bin**
1	**Balance Scale**	**Bin**
15	**Marbles**	**Bin**
1	**Ball with strings attached**	**Bin**
3 boxes	Straw	Bin
15	**Ping pong balls**	**Bin**
1 per student pair	Ping Pong ball handout	Binder
2 packets	**Index Cards**	**Bin**
	Paper clips	Classroom Teacher
1 per student	Ruler	Classroom Teacher

	Mobile Poster	Binder
	Craft supplies for decorating mobiles	**Bin**
1	Roll of masking/colored tape (optional)	Classroom Teacher

Lesson 5

Quantity	Item	Source
1 package	Matte finish paper plates	Bin
	Craft supplies	Classroom Teacher
1 package	**Coin Magnets**	**Bin**
	Various types of magnets	**Bin**
1	**Box of paper clips**	**Bin**

Lesson 6

Quantity	Item	Source
1 per group	**Wooden ramp**	**Bin**
1 per group	**Small ball**	**Bin**
1 per group	**Milk Carton (or similar hollow box)**	**Bin**
1 per group	Ruler	Classroom Teacher
1 per group	**Block of wood**	**Bin**
1 per group	**Square of carpet**	**Bin**
1 per group	**Square of Sandpaper**	**Bin**

1 per group	**Square of Felt**	**Bin**
1 per group	**Square of Laminated paper**	**Bin**
1 per two students	A sheet of tissue paper	Classroom Teacher
1 per student	Vocabulary Worksheet	Binder
1 per student	Ramp Lab Worksheet	Binder

Lesson 7

Quantity	Item	Source
1	**Steel can**	**Bin**
30 cm	String	Bin
1-2	Piece tape	Bin
6 each	**Magnets (different types)**	**Bin**
1 Package	**Feathers**	**Bin**
1 each	Box Paper clips (small and large)	Bin
1	**Roll string**	**Bin**
1	**Package of craft Foam sheets**	**Bin**
1	**Package of popsicle sticks**	**Bin**
1	**Package of pom poms**	**Bin**
1	**Package of clothespins**	**Bin**
1	List of design problems	Binder
1 per child	Science Journals	Classroom Teacher