

3rd Grade Physical Science: Force & Motion on the Playground



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Developed for Chapel Hill Carrboro City Schools
Northside Elementary School Outdoor Wonder & Learning (OWL) Initiative

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3rd Grade Force & Motion on the Playground

Overarching Unit Question

What can we learn about force and motion, and how can we apply it on a playground?

Essential Questions

Arc 1: What can playgrounds teach us about force and motion?

Arc 2: How do different forces change the position and motion of objects around us?

Arc 3: How can we use our knowledge of forces and motion to plan and build playgrounds that are fun?

Transfer Goals

- Use scientific approaches and methodologies to investigate phenomenon, claims, results and information.
- Identify real-world dilemmas and opportunities and apply scientific thinking to develop solutions for them.

Enduring Understandings (Science)

- We can learn about objects by observing them.
- The position and motion of objects around us change, depending on forces affecting them.
- We can use our knowledge of forces and motion to solve problems in the real world.

Target Science Essential Standards

3.P.1 Understand motion and factors that affect motion.

3.P.1.1 Infer changes in speed or direction resulting from forces acting on an object.

3.P.1.2 Compare the relative speeds (faster or slower) of objects that travel the same distance in different amounts of time.

3.P.1.3 Explain the effect of earth's gravity on the motion of any object on or near the earth.

Secondary Target Standards (ELA, Math, Social Studies)

ELA

RI.3.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.

RI.3.4 Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 3 topic or subject area.

RI.3.5 Use text features and search tools to locate information relevant to a given topic efficiently.

RI.3.7 Use information gained from illustrations and the words in a text to demonstrate understanding of the text.

W.3.2 Write informative /explanatory texts to examine a topic and convey ideas and information clearly.

- W.3.5** Conduct short research projects that build knowledge about a topic.
- W.3.6** Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories.
- SL.3.1** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 3 topics and texts, building on others' ideas and expressing their own clearly.
- SL.3.3** Ask and answer questions about information from a speaker, offering appropriate elaboration and detail.

Math

- 3.G.1** Reason with two-dimensional shapes and their attributes.
- 3.MD.2** Solve problems involving customary measurement.
- 3.MD.3** Represent and interpret scaled picture and bar graphs.
- 3.MD.7** Relate area to the operations of multiplication and addition.
- 3.MD.8** Solve problems involving perimeters of polygons, including finding the perimeter given the side lengths, and finding an unknown side length.

Unit Overview

In this unit, students will learn about force and motion using hands-on activities on the playground and in the classroom. Students will start off the unit in Arc 1 by beginning to think about the playground as a place to learn about science. Force and motion concepts will be introduced using the book *Newton and Me* by Lynne Mayer. The playground will then be used to make observations about force and motion and about how fun a playground is intertwined with force and motion. Students will perform experiments using ramps to further their explorations of how force and motion impacts speed and direction.

Using the knowledge they have gained, in Arc 2, students will collaborate to create experiments on the playground. Designing and creating a Rube Goldberg machine in the classroom will continue this application of how force changes the position and motion of an object.

In Arc 3, a field trip to a nearby playground is used to create an additional experiment to deepen their knowledge of force and motion. To think about force and motion from another perspective, groups will design and build a playground for a millipede. The culminating activity will be to use all they have learned to research and choose what additional type of playground equipment could be added to the school's playground to have the playground more fully encompass the aspects of force and motion as well as to make the playground more fun.

Note: You may want to ask students at the beginning of the unit to bring in materials, such as empty paper towel rolls, toilet paper rolls, cereal boxes, or granola bar boxes, to share with the class for building materials for Learning Activity 9: Rube Goldberg Design Challenge and Learning Activity 11: Design a Millipede Playground.

Duration

15-22 days of 30 minute learning activities

Note: Length of unit depends on how many days you elect to spend with the various design challenges and Learning Activity 7: Colliding Cars from Wake UTD

*Vocabulary**

Direction, distance, force, friction, gravity, motion, relative speed, speed, air resistance, energy, engineering, inertia, mass, mechanical engineer

* Definitions of vocabulary words can be found on the Arc overview pages. Relevant vocabulary is also listed on each learning activity page.



Go Outdoors! Tips & Tools

Taking your class outside for science or any lessons can be rewarding and challenging. Along with behavior and materials management tips with each lesson, this section is intended to help you have the tools you need to successfully take your class outside.

Before You Go Outside

- Create **ground rules** with students for all outdoor lessons. Post the rules for students to be able to easily see.
- Ask for **parent volunteers**. Extra help can make an outdoor learning experience much more manageable.
- Teach students proper use, including safety, of the science tools they will be using.
- Set expectations before go. Give instructions both inside and repeat once outside.
- Have a clear **objective** for going outdoors. This will help focus students' attention.
- Be flexible. Structure lessons to take advantage of **opportunities and challenges**.
- Establish a meeting spot and emergency plan. Have a signal for emergency situations.
- Take students outside for short exercises to practice rules before longer outdoor lessons.
- Use **same door** to always go outside for learning. Emphasize this is different than going outside for recess.

While You Are Outside

- **Model** the activities and outdoor skills for students. Show them what you expect them to be doing.
- **Participate in the activity**. Get down on your students' level. Get your hands dirty.
- Model **respect for nature** with your students.
- The outdoors is full of **teachable moments**. Use "I wonder" statements to engage students in questioning the experience. Have students write down questions to be researched back in the classroom.
- Allow students to be **leaders** in the activity. Ask students to volunteer as teacher assistant or materials manager.
- Acknowledge that students want to explore and can do so once the assigned task is complete.

Safety First!

- Scout outdoor areas ahead of time if possible, to note **potential hazards** such as poison ivy.
- Students should **never be alone**. If a student needs to go back to the building, send 2 students.
- Take a **first aid kit and phone/walkie-talkie**. Consider bringing along staff trained in first aid/CPR.
- Let office staff know where you and your class are going if headed out on a walking field trip.
- **Stay on the trail/path**, unless otherwise directed. On the greenway, stay on the right side of path.
- **Do not eat wild plants**, unless harvesting in the garden with a teacher.
- Set **boundaries** for the students to stay within. You have to be able to see me and I have to be able to see you!

A Note on Nature Journaling

Nature journals that you use with your class should be small composition books or other blank books that students use to make outdoor observations, including writing, drawing, and painting. Students can use colored pencils, watercolor pencils, or other materials to remember details of plants, animals, and habitats they are investigating around the schoolyard. This is different from a science notebook. However, some teachers may choose to have students paste blank pages into their science notebook to use for nature journaling pages.

Essential Questions

What can playgrounds teach us about force and motion?

NC Science Essential Standards – Unpacked Content

3.P.1.1 Students know that when a force acts on an object it will result in a change of speed and / or direction.

3.P.1.2 Students know that speed can vary. Students know that varying the speed of a moving object will affect the time it takes for the object to travel a particular distance.

3.P.1.3 Students know that the earth ‘pulls’ on all objects on or near the earth without touching those objects.

Lessons in this Arc

- ❖ Engaging Activity: Science & Playgrounds
- ❖ Learning Activity 1: Newton and Me
- ❖ Learning Activity 2: Dream Playground Design Challenge: Part 1
- ❖ Learning Activity 3: Playground Scavenger Hunt
- ❖ Learning Activity 4: Tug of War
- ❖ Learning Activity 5: Ramp Investigations – Ramp Height
- ❖ Learning Activity 6: Ramp Investigations – Ramp Surfaces

Go Outdoors!

- ✓ Engaging Activity: Science & Playgrounds
- ✓ Learning Activity 2: Dream Playground Design Challenge: Part 1
- ✓ Learning Activity 3: Playground Scavenger Hunt
- ✓ Learning Activity 4: Tug of War

Nature Journal Connection

- Engaging Activity: Science & Playgrounds

Duration

8 days of 30 minute learning activities

Background Information

A **force** can either be a push or pull that is enacted upon an object. When a force acts upon an object it will result in a change in speed and/or direction. Each force that is applied to an object has strength and direction. For each force exerted on an object, there is an equal and opposite force acting on it. This is known as Newton’s Third Law of Motion. **Direction** is the line along which anything lies, faces, or moves. **Speed** refers to how fast or slow something moves. This change in speed or direction results in motion. **Motion** is moving or changing position.

Because all matter is moving, motion is relative to a chosen point. The motion can be straight, zigzag, round and round, back and forth, fast and slow, or any other change in position.

Speed can vary and will affect the time it takes a certain object to travel a certain distance. **Relative speed** is the speed of an object in relation to another object or point. The quantity of space between two different places is the **distance**. **Friction** is a force that resists motion between two bodies in contact with each other. Friction can affect the speed of an object and can also produce heat.

Gravity affects the motion of any object on or near Earth. It is the natural force of attraction between two objects of mass. Earth pulls objects towards its center using gravity without touching them. Earth is spherical because gravity is center-directed.

Vocabulary

- **Direction** is the line along which anything lies, faces, moves, etc., with reference to the point or region toward which it is directed.
- **Distance** is the amount of space between two places.
- **Force** is a push or a pull exerted on an object.
- **Friction** is a force that resists motion between two bodies in contact.
- **Gravity** is the natural force that attracts any two objects with mass toward each other.
- **Motion** is moving or changing position (straight, zigzag, round and round, back and forth, fast and slow).
- **Relative speed** is the speed of an object in relation to a reference point.
- **Speed** is how fast or slow something moves.

Literature Connections

Books

- *Newton and Me* by Lynne Mayer (530 MAY)*

Book Sets

- Give it a Push! Give it a Pull! A Look at Forces by Jennifer Boothroyd*
- Roller Coaster! By Paul Mason*
- Motion: Push and Pull, Fast and Slow by Darlene Stille*

*currently available in Northside Elementary's media center

Lesson Prep

- ✓ Review the science topics taught throughout the year.

Vocabulary

Force, motion


Procedure

Mini-Lesson

- Remind the students of the **science topics** they have learned about this year and share the topics they will be learning about the rest of the year before you give them their journaling prompt.

Independent Work



- Take students outside to **observe** the playground.
- Give them a few minutes to look around and complete the following nature journaling prompt on their own.
- **Nature Journaling** prompt: 
 - Make a list of science concepts we could explore on the playground. How could we explore them?

Independent Group Work



- Have students **turn and talk** to a partner about what they wrote.
- Then have students briefly **explore** some of the different connections to science that can be made on a playground:
 - Use IR thermometers to collect **temperature** data of different surfaces.
 - Look at where **shadows** are on the playground and how that might change throughout the day.
 - Look for how **plants** impact the playground.

Assessment

- Bring the class back inside and create a class **list** of their ideas.
- **Circle** ones that have to do with force and motion.
- **Star** ideas that you will be exploring in this unit.
- You can use this discussion as a formative pre-assessment.

Behavior Management Tips

- ◆ Discuss how learning on the playground will look different than recess.

Learning Objectives:

Students will be able to recognize elements of science on their school playground.

Nutshell/Skill:

Students can find connections to science on the playground.

Science Essential Standards:

3.P.1, 3.P.2, 3.P.3, 3.E.1, 3.E.2, 3.L.1, 3.L.2

ELA Essential Standards:

W.3.6

Time:

30 minutes

Student Materials:

- Nature Journals
- Pencils
- IR thermometers (optional)

Lesson Prep

- ✓ Preview *Newton and Me*.
- ✓ Choose desired activities to use with the book.
- ✓ Make copies of chosen student activities.

Vocabulary

Direction, force, friction, gravity, motion, speed

Procedure

Mini-Lesson

- Show students the cover of *Newton and Me*. Ask them to **predict** what the story might be about.
- Prompt students to look and listen for **force and motion** concepts.
- **Read** the story *Newton and Me* aloud to the class.
- Ask students to give you a thumbs up if their **prediction** was correct.

Independent Work

- **Questions and activities** are at the back of the book and on the [publisher's website](#), including a [teaching activity guide](#). The **teaching activity guide** includes vocabulary, reading graphic organizers, and science graphic organizers. Some of the materials are available in Spanish.
- **Recommended activities to use:**
 - [For Creative Minds](#) has students connect the book with force and motion ideas. (Also, in the back of the book.)
 - From the [Teaching Activity Guide: Force and Motion True/False](#) p. 15-16 and [Science Journal Vocabulary Activity](#) p. 17-18

Assessment

- Answers for the activities are at the end of the guide, p. 21-23.
- Quizzes can be found on the [publisher's website](#).

Opportunities for Extended Learning

1. Videos on Brainpop on [Gravity](#), [Forces](#), and [Isaac Newton](#). These videos could be used at any point throughout the unit.
2. [Force, Sports, and Fitness](#) - Interactive [online activity](#) combining text features and a lesson on force. Intended as a homework activity to be done with parents but could also be done as a classroom activity.

Learning Objectives:

Students will be able to recognize how forces affect the objects in the story.

Nutshell/Skill:

Students can describe how forces affect objects.

Science Essential Standards:

3.P.1.1, 3.P.1.2, 3.P.1.3

ELA Essential Standards:

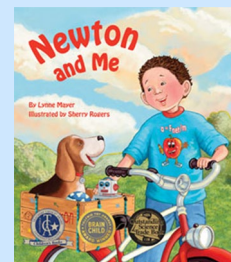
RI.3.1, RI.3.4, RI.3.7, RI.3.5 (extension)

Time:

30 minutes

Teacher Materials:

- *Newton and Me* by Lynne Mayer



Student Materials:

- Copies of chosen activities
- Pencils



Learning Activity 2

Dream Playground Design Challenge: Part 1

Note: This activity adapted from the publication *Swing Set Makeover: Grade 3 STEM Road Map for Elementary School* edited by C.C. Johnson, J.B. Walton, and E. Peters-Burton and published by NSTA Press.

Lesson Prep

- ✓ Review the following pages in *Swing Set Makeover*, located in the Northside Elementary Media Center Professional Collection.
- ✓ Read p. 61-63, 77-83 and any additional pages such as the learning theory used (p. 16-17) & teacher background information (p. 53-57).
- ✓ Make copies of *Fun Factor Survey* handouts p. 77-83, 1 per student.
- ✓ Choose images of playgrounds from Internet Resources on p. 75 or use the images provided on p. 76 of *Swing Set Makeover*.

Vocabulary

Direction, distance, force, friction, gravity, motion, relative speed, speed

Procedure Part 1

Guided Practice

- Discuss how people find different playground equipment more or less fun and why.
- Discuss how you could **evaluate** playground equipment on the basis of how fun it is.
- Students will complete page 1 of the *Fun Factor Survey* to determine their **personal** metric of fun.
- Working in **groups***, students will use their data to create a *Fun Factor Survey* to assess various playgrounds.
- **Practice** evaluating playgrounds by looking at a few pictures of different playgrounds. Evaluate at least one picture before going outside.
- **Explain** that students will use their *Fun Factor Survey* results for the **Dream Playground Design Challenge** at the end of the unit.
- Tell students that while learning about force and motion their job is **to evaluate their playground for its fun factor and use of force and motion**.
- They will eventually be solving the **problem** of what playground equipment could be added to increase the fun factor of their playground, taking advantage of the laws of force and motion.

***The same groups assigned for this activity should also be used for the Playground Experiments, Playground Field Trip, and Dream Playground Design Challenge: Part 2.** These four activities are connected and build on each other, culminating in the Dream Playground Design Challenge. The Playground Experiments and Playground Field Trip could also be done as stand-alone activities.

Learning Objectives:

Students will be able to evaluate the elements of force & motion that may enhance or detract from a playground's fun factor.

Nutshell/Skill:

Students can assess the attributes that make playground equipment more or less fun for them through an examination of the forces & motion at work on the various pieces of equipment and themselves.

Science Essential Standards:

3.P.1.1, 3.P.1.2, 3.P.1.3

ELA Essential Standards:

SL.3.1

Math Essential Standards:

NC.3.MD.3 (extension)

Time:

Part 1: 30 minutes
Part 2: 30 minutes

Teacher Materials:

- Pictures of playgrounds
- Fun Factor Survey lesson (p. 61-63, 77-83) from *Swing Set Makeover: Grade 3 STEM Road Map for Elementary School* edited by C.C. Johnson, J.B. Walton, and E. Peters-Burton and published by NSTA Press (or a Fun Factor Survey you create)



Student Materials:

- Playground
- Fun Factor Survey

Procedure Part 2



Independent Group* Work

- Go outside to the playground most often used by your class.
- Have students **evaluate** its fun factor using the *Fun Factor Survey*.
- Students will also begin thinking about how to optimize the playground to their preferences.
- Students will **use the results of their *Fun Factor Surveys*** for Learning Activity 12: Dream Playground Design Challenge: Part 2. Their Fun Factor Surveys will also be referred to in Learning Activity 8: Playground Experiments and Learning Activity 10: Playground Field Trip.

Assessment

- As this activity is used to complete the project for Learning Activity 12: Dream Playground Design Challenge: Part 2, it will be incorporated into the assessment of that activity.

Opportunities for Extended Learning

1. Have students create a bar graph of the fun factor survey results. (p. 65-66, 84 in *Swing Set Makeover: Grade 3 STEM Road Map for Elementary School*)

Behavior Management Tips

- ◆ Before going outside, discuss how learning on the playground will look different than recess.
- ◆ Remind students of the goals of the lesson before going outside.
- ◆ Notify students of how much time they have left to finish their Fun Factor Survey while outside to refocus them to the task at hand.

Lesson Prep

- ✓ Make copies of the *Playground Scavenger Hunt*, 1 per student.
- ✓ Note: This activity provides an opportunity to integrate the study of math and science concepts in one activity. It can be taught within this science unit, or when shapes, area & perimeter are taught in 3rd grade mathematics.

Vocabulary

Direction, distance, force, friction, gravity, motion, relative speed, speed

Procedure

Mini-Lesson

- This is an **inquiry**-based activity. Students will be learning in the process of completing the scavenger hunt, so do not give them answers beforehand.

Independent Group Work



- Students will work in teams of 2 or 3 to complete a playground **scavenger hunt**.
- The scavenger hunt includes looking for different aspects of **force** and **motion** on the playground as well as looking for **shapes** and finding **perimeter** and **area** of objects.
- Take students to the playground to complete the scavenger hunt.

Assessment

- **Debrief** and **discuss** what students found on their scavenger hunt.
- Ask students to **share** what they found for each item on the scavenger hunt. As a **formative assessment**, have the other students give a thumbs up or thumbs down in agreement or disagreement as each student shares an item they found.

Opportunities for Extended Learning

1. Watch this [video on forces and motions at an amusement park](#) (2:59).

Behavior Management Tips

- ◆ Ask students to remind you of the expectations for outdoor learning.
- ◆ Discuss how learning on the playground will look different than recess. Some exploration of the playground will be necessary to complete the scavenger hunt.

Learning Objectives:

Students will be able to identify examples of both forces and shapes, as well as find area and perimeter, using playground equipment.

Nutshell/Skill:

Students can recognize examples of forces and shapes as well as find area and perimeter using playground equipment.

Science Essential Standards:

3.P.1.1, 3.P.1.3

ELA Essential Standards:

SL.3.1

Math Essential Standards:

NC.3.G.1, NC.3.MD.8, NC.3.MD.7, NC.3.MD.3, NC.3.MD.2

Time:

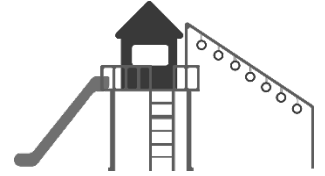
30 minutes

Student Materials:

- Tape measures
- Pencils
- Clipboards (optional)
- *Playground Scavenger Hunt*
- Playground

Name: _____

Playground Scavenger Hunt



Force and Motion

Where on the playground do you use a **pull force**? **Name** and **sketch** the playground equipment you found. Add an **arrow** showing the force.

Find equipment on the playground that uses **friction**. **Name** and **sketch** what you found. Add an **arrow** showing the force.

Where on the playground do you use a **push force**? **Name** and **sketch** what you found. Add an **arrow** showing the force.

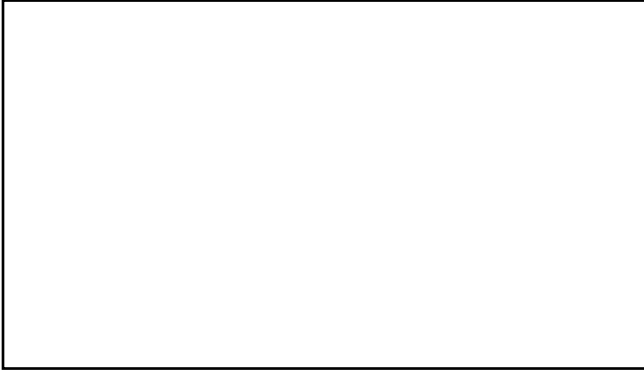
Where on the playground do you **move vertically** (up and down)? **Name** and **sketch** what you found. Add an **arrow** showing the force.

Find something on the playground that uses **gravity**. **Name** and **sketch** what you found. Add an **arrow** showing the force.

Where on the playground do you **move in a circle**? **Name** and **sketch** what you found. Add an **arrow** showing the force.

Math

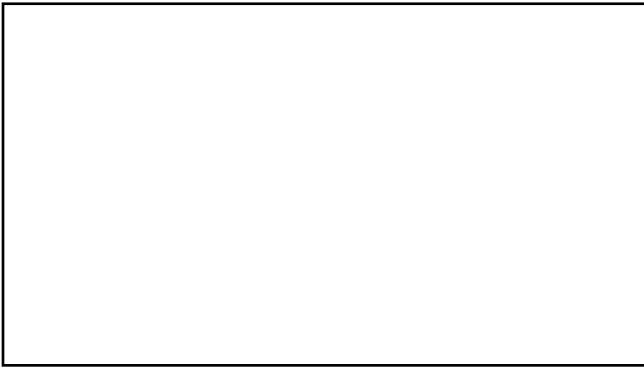
Find and sketch a **parallelogram**. Where did you find it?



Find the **perimeter** of one of the shapes you found. Measure to the nearest **foot**. Show your work.

Shape: _____
_____ + _____ + _____ + _____ =
_____ feet

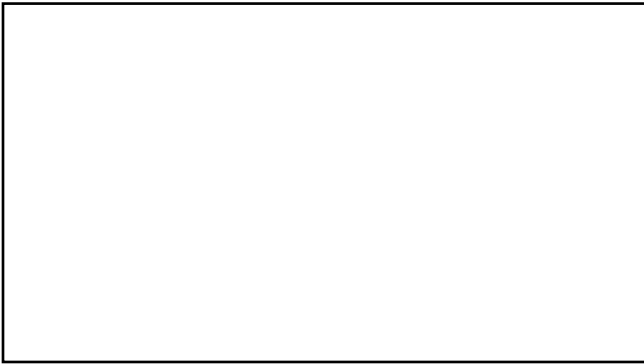
Find and sketch a **rectangle**. Where did you find it?



Find the **area** of one of the shapes you found.

Shape: _____
_____ x _____ = _____ feet²

Find and sketch a **rhombus**. Where did you find it?



Find the **perimeter** of a section of the ropes dome.

_____ + _____ + _____ + _____ =
_____ feet

Find and sketch a **trapezoid**. Where did you find it?



Find the **area** of another section of the ropes dome.

_____ x _____ = _____ feet²

Lesson Prep

- ✓ Determine which field or open area you will use outside.

Vocabulary

Direction, distance, force, friction, motion, speed

Procedure

Mini-Lesson

- Review what a force is and how applying a force can affect an object.

Guided Practice



- Take students outside to a field or other open area.
- Divide the class into two groups for tug of war.
- Talk the class through having one side apply a **gentle pull force** and notice what happens.
- Repeat with the other side pulling.
- Challenge the class to pull with **equal force** so that the rope is not moving.
- Then challenge them to apply a **strong pull force** with the purpose of pulling the marked midpoint of the rope across a marked area toward them.

Assessment

- Ask students to explain why the team that won was able to pull the rope across the boundary.
- Have students vote with a thumbs up or down if they agree with their classmate's answer as a formative assessment.

Opportunities for Extended Learning

1. You may choose to mix up the teams and repeat the game of tug of war. Discuss how this applies concepts of force and motion.
2. Have classes compete against each other using the same procedure. Include a discussion of how this connects to force and motion.

Behavior Management Tips

- ◆ Have students remind the class of expectations for outdoor learning and how to be safe during this activity.

Learning Objectives:

Students will be able to conclude that when a force is applied to an object it will result in a change of speed and/or direction.

Nutshell/Skill:

Students can recognize that a relationship exists between forces and changes in motion.

Science Essential Standards:

3.P.1.1

Time:

30 minutes

Student Materials:

- Large tug-of-war rope

Lesson Prep

- ✓ Make copies of the data sheet, 1 per group.
- ✓ Gather materials.
- ✓ Determine where each group will be working.

Vocabulary

Direction, distance, force, gravity, motion, relative speed, speed

Procedure

Mini-Lesson

- Conduct a **class demonstration** of how ramp height affects the movement of a ball.
 - Have the class form a circle.
 - Have a student volunteer stick their arms out straight in front of them. Place a ball on their arms.
 - Extend your arms and touch fingertips.
 - Take turns squatting to show how your arms form a ramp that the ball rolls down.
 - Have the class pass the ball around the circle by making ramps with their arms.
 - First, have the class do it slowly.
 - Then, challenge the class to do it more quickly.
- **Discuss** how they changed the speed of the ball, what made the ball move, and other aspects of their ramps.
- Ask students for real world **examples** of ramps (i.e. a ramp for a wheelchair).
- Review how to **measure** distance with students.
 - Emphasize consistency - always measuring from the same starting point and to the same ending point, i.e. bottom of the ramp to the back bumper of the car.
- **Model** using the tape measure with a student volunteer.
 - Ask students what to do if what they are measuring is longer than the tape measure (mark the spot at the end of the tape measure, then move the tape measure to measure from spot that was marked).
 - Students should be able to come up with a few ideas, but make sure all students know a way to handle this situation before starting as cars may travel farther than the tape measure is long.
 - Provide masking tape as a way to mark where the car starts and stops rolling.

Learning Objectives:

Students will be able to identify how gravity affects the speed and distance an object will travel by changing the ramp height.

Nutshell/Skill:

Students can recognize the impact gravity has on the speed and distance of an object.

Science Essential Standards:

3.P.1.1, 3.P.1.2, 3.P.1.3

ELA Essential Standards:

SL.3.1

Math Essential Standards:

NC.3.MD.2, NC.3.MD.3 (extension)

Time:

30 minutes

Teacher Materials:

- Ball, such as playground ball, soccer ball, or basketball

Student Materials:

- Ramps
- Objects to roll down ramps i.e. balls or toy cars
- Books or blocks to adjust ramp height
- Tape measures
- Masking tape
- *Ramp Investigations: Ramp Height* data sheets
- Pencils

- Talk through the data sheet and directions with students.
 - Ask students why it is good practice as scientists to do the same thing more than once.
 - **Emphasize** that they will roll their object down the ramp at the same height 4 times **before** changing the ramp height.
 - Indicate where each group will be working on the floor.

Independent Group Work

- Students will work in groups to **test** how **ramp height** affects how fast and how far an object will roll.
 - The object rolled down the ramp can be a toy car, marble, or small ball.
- Students will record how far their object rolls down the ramp for each different height.
- Students will **collect data** and **answer questions** on the group data sheet, *Ramp Investigations: Ramp Height*.

Assessment

- Use the completed data sheet as an assessment.
 - The force causing the object to roll down the ramp is gravity.

Opportunities for Extended Learning

1. Have students make a **bar graph** of the data they have collected.
2. Recreate similar experiments on slides. You would need slides of different height for comparison.
3. Recreate experiments but mark a certain distance and time how long it takes for the car to reach that spot.

Behavior & Materials Management Tips

- ◆ Have job cards to give each group to assign a role to each person. Jobs may include **Scribe** – person who records data and reads directions, **Engineer** – person who builds the ramp and adjusts its height, **Driver** – person who rolls the object, and **Measurer** – person who measures how high the ramps is and how far the object rolls. Assign the engineer or driver to assist the measurer.
- ◆ Have one person (the engineer) from each group come to a central location to collect materials.
- ◆ Ramps should be built on the floor as objects are likely to roll farther than the table is long. Try to find an area for each group to work where groups are less likely to have conflicts over space and collisions.

Names: _____



Ramp Investigations: Ramp Height

Our question: How does ramp height affect the speed and distance an object rolls down a ramp?

We predict _____

We know _____ is the force causing the object to roll down the ramp.

Our experiment:

- We will let the object roll down from the top of the ramp, without pushing it.
- Once the object stops moving, we will measure in inches (in) to the closest half inch the distance the object rolled from the end of the ramp to the back of the object.
- We will repeat for 4 trials at the same height.
- We will then change the ramp height and repeat the experiment.
- We will test 4 different ramp heights.
- We will record each ramp height and the distance measured in our data table.

Our data:

Ramp Height	Trial 1 Distance in inches	Trial 2 Distance in inches	Trial 3 Distance in inches	Trial 4 Distance in inches

In the space below, provide an answer to the original question: How does ramp height affect the speed and distance an object rolls down a ramp?

Our results: _____



Lesson Prep

- ✓ Make copies of the data sheet, 1 per group.
- ✓ Gather materials.
- ✓ Determine where each group will be working.

Vocabulary

Direction, distance, force, friction, gravity, motion, relative speed, speed

Procedure

Mini-Lesson

- Briefly explain what **friction** is and how it affects movement.
 - Include in your explanation the fact that **friction is a force**.
- Ask students for **examples** of when they have experienced friction.
 - Prompt students with questions about what they have done to slow down before, i.e. dragging feet when swinging or using the brakes on a bicycle.
 - Explain how they are using friction to slow themselves down.
- Review with students how to **measure** distance.
 - Emphasize consistency - always measuring from the same starting point and to the same ending point, i.e. bottom of the ramp to the back bumper of the car.
- **Model** using the tape measure with a student volunteer.
 - **Ask** students what to do if what they are measuring is longer than the tape measure (see Activity 5).
 - Students should be able to come up with a few ideas, but make sure all students know a way to handle this situation before starting as cars may travel farther than the tape measure is long.
 - Provide masking tape as a way to mark where the car starts and stops rolling.
- Go over the **data sheet** and **directions**.
 - **Ask** students why it is good practice as scientists to do the same thing more than once.
 - **Emphasize** that they will roll their object down the ramp on the same surface 4 times **before** changing to a different surface.
 - Tell students the specific **height** everyone should use for their ramp. The ramp height should **not** change for this experiment.
 - Indicate where each group will be working on the floor.

Learning Objectives:

Students will be able to identify how friction affects the speed and distance an object will travel by changing the ramp surface.

Nutshell/Skill:

Students can recognize the impact friction has on the speed and distance an object rolls.

Science Essential Standards:

3.P.1.1, 3.P.1.2, 3.P.1.3

ELA Essential Standards:

SL.3.1

Math Essential Standards:

NC.3.MD.2, NC.3.MD.3 (extension)

Time:

30 minutes

Student Materials:

- Ramps
- Objects to roll down ramps i.e. balls or toy cars
- Various materials to put on ramps such as wax paper, felt, bubble wrap, sandpaper, aluminum foil
- Masking tape
- Books or blocks to give the ramp height
- *Ramp Investigations: Ramp Surface* data sheets
- Pencils

Independent Group Work

- Students will work in groups to **test** how **friction** affects how fast and far an object rolls by testing various **ramp surfaces**.
 - The object rolled down the ramp can be a toy car, marble, or small ball.
- Students will be recording how far their object rolls down the ramp for each different surface.
- Students will **collect data** and **answer questions** on a group data sheet, *Ramp Investigations: Ramp Surfaces*.

Assessment

- The completed data table can serve as an assessment.
 - Friction is the force that slows down and stops the object.

Opportunities for Extended Learning

1. Have students make a **bar graph** of the data they have collected.
2. Recreate similar experiments on slides. Various materials: felt, cardboard, wax paper, aluminum foil, sandpaper, bubble wrap, carpet, towels, fabric.
3. Recreate experiments but mark a certain distance and time how long it takes for the car to reach that spot.

Behavior & Materials Management Tips

- ◆ Have job cards to give each group to assign a role to each person. Jobs may include **Scribe** – person who records data and reads directions, **Engineer** – person who builds the ramp and changes the surface, **Driver** – person who rolls the object, and **Measurer** – person who measures how high the ramps is and how far the object rolls. Assign the engineer or driver to assist the measurer.
- ◆ Have one person (the engineer) from each group come to a central location to collect materials.
- ◆ Ramps should be built on the floor as objects are likely to roll farther than the table is long. Try to find an area for each group to work where groups are less likely to have conflicts over space and collisions.

Names: _____

Ramp Investigations: Ramp Surface



Our question: How does ramp surface affect the speed and distance an object rolls down a ramp?

We predict _____

We know _____ is the force that slows down and stops our object.

Our experiment:

- We will let the object roll down from the top of the ramp, without pushing it.
- Once the object stops moving, we will measure in inches (in) to the closest half inch the distance the object rolled from the end of the ramp to the back of the object.
- We will repeat for 4 trials with the same surface.
- We will then change the ramp surface and repeat the experiment.
- We will test 4 different ramp surfaces.
- We will record each ramp surface and the distance measured in our data table.

Our data:

Ramp Surface	Trial 1 Distance in inches	Trial 2 Distance in inches	Trial 3 Distance in inches	Trial 4 Distance in inches

In the space below, provide an answer to the original question: How does ramp surface affect the speed and distance an object rolls down a ramp?

Our results: _____

Essential Questions

How do different forces change the position and motion of objects around us?

NC Science Essential Standards – Unpacked Content

3.P.1.1 Students know that when a force acts on an object it will result in a change of speed and / or direction.

3.P.1.2 Students know that speed can vary. Students know that varying the speed of a moving object will affect the time it takes for the object to travel a particular distance.

3.P.1.3 Students know that the earth ‘pulls’ on all objects on or near the earth without touching those objects.

Lessons in this Arc

- ❖ Learning Activity 7: Colliding Cars
- ❖ Learning Activity 8: Playground Experiments
- ❖ Learning Activity 9: Rube Goldberg Design Challenge

Go Outdoors!

- ✓ Learning Activity 8: Playground Experiments

Duration

3-8 days of 30 minute learning activities

Background Information

Force is equal to mass times acceleration. **Mass** is the amount of material in an object. Acceleration is the rate of change of velocity in relation to time. In physics, acceleration can be an increase or decrease in speed as it deals with the change in velocity. An object at rest still has forces acting on it but the net force is zero. **Inertia** is a property of matter where it will remain at rest or in unchanging motion unless acted on by some external force. This comes from Newton’s First Law of Motion. **Friction** is a force that resists motion between two bodies in contact with each other which means it usually causes an object’s speed to decrease. **Air resistance** slows an object as it moves through the air. It is a form of friction and is also referred to as drag.

Energy is the ability to do work. Energy can be in the form of heat, light, or motion. It must be transferred from one object to another to perform work. **Engineering** is the science or profession that specializes in developing ways to use nature’s power and resources in ways that are helpful to people. Much of engineering is concerned with using and improving how energy is used for human purposes.

Vocabulary

- **Air resistance** is the friction between air and an object that slows the motion of an object. Also called drag.
- **Energy** is the ability to do work and comes in different forms.
- **Engineering** is the science or profession of developing and using nature's power and resources in ways that are useful to people (as in designing and building roads, bridges, dams, or machines and in creating new products).
- **Inertia** is a property of matter by which it remains at rest or in unchanging motion unless acted on by some external force.
- **Mass** is the amount of material in an object.



This activity made available through [Wake-UTD Problem-Based Learning](#).

Lesson Prep

- ✓ Review the Wake/UTD PBL lesson "[Colliding Cars](#)".
- ✓ Gather materials.

Vocabulary

Direction, distance, force, friction, gravity, motion, relative speed, speed

Procedure

Guided Practice

- This is an inquiry-based lesson. Students will work in groups to solve a problem and should be allowed to direct their own learning.
- Have a student volunteer read the problem aloud.
- Discuss and create a chart of what we know, the need to know, and learning issues surrounding the problem given.

Independent Group Work

- Students work in a group to solve the problem: You are a safety engineer that designs cars, and you need to know more about what happens when cars collide so you can make cars safer.
- You have been given toy cars, car tracks, ramps, and tape measures.
- You will create a presentation and report to your boss.

Assessment

- Presentation of team results along with a written summary by each student. Rubric provided in Wake UTD lesson materials.

Opportunities for Extended Learning

1. In [this video](#), Bill Nye shows how a ping pong ball doesn't have enough momentum to knock down bowling pins and that a bowling ball does. Momentum is the quantity of motion of a moving body, measured as a product of its mass and velocity.
2. Worksheet - "Which one needs a harder push?" from the ["Newton and Me" Teaching Activity Guide](#) p. 20 - Worksheet that has students determining how relatively hard of a push balls of varying mass will need to reach a certain point.

Behavior Management Tips

- ◆ Have each group discuss how they will work as a team. Will they divide the work based on specific jobs? Will they take turns? Will they raise their hand when they want a turn or have input?
- ◆ Have one person from each group come to a central location to collect materials.
- ◆ Ramps should be built on the floor as toy cars are likely to roll farther than the table is long. Try to find an area for each group to work where groups are less likely to have conflicts over space and collisions.

Learning Objectives:

Students will be able to analyze the forces that affect motion.

Nutshell/Skill:

Students can describe how speed affects car collisions.

Science Essential Standards:

3.P.1.1, 3.P.1.2

ELA Essential Standards:

SL.3.1, W.3.2

Time:

1-4 sessions of 30 minutes each
(length of time dependent on if students research the learning issues and what final products are created)

Student Materials:

- Toy cars
- Tape measures
- Ramps
- Car tracks (optional)

Lesson Prep

- ✓ Make copies of the *Playground Experiments* graphic organizer, 1 per student.
- ✓ Preview the video "[Swings Slides, and Science](#)" (3:37).

Vocabulary

Direction, distance, force, friction, gravity, motion, relative speed, speed, air resistance, energy, engineering, inertia, mass

Procedure

Mini-Lesson

- **Before** going outside ask students to tell you what they **know** about **force and motion** so far.
- Record student responses in a manner that the class can see.
- Tell them that they will be working in **groups*** to test one of these ideas.

Guided Practice

- Walk through the graphic organizer using one of the previous experiments they have done as an example, i.e. tug of war.

Independent Group Work

- Students will be given a graphic organizer with parameters which guide them to create and perform an experiment involving force and motion. Students will be working in groups*.
- The **experiments** will be **inquiry-based** involving gravity, friction, slides, climbing, spinning, push, pull.
- The graphic organizer will walk students through designing and implementing a simple experiment.
- To allow a more thorough exploration of force and motion, students will complete **two experiments - one per day**.
 - To allow for more choices, one day could be done at the upper grades playground and the other on the lower grades playground.

***The groups assigned for this activity should also be used for the Dream Playground Design Challenge: Part 1, Playground Field Trip, and Dream Playground Design Challenge: Part 2. The Playground Experiments and Playground Field Trip can be done as stand-alone activities.**

Learning Objectives:

Students will be able to evaluate the aspects of force and motion involved in various parts of a playground.

Nutshell/Skill:

Students can evaluate how playground equipment uses force and motion.

Science Essential Standards:

3.P.1.1, 3.P.1.2, 3.P.1.3

ELA Essential Standards:

SL.3.1

Time:

1-2 sessions of 30 minutes each

Teacher Materials:

- "[Swings Slides, and Science](#)" video from SciShow Kids (3:37)

Student Materials:

- Playground
- *Playground Experiments* graphic organizer

Mini-Lesson

- **After** students have **completed** their playground experiments, show them "[Swings Slides, and Science](#)" (3:37) from SciShow Kids, which demonstrates the physics of playgrounds.
 - You can adjust the speed at which the characters speak by changing the playback speed in the settings on the video.
- By playing the video **after** they have done their experiments, the students have had the opportunity to learn through their investigations, and the video will add to and, hopefully, **confirm** what they have discovered.
- Use the video as a way to **discuss** what they did and solidify **connections** to force and motion.

Assessment

- The completed graphic organizer can serve as an assessment.

Opportunities for Extended Learning

1. [Falling for Gravity](#) activities - Gravity and air resistance - Introduce the concept of air resistance or drag. Reinforce the idea that Earth's gravity is pulling all objects towards Earth.
2. Watch [the Hammer vs. Feather - Physics on the Moon video](#) of Commander David Scott dropping a feather and a hammer on the moon. (1:22)
3. Watch [the Mythbusters clip](#) of a recreation of the experiment on the Moon. (3:52)

Behavior Management Tips

- ◆ Ask students to remind you of the expectations for outdoor learning.
- ◆ Discuss how learning on the playground will look different than recess. Some exploration of the playground will be necessary to complete the playground experiments.

Name _____

Playground Experiments



- ❖ Your group will be designing and testing an experiment about **force and motion** using playground equipment.
- ❖ Choose **where** on the playground you want to do your experiment.
- ❖ Discuss with your group how you think **force and motion** relates to your chosen piece of playground equipment. Questions to think about during your discussion:
 - ✓ How is gravity involved?
 - ✓ Is friction important?
 - ✓ Do you push or pull anything?
 - ✓ How are force and motion interacting with your body?
 - ✓ How does it move?
 - ✓ How do you move?
 - ✓ Connect it to your Fun Factor Survey.

❖ **Draw or describe:**

Our **question about force & motion on our playground** (what we want to know)

What we already **know**

Our **prediction** (what we think will happen)

Testing our prediction (what we will do)

1. _____

2. _____

3. _____

4. _____

Our **data** / observations

Our **conclusion** (what we learned)

How was your **prediction** different from your **conclusion**?

How is **gravity** affecting your body when you play on this piece of equipment?

I still **wonder** about _____





Lesson Prep

- ✓ Ask students to bring in any empty paper towel rolls, toilet paper rolls, cereal boxes, or granola bar boxes to share with the class.
- ✓ Gather materials for students to use to create their Rube Goldberg.
- ✓ Make copies of the graphic organizer, 1 per student.

Vocabulary

Force, friction, gravity, motion, speed, engineering, inertia

Procedure

Mini-Lesson

- Introduce students to Rube Goldberg and the idea of Rube Goldberg machines. The official [Rube Goldberg website](#) has lots of resources, including information about the man, his cartoons, and inventions.
- Students need to understand the idea that a Rube Goldberg machine completes a **simple task** in a **fun, complicated** way.
- Along with the resources found on the official Rube Goldberg site, you may choose to show a **video** of a contraption such as a GlodieBlox commercial showing [girls creating a Rube Goldberg to turn off the tv](#) (2:07) or the [World's largest Rube Goldberg machine](#) (4:44) or one of a [Rube Goldberg created by a child to feed his dog](#) (2:09).

Independent Group Work

- Students will work in groups to create a Rube Goldberg contraption.
- Their contraption must have **at least 4 separate steps** to it and **complete a task**.
- Students will complete a graphic organizer as they work.

Assessment

- The completed graphic organizer can serve as an assessment.

Opportunities for Extended Learning

1. Have groups present their contraptions to the class.
2. More great [lessons](#) using Rube Goldberg machines.

Behavior & Materials Management Tips

- ◆ **Before** allowing them to collect materials, have groups show you their **completed design** on the graphic organizer.

Learning Objectives:

Students will be able to apply their understanding of force and motion.

Nutshell/Skill:

Students can build a Rube Goldberg machine and explain how it uses force and motion.

Science Essential Standards:

3.P.1.1, 3.P.1.2, 3.P.1.3

ELA Essential Standards:

SL.3.1

Time:

1-2 sessions of 30 minutes each
(Have session 1 focus on designing the Rube Goldberg, and session 2 on building it.)

Teacher Materials:

- Video or cartoon of a Rube Goldberg machine

Student Materials:

- Materials to create Rube Goldbergs such as
 - cardboard
 - paper towel rolls
 - craft sticks
 - cups
 - straws
 - balls
 - toy cars
 - flashlights
 - masking tape
- Rube Goldberg Design Challenge graphic organizer

Name _____

Rube Goldberg Design Challenge

Remember: A Rube Goldberg machine completes a simple task in a fun and complicated way.

1. Which task is your group's Rube Goldberg machine going to do? **Circle** your choice:

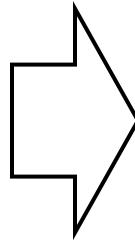
Put a ball/marble in a cup

Roll a car through a tunnel

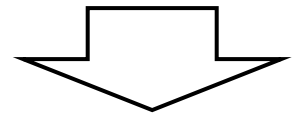
Turn on a flashlight

2. Your Rube Goldberg machine must complete at least **4 steps** to complete its task.

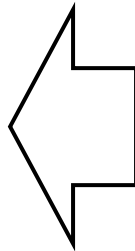
Describe Step 1.



Describe Step 2.





Describe Step 4.

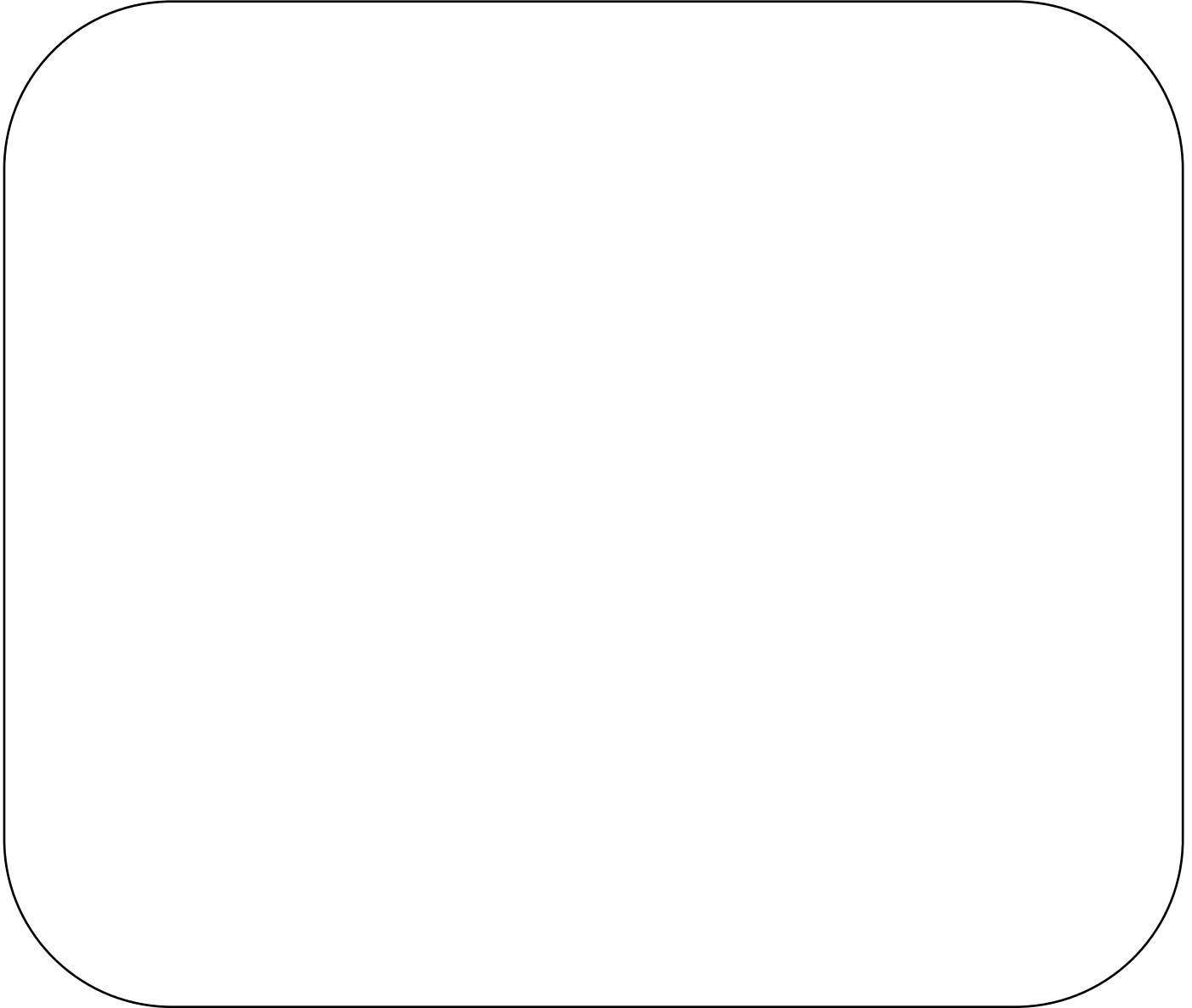


Describe Step 3.

Will you need additional steps to complete your Rube Goldberg machine? _____

3. **Draw** a diagram of your group's plan for a Rube Goldberg machine. 

4. Working as a team, **build** and **test** your group's Rube Goldberg machine.
5. Does your Rube Goldberg machine complete its task? _____ How can you **improve** your design? **Change** your design to make it complete its task or to make it better.
6. **Draw** your group's completed Rube Goldberg machine. **Number** the steps. **Label** the forces: gravity, friction, push, pull. 



7. **Describe** how you used force and motion to accomplish your task.



Arc 3 – Using knowledge of forces & motion to plan & build playgrounds

Essential Questions

How can we use our knowledge of forces and motion to plan and build playgrounds that are fun?

NC Science Essential Standards – Unpacked Content

- 3.P.1.1** Students know that when a force acts on an object it will result in a change of speed and / or direction.
- 3.P.1.2** Students know that speed can vary. Students know that varying the speed of a moving object will affect the time it takes for the object to travel a particular distance.
- 3.P.1.3** Students know that the earth ‘pulls’ on all objects on or near the earth without touching those objects.

Lessons in this Arc

- ❖ Learning Activity 10: Playground Field Trip
- ❖ Learning Activity 11: Design a Millipede Playground
- ❖ Learning Activity 12: Dream Playground Design Challenge

Go Outdoors!

- ✓ Learning Activity 10: Playground Field Trip
- ✓ Learning Activity 11: Design a Millipede Playground

Nature Journal Connection

- Learning Activity 11: Design a Millipede Playground

Duration

4-6 days of 30 minute learning activities plus travel time for field trip

Background Information

Engineers design and build things to solve a particular problem. Many types of engineers exist including mechanical engineers, electrical engineers, and aerospace engineers. **Mechanical engineers** would be involved in designing and creating playgrounds as they solve problems that involve anything mechanical such as machines, tools, and engines as well as aspects of the manufacturing industry.

Vocabulary

- A **mechanical engineer** is an engineer that deals with tools, machinery, and the application of mechanics in industry.

Lesson Prep

- ✓ Make copies of the *Playground Experiment* graphic organizer (end of this lesson) and *Fun Factor Survey (Swing Set Makeover, p. 83)*.
- ✓ Determine which playground you want to visit for this field trip.
- ✓ Walk the route you will journey with your students to identify any hazards and any potential stopping points for discussions.

Vocabulary

Direction, distance, force, friction, gravity, motion, relative speed, speed, air resistance, energy, engineering, inertia, mass

Procedure

Independent Group* Work



- Take students to another playground to complete additional **playground experiments** and **compare** playground equipment.
- As you walk to your nearby playground, pause periodically to make force and motion **observations** or other observations from previous science units (i.e. plants).
- You can also give them questions to focus on as they walk.
 - Have questions written on index cards or slips of paper to pass out to the students as you walk.
 - Students can trade questions with another student or group periodically.
- Once at the playground, students should work in their groups* to complete the **Fun Factor Survey** for the playground they visit. Refer to Learning Activity 2.
- Students will also complete one **experiment** using the same graphic organizer from Learning Activity 8: Playground Experiments.

***The groups assigned for this activity should also be used for the Dream Playground Design Challenge: Part 1, Playground Experiments, and Dream Playground Design Challenge: Part 2. The Playground Experiments and Playground Field Trip can be done as stand-alone activities.**

Assessment

- Discuss how this playground compares to the school playgrounds.
 - Ask questions about fun factor as well as force and motion.
- Discuss the Playground Experiments graphic organizer.
- Use these discussions not only to assess student understanding but also to correct any remaining misconceptions.

Learning Objectives:

Students will be able to compare how different playgrounds use force and motion to create a fun experience.

Nutshell/Skill:

Students can compare how different playgrounds use force and motion and how they have different Fun Factors.

Science Essential Standards:

3.P.1.1, 3.P.1.2, 3.P.1.3

Math Essential Standards:

NC.3.G.1, NC.3.MD.2, NC.3.MD.3, NC.3.MD.7, NC.3.MD.8 (all in extension)

Time:

30 minutes plus travel time to playground and any additional time desired for lunch or extended learning

Student Materials:

- *Fun Factor Survey* graphic organizer from *Swing Set Makeover*
- *Playground Experiments* graphic organizer
- Playground
 - Umstead Park is close enough to walk to and has picnic tables for lunch. Students can walk the 0.7 miles in approximately 15 minutes on the Tanyard Branch Trail. [Umstead Park, 399 Umstead Dr, Chapel Hill, NC 27516](#)
 - Hargraves Community Center is also close enough to walk to and has picnic tables for lunch. Students can walk the 0.4 miles in approximately 10 minutes. [Hargraves Community Center, 216 N. Roberson St, Chapel Hill, NC 27514](#)

Opportunities for Extended Learning

1. While on their field trip, students could also complete the *Playground Scavenger Hunt* from Learning Activity 3, if time allows.

Behavior Management Tips

- ◆ Ask students to remind you of the expectations for outdoor learning.
- ◆ Discuss expectations for the walk to the playground.
- ◆ Discuss how learning on the playground will look different than recess. Some exploration of the playground will be necessary to complete the playground experiments.

Name _____

Playground Experiments



- ❖ Your group will be designing and testing an experiment about **force and motion** using playground equipment.
- ❖ Choose **where** on the playground you want to do your experiment.
- ❖ Discuss with your group how you think **force and motion** relates to your chosen piece of playground equipment. Questions to think about during your discussion:
 - ✓ How is gravity involved?
 - ✓ Is friction important?
 - ✓ Do you push or pull anything?
 - ✓ How are force and motion interacting with your body?
 - ✓ How does it move?
 - ✓ How do you move?
 - ✓ Connect it to your Fun Factor Survey.

❖ **Draw or describe:**

Our **question** (what we want to know)

What we already **know**

Our **prediction** (what we think will happen)

Testing our prediction (what we will do)

1. _____

2. _____

3. _____

4. _____



Learning Activity 11

Design & Build a Millipede Playground

Lesson Prep

- ✓ Make copies of the graphic organizer, 1 per student.
- ✓ Preview the [Design Challenge: Millipede Playground PowerPoint](#).
- ✓ Gather materials.

Vocabulary


Direction, distance, force, friction, gravity, motion, relative speed, speed, air resistance, energy, engineering, inertia, mass, mechanical engineer

Procedure

Mini-Lesson

- Briefly introduce millipedes and the design challenge using the PowerPoint.
 - Students will be mechanical engineers for the design challenge.
 - Ask students, "What do you think would be on a millipede playground?"
 - Connect the idea of creating a playground for millipedes to people having different abilities and different preferences. You can connect this with earlier activities by discussing how not everyone's fun factor surveys looked the same.

Independent Group Work

- Students should work in groups to **apply** their knowledge of force and motion to design and create a playground for millipedes.
- Students will complete a graphic organizer as they **design and build** their playground.
- Once playgrounds are created, **millipedes can be found and collected from outside, typically underneath logs in the forested areas, to test** the playgrounds.
 - Playgrounds could be carried outside to be tested, so that millipedes could easily be returned to their habitats.
 - You can allow students to use other creatures they find, such as beetles.
- Students should record their observations of the millipedes in their playgrounds in their **Nature Journals**. 



Assessment

- The completed graphic organizer can serve as an assessment.

Learning Objectives:

Students will be able to create a playground that applies their understanding of force and motion.

Nutshell/Skill:

Students can design and build a playground for millipedes that uses concepts of force and motion.

Science Essential Standards:

3.P.1.1, 3.P.1.2, 3.P.1.3

ELA Essential Standards:

SL.3.1

Time:

1-2 sessions of 30 minutes each
(Have session 1 focus on designing and creating their playgrounds, session 2 focus on testing it with millipedes)

Teacher Materials:

- ✓ [Design Challenge: Millipede Playground PowerPoint](#)

Student Materials:

- Copy paper box lid or plastic tub per group
- Various materials to build with:
 - straws
 - paper towel rolls
 - cardboard
 - craft sticks
 - empty tape rolls
 - tape
- Nature Journals
- [Millipede Playground Design Challenge](#) graphic organizer

Opportunities for Extended Learning

1. Students could test another group's millipede playground. They could then discuss with that group how the two compare.
2. Watch a video about engineers or the engineering process, such as "[What's an Engineer?](#)" from Crash Course Kids, "[Solve Problems: Be an Engineer!](#)" from SciShow Kids, or "[The Engineering Process](#)" from Crash Course Kids. The playback speed of the video can be adjusted in settings to slow down the speed of the speaker.

Behavior & Materials Management Tips

- ◆ Have students show you their completed design before gathering materials.
- ◆ Remind students to be gentle with the millipedes, as they are living things.
- ◆ Remind students that the goal is for the millipedes to test the playground, so the millipedes must be allowed to explore the playground.

Name _____

Millipede Playground Design Challenge



1. Discuss with your group what you think will be fun for a millipede. Think about your fun factor survey and previous experiments in this unit.

a) How could you use **gravity** in your playground design?

b) How could you use **friction** in your playground design?

c) What could you create that would be fun for the millipede to **push**?

d) What could you create that would be fun for the millipede to **pull**?



2. In the box, **draw** a diagram of the playground you want to create for your millipede. **Label** your diagram with the forces and motions used, such as gravity, friction, push, pull, straight, and slow.

3. As a group, use the materials provided to **create** a playground for a millipede.



4. How did you need to **change** your design when you built the playground? **Why?**



5. **Draw** your group's millipede playground. **Label** your diagram with the forces and motions used.



Learning Activity 12

Dream Playground Design Challenge: Part 2

Note: This activity adapted from the publication *Swing Set Makeover: Grade 3 STEM Road Map for Elementary School* edited by C.C. Johnson, J.B. Walton, and E. Peters-Burton and published by NSTA Press.

Lesson Prep

- ✓ Make copies of the graphic organizer, 1 per group.
- ✓ Make copies of the presentation rubric, 1 per group.
- ✓ Review p. 189-214 in *Swing Set Makeover: Grade 3 STEM Road Map for Elementary School* to better understand the design challenge and modifications recommended.

Vocabulary

Direction, distance, force, friction, gravity, motion, relative speed, speed, air resistance, energy, engineering, inertia, mass, mechanical engineer

Procedure

Independent Group Work

- Students will work in groups* to use their experiments from this unit to come up with a plan of how they would modify the existing playground to optimize the fun factor.
- Project a picture of the school playground to remind students what pieces of equipment are already there.
- Students will use the graphic organizer to record their information to be presented.
- They should use the same company that provided the current equipment, [KOMPAN](#), to find the exact pieces they would like to add.
- Students will create a slideshow and present what they choose to add and why to the class.
- Allow classmates to ask questions after each presentation.

***The groups assigned for this activity should be the same as the ones used for the Dream Playground Design Challenge: Part 1, Playground Experiments, and Playground Field Trip. The Playground Experiments and Playground Field Trip can be done as stand-alone activities.**

Assessment

- Use the **rubric** on p. 210 of *Swing Set Makeover: Grade 3 STEM Road Map for Elementary School* to assess the student presentations.

Learning Objectives:

Students will be able to use their knowledge of force and motion to design their dream playground.

Nutshell/Skill:

Students can select an appropriate piece of playground equipment to optimize my playground fun factor and application of force and motion.

Science Essential Standards:

3.P.1.1, 3.P.1.2, 3.P.1.3

ELA Essential Standards:

SL.3.1, SL.3.3, W.3.2, W.3.5, W.3.6

Time:

2-3 sessions of 30 minutes each

Teacher Materials:

- p. 189-214 in *Swing Set Makeover: Grade 3 STEM Road Map for Elementary School* edited by C.C. Johnson, J.B. Walton, and E. Peters-Burton and published by NSTA Press
- Photo of your school playground
- Presentation rubric from p. 210 of *Swing Set Makeover*

Student Materials:

- *Dream Playground Design Challenge* graphic organizer
- Chromebooks or iPads
- Group's previously completed *Fun Factor Surveys and Playground Experiments*

Names: _____

Dream Playground Design Challenge

1. What was your total fun factor score for our school playground? _____
2. Based on your Fun Factor Survey, what fun factor needs the most improvement? _____
3. What connections to force and motion can you make about the fun factor that needs improvement?

4. You have surveyed and experimented with different playgrounds. Using the data, you have gathered, your group will be choosing a piece of playground equipment to add to our playground to make it your dream playground. Our playground has equipment from a company called KOMPAN. Search <https://www.kompan.us/play> to find a piece of playground equipment that would increase your fun factor score.
5. What piece did your group chose? _____
6. What is the perimeter of this piece of equipment? _____

7. How much area will this piece of equipment take up on our playground? _____

8. How would it rate on your Fun Factor Survey? _____
9. How does the piece you chose use force? _____

10. How is it different than other existing pieces? _____

11. How might shadows and heat from the sun be important in your selections?

12. When have you felt heat on the playground?

13. You will be presenting your choice to the class. Create a Google Slides presentation that includes a picture of your chosen piece of playground equipment and the answers to the questions on this paper.

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Learning Activity 1: Newton and Me

Mayer, L. (2013). *Newton and Me*. Mount Pleasant, SC: Sylvan Dell Pub.
Arbordale Publishing. (n.d.). Newton and Me. Retrieved from

<https://www.arbordalepublishing.com/bookpage.php?id=Newton>

BrainPOP. (n.d.). Forces. Retrieved from <https://www.brainpop.com/science/motionsforcesandtime/forces/>

BrainPOP. (n.d.). Gravity. Retrieved from <https://www.brainpop.com/science/motionsforcesandtime/gravity/>

BrainPOP. (n.d.). Isaac Newton. Retrieved from

<https://www.brainpop.com/science/motionsforcesandtime/isaacnewton/>

Newton and Me Teaching Activity Guide. (2010.). Retrieved from

http://www.arbordalepublishing.com/documents/TeachingActivities/Newton_TA.pdf

Public Media Connect. (2017, November 17). Forces, Sports and Fitness! Retrieved from

<https://unctv.pbslearningmedia.org/resource/reach-with-stem-forces-sports-fitness/forces-sports-and-fitness/>

Learning Activity 2: Dream Playground Design Challenge: Part 1

Johnson, C. C., Walton, J. B., & Peters-Burton, E. E. (2018). *Swing set makeover, grade 3: STEM road map for elementary school*. Arlington, VA: National Science Teachers Association.

Learning Activity 3: Playground Scavenger Hunt

Science Trek. (2019, May 24). Force and Motion: Science Trek. Retrieved from

<https://unctv.pbslearningmedia.org/resource/idptv11.sci.phys.maf.d4kfom/force-and-motion/>

Learning Activity 7: Colliding Cars

Wake Forest Baptist Medical Center. (n.d.). Wake UTD Colliding Cars. Retrieved from <https://www.wake-utd.org/details/ProductId/96>

Newton and Me Teaching Activity Guide. (2010.). Retrieved from

http://www.arbordalepublishing.com/documents/TeachingActivities/Newton_TA.pdf

Nye, B. (2009, April 08). Bill Nye The Science Guy on Momentum (Full Clip). Retrieved from

<https://www.youtube.com/watch?v=y2Gb4Niv0Xg>

Wake Forest Baptist Medical Center. (n.d.). Inquiry Based Learning Design. Retrieved from <http://www.wake-utd.org/>

Learning Activity 8: Playground Experiments

AAAS. (2011). Falling for Gravity. Retrieved from <http://sciencenetlinks.com/media/filer/2011/09/27/tf-snl-falling-for-gravity.pdf>

AIRBOYD. (2010, April 01). Hammer vs Feather - Physics on the Moon. Retrieved from

<https://www.youtube.com/watch?v=KDp1tiUsZw8>

Discovery Communications. (n.d.). Lunar Lunacy - MythBusters. Retrieved from <https://www.discovery.com/tv-shows/mythbusters/videos/lunar-lunacy>

SciShow Kids. (2015, July 08). Swings, Slides, and Science | Physics for Kids. Retrieved from <https://www.youtube.com/watch?v=JvSCIZ3vHOI>

Learning Activity 9: Rube Goldberg

Dunn, K. (2017, October 27). Rube Goldberg easy examples. Retrieved from <https://www.youtube.com/watch?v=OHwDf8njVfo>

GoldieBlox. (2013, November 26). GoldieBlox & Rube Goldberg "Princess Machine". Retrieved from <https://www.youtube.com/watch?v=llGyVa5Xftw>

Guinness World Records. (2016, December 06). World's largest Rube Goldberg machine lights up Christmas tree. Retrieved from <https://www.youtube.com/watch?v=RBOqfLVCDv8>

Rube Goldberg Inc. (2018). Home of the Official Rube Goldberg Machine Contests. Retrieved from <https://www.rubegoldberg.com/>

Learning Activity 10: Playground Field Trip

Johnson, C. C., Walton, J. B., & Peters-Burton, E. E. (2018). *Swing set makeover, grade 3: STEM road map for elementary school*. Arlington, VA: National Science Teachers Association.

Learning Activity 11: Design a Millipede Playground

Johnson, C. C., Walton, J. B., & Peters-Burton, E. E. (2018). *Swing set makeover, grade 3: STEM road map for elementary school*. Arlington, VA: National Science Teachers Association.

Crash Course Kids. (2015, May 29). The Engineering Process: Crash Course Kids #12.2. Retrieved from <https://www.youtube.com/watch?v=fxJWin195kU&list=PLhz12vamHOnZ4ZDC0dS6C9HRN5Qrm0jHO&index=2>

Crash Course Kids. (2015, May 26). What's an Engineer? Crash Course Kids #12.1. Retrieved from <https://www.youtube.com/watch?v=owHF9iLyxic>

SciShow Kids. (2015, November 16). Solve Problems: Be an Engineer! Retrieved from <https://www.youtube.com/watch?v=D9I35Rqo04E>

Learning Activity 12: Dream Playground Design Challenge: Part 2

KOMPAN. (n.d.). Playground Equipment. Retrieved from <https://www.kompan.us/play>