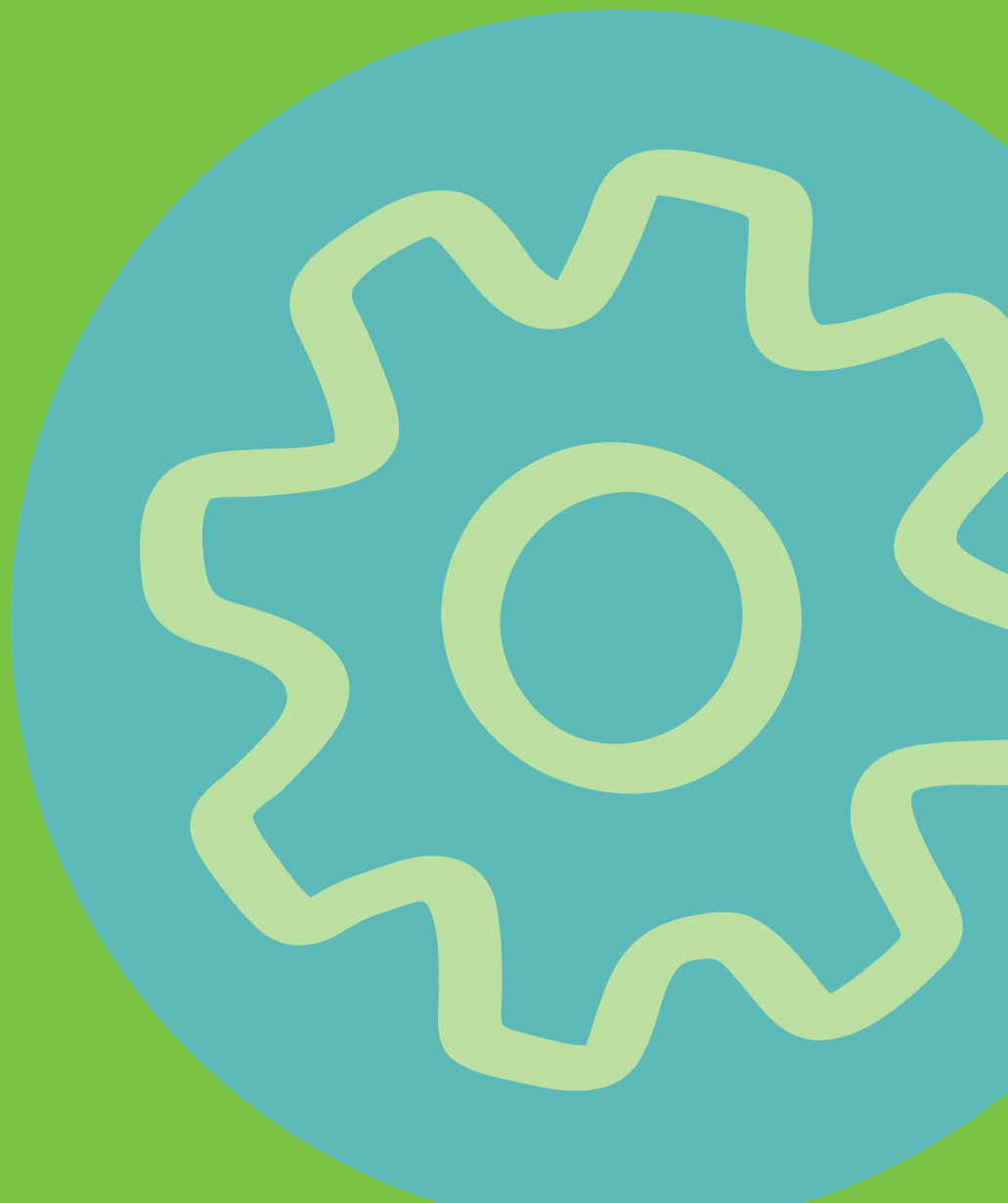


**New York Hall of Science:
Inspiring Young Innovators Through
Literacy-Based Engineering Activities**



Inspiring Young Innovators Through Literacy-Based Engineering Activities

This guide includes literacy-based engineering activities that were developed by the New York Hall of Science (NYSCI), in collaboration with teachers from District 24 in Queens, NY. The activities use NYSCI's Design, Make, Play approach to learning, which helps young learners (grades PreK – 2) understand science, technology, engineering and math concepts, fosters problem solving and critical thinking skills, supports language development, and strengthens learning across all domains.

Design emphasizes problem solving and intentionality, and helps you see the possibilities in the world;

Make invites you to be hands-on with materials, tools and processes, and nurtures the development of skills and confidence;

Play promotes intrinsic motivation and deep engagement.

The activities in this guide use grade appropriate, read-aloud books to motivate students to participate in the engineering design process. The activities are rooted in noticing and discovery, and build skills that are key to the scientific process, such as observation, experimentation, prediction and communication. The activities also promote material literacy, a potent skill that builds confidence and enables children to see the possibilities in the world around them by transforming the form and function of a material in innovative ways.

Activity Format

Each of the activities in this guide were co-developed and tested with teachers to ensure practicality of classroom use and integration of classroom needs. Key factors addressed in the development of the activities included using inexpensive or everyday materials, connecting to science concepts/standards, and efficiently managing time in the classroom. Also included are questions, strategies and prompts to help guide the discussions and reflections with students.

The core framework of each activity consists of three main components:

Introduction — A read-aloud storytime, followed by an engineering design challenge that is motivated by the plot or characters in the story.

Materials Exploration and Design — Students explore properties of materials, how they work, and how the function of the materials can be used, combined or manipulated to solve a problem.

Test and Reiterate — Students test their solutions, share results with each other, and build on this knowledge to improve or modify their solutions.

Each activity concludes with students documenting their engineering design process using the *My Design* worksheet. The *My Design* worksheet is an opportunity for young learners to build confidence by sharing and communicating their work, build literacy skills, reflect on their design, and inspire further investigation.

As with any set of activities, teachers are encouraged to adapt the format or materials to suit their classroom needs or available resources.

The activities were designed to be fun, engaging and easy to implement. They introduce young learners to the engineering design process, enrich science content learning, and foster problem solving/critical thinking skills. More importantly, these activities empower young learners as engineers or scientists and instill positive attitudes that lead to self-efficacy.

Inspiring Young Innovators Through Literacy-Based Engineering Activities was made possible through the generous support of 100K in 10 Foundation and the Richmond County Savings Foundation.



Literacy-Based Engineering Activities

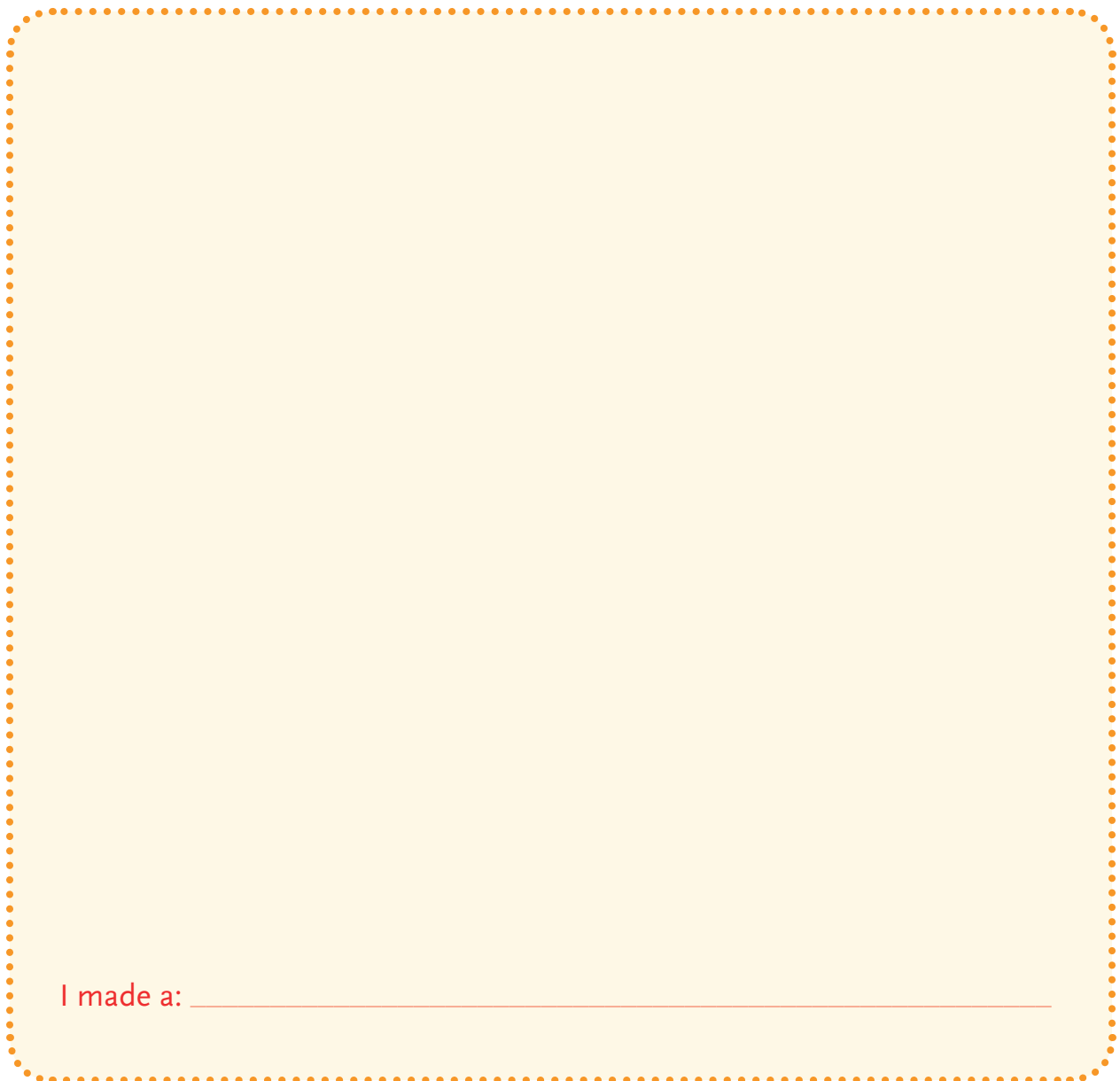
Lesson Title	Pre-Kindergarten	Kindergarten	1st Grade	2nd Grade
ABC Tree				
Rolling Along				
Paper Clay Creations				
Build a Bath Toy				
Winding Water Pipelines				
Scratch That Itch!				
Strong and Sturdy Shelters				
Magnificent Riders				

My Design

Name _____

Date _____

Draw and label your design:



I made a: _____

Activity: ABC Tree

Grades: Pre-K — Kindergarten

Objective

After reading the book *Chicka Chicka Boom Boom* by Bill Martin Jr., students will build a tree to support the letters of the alphabet. They will practice writing their name and then match each letter to the larger foam letters. They will test their design by placing the large letters in the tree and observing how many letters their structure can hold. Students will explore forces, motion and cause and effect as they build a structure to support different weights and shapes.

Grade	Learning Objectives	Key Vocabulary
Pre-K	<p><i>Students will be able to:</i></p> <ul style="list-style-type: none">• Identify the different parts of a tree.• Identify letters of the alphabet.• Practice writing capital and lowercase letters.• Explore and go through each step of the design process.	<p><i>Roots</i></p> <p><i>Trunk</i></p> <p><i>Branches</i></p> <p><i>Leaves</i></p> <p><i>Dirt</i></p> <p><i>Grow</i></p>
Kindergarten	<p><i>Students will be able to:</i></p> <ul style="list-style-type: none">• Identify the variety of shapes within the different letters of the alphabet.• Explore the different aspects of structure and support.• Explore and go through each step of the design process.	<p><i>Tree</i></p> <p><i>Seeds</i></p>

Activity: ABC Tree

Materials

- *My Design* worksheet
- Solid blocks
- Jumbo craft sticks
- Alphabet letters (different textures and sizes)

Alternative Material Options

- Plank blocks or cardboard cut into plank shapes
- Craft sticks of various sizes

Introduction

1. Read *Chicka Chicka Boom Boom*, by Bill Martin Jr.
2. Have a discussion with students to review what happened in the story.
 - *What are the various parts of the coconut tree?*
 - *How did the different letters try to fit in the coconut tree?*
 - *What happened when the letter Z tried to climb the tree?*
3. Group students into pairs. Have each student write out their name on a large sentence strip, then have them point and identify each letter as they spell out their name.
4. Introduce the engineering challenge that relates to the story with the following prompt: *The coconut tree wasn't strong enough to hold all of the letters in the alphabet. Design a new tree that can hold most of the letters in your name.*
5. Once their name is written out, have them find and match the corresponding letters from a small assortment of letters. (Make sure that each student has the correct number of letters on their sentence strip in front of them.)



Activity: ABC Tree

Materials Exploration and Design

1. Introduce the materials available for building and allow students to explore the different properties (weight, shapes, etc.).
 - *Think about the various parts of a tree — which materials can you use for each part?*
 - *Think about the different shapes of the letters — how can you fit the different shapes within the structure of the tree?*
2. Inform students that they will be testing their design by supporting as many letters as they can fit on their tree before it topples over.
3. Have students start designing and building their tree using the materials.

Provide guiding questions such as:

- *What materials could you use to create the different parts of the tree?*
- *How many letters do you need to fit on your tree?*

Test and Iterate

1. Once students have completed their structure, have them test their design by placing the letters of their name within the tree.
2. If their tree topples over, discuss with students how they can improve their design to support more letters without falling over. *What do you think caused your tree to fall over? What can you change to stop it from falling over?*
3. Have students draw, describe and label their tree on the *My Design* worksheet.

Extensions

- Conduct a classroom or school-wide scavenger hunt where students can identify and write letters that they find around the school. One hunt can focus on specific letters (vowels, consonants, etc.), the letters in each student's names, or the letter or sound being taught that day.
- Students can count the total number of letters in their tree. They can then compare their number to other students to introduce *less than*, *more than*, or *equal to*.
- Group students into pairs or small groups and have them try counting or adding the total number of letters in all their names.

Activity: ABC Tree

- Alphabet Bingo — Have students fill in a blank bingo board using the letters of their name and mark off the different letters as they are called at random.
- Have students take turns drawing alphabet flash cards, then finding something within the classroom that matches that letter or identifying a student whose name begins with that letter.

What's Happening?

Different types of structures require different types of support systems. Just like buildings have foundations and different parts to keep it standing up straight, trees have support systems that allow the tree to grow and stand tall. The tree's roots serve as a foundation and anchor them into the ground. The tree's trunk provides structure and supports the weight of the branches, and the branches spread out to capture sunlight and allow for the growth of leaves, flowers or fruit.

Materials exploration allows for students to investigate the different properties and purposes of the presented materials. While certain materials have intended purposes, their properties may lend themselves to other uses that replicate the properties of other matter found in the real world. For example, children may be familiar with craft sticks for arts and craft purposes, but they may not be familiar with how to stack them out flat to represent branches or leaves.



ABC Tree Standards Alignment

Grade	Pre-K for All Interdisciplinary Units of Study	Pre-K Scope & Sequence	PKFCC
Pre-K	Unit 8: Plants	The Environment & Me	<p>Domain 4: Communication, Language & Literacy: Motivation (1-3), Background Knowledge (2), Viewing (3), Representing (4), Vocabulary (4, 5, 6)</p> <p>ELA & Literacy: Key Ideas & Details (1–3), Craft & Structure (4–6), Integration of Knowledge & Ideas (7–8)</p> <p>Domain 5: Cognition & Knowledge of the World: Science: Scientific Thinking, Physical Properties (6.a, 6.c, 6.f, 6.g), Living Things (5.h) Mathematics: Mathematical Practices, Counting and Cardinality, Operations & Algebraic Thinking, Measurement & Data, Geometry</p>

Grade	NYC Scope & Sequence Standards	Common Core Standards	NGSS Science & Engineering Practices	Disciplinary Core Ideas	NGSS Cross Cutting Concepts
Kindergarten	Unit 2: Exploring Properties 3.1b, 3.1c, 3.1d, 3.1e, 3.1f	RI.K.1, RI.K.2, RI.K.4, RI.K.7, RI.K.10, SL.K.3, SL.K.5, SL.K.6, MP.2, K.MD.A.1, K.MD.A.2	<p>Motion & Stability: Forces & Interactions K-PS2-1, K-PS2-2</p> <p>Engineering Design K-2ETS1-1, K-2ETS1-2, K-2ETS1-3</p>	<p>Types of Interactions PS2.B</p> <p>Relationship Between Energy & Forces PS3.C</p> <p>Defining & Delimiting Engineering Problems ETS1.A</p> <p>Developing Possible Solutions ETS1.B</p> <p>Optimizing the Design Solution ETS1.C</p>	<p>Cause & Effect (K-PS2-1, K-PS2-2)</p> <p>Structure & Function (K-2-ETS1-2)</p>

Activity: Rolling Along

Grades: Pre-K – Kindergarten

Objective:

After reading the book *Oscar and Cricket: A Book About Moving and Rolling* by Geoff Waring, students will create a path for the ball to move from Oscar to Cricket while bypassing the obstacle of a mud pit. They will test their design by rolling different balls through their paths and observing how they traveled between the two designated points. Students will explore different forces as they accurately describe how their balls travel.

Grade	Learning Objectives	Key Vocabulary
Pre-K	<p><i>Students will be able to:</i></p> <ul style="list-style-type: none">• Learn about push and pull by testing out the ball's movements.• Learn about bounce by testing the ball's movements against an object.• Explore materials to see which are sturdy enough to support the ball (exploring properties of matter).	<p><i>Bounce</i></p> <p><i>Direction</i></p> <p><i>Force</i></p> <p><i>Pull</i></p> <p><i>Push</i></p> <p><i>Stop</i></p> <p><i>Slow down</i></p>
Kindergarten	<p><i>Students will be able to:</i></p> <ul style="list-style-type: none">• Learn about force and motion (push/pull) through the ball's movements.• Explore three types of balls to see which one is strong enough to go through the structure that the students create.	<p><i>Straight</i></p> <p><i>Curved</i></p> <p><i>Over</i></p> <p><i>Under</i></p> <p><i>Around</i></p>

Activity: Rolling Along



Materials

- *My Design* worksheet
- Toilet paper/paper towel rolls
- Chipboard
- Blocks
- Wax paper
- Large pieces of cardboard
- Tape

Materials Necessary for Testing

- Small balls (ping pong, golf, etc.)
- Something to represent the mud obstacle (brown paper, a block, etc.)

Introduction

1. Read *Oscar and Cricket: A Book About Moving and Rolling* by Geoff Waring.
2. Have a discussion with students to review what happened in the story.
 - *What happened to the ball when Oscar pushed the ball with his paw?*
 - *How did the ball move as it rolled through the grass?*
 - *How did the ball move as it rolled through the mud?*
 - *What happened when Oscar moved the ball on a smooth surface?*
 - *What are some things that made the ball slow down?*
3. Introduce the engineering challenge that relates to the story with the following prompt: *Oscar and Cricket are playing with a ball but they learned that the ball gets stuck when it's rolled through the mud. Design a way to get the ball from Oscar to Cricket without going through the mud.*

Materials Exploration and Design

1. Introduce the materials available for building and allow the students to explore the different properties (size, texture, etc.).
 - *How do each of the balls move differently (bounce versus roll)?*
 - *Which direction do you want the ball to move in? Over, under, around?*
 - *Which materials will help control the balls direction?*

Activity: Rolling Along

2. Inform students that they will be using the different balls to test if the pathway that they created is successful. Encourage students to think about which materials will work with the different balls. Then, set up the mud obstacle and point out to students that this is the object that the ball will have to move over or around without touching in order to successfully get to the other side.
3. Have students start designing and building their pathway using the materials. Provide guiding questions such as:
 - *Think about how the ball moved in the story. What are some ways you can move the ball from Oscar to Cricket?*
 - *Do you want to go over the mud or around the mud?*
 - *Which materials can the ball roll on top of, under or through?*
 - *Do you want to bounce or roll the ball through the path that you designed?*

Test and Reiterate

1. Once students have completed their path, have them test their design by rolling the different types of balls through their path.
2. Discuss with students what they could change to improve their path. If time permits, encourage them to make modifications and then test again.
3. Have students draw, describe and label their path on the *My Design* worksheet.

Extension

- After the reading, create a word chart with vocabulary from the book of the movements of the ball such as push, pull, bounce, stop, slow down and smooth. The students can create body movements to represent each action or word. This can help the students visualize and/or describe the movements the balls will be making.
- Have students use a stopwatch to time the trials of each of the different balls. This can be used for comparisons, charting, etc.
- Have students create a timeline of the ball's path from the story, starting with Cricket's push and ending with Ted's paw. Draw a line from one end of paper to the other, label one side Cricket's push and the other Ted's paw. Then, have students write the series of events within the timeline.

Activity: Rolling Along

- Have students explore different animals and write about how each could move the ball differently based on their structures.

What's Happening?

A force is a push or pull on an object that changes the object's position or direction of motion. A force can cause an object to accelerate, slow down, remain in place, or change shape. Friction is the resistance of motion when one object interacts with another. Smooth or sleek surfaces create less friction than rough or coarse surfaces.

Gravity is the force that keeps our feet on the ground and keeps everything around us stuck on Earth. When you release a ball, gravity forces the ball to drop the ground. After a ball is dropped, the materials the ball interacts with then determine the direction it will move in (how it will roll, bounce, etc.).



Rolling Along Standards Alignment

Grade	Pre-K for All Interdisciplinary Units of Study	Pre-K Scope & Sequence	PKFCC
Pre-K	Unit 5: Transportation	The Environment & Me (Transportation)	<p>Domain 4: Communication, Language & Literacy: Motivation (1-3), Background Knowledge (2), Motivation (1-3), Background Knowledge (2), Viewing (3), Representing (4), Vocabulary (4, 5, 6)</p> <p>ELA & Literacy: Key Ideas & Details (1-3), Craft & Structure (4-6), Integration of Knowledge & Ideas (7-8)</p> <p>Domain 5: Cognition & Knowledge of the World: Science: Scientific Thinking (1-3), Physical Properties (6, 6.c, 6.f, 6.g), Technology (1, 2.a, 2.c, 2.d, 3.e)</p>

Grade	NYC Scope & Sequence Standards	Common Core Standards	NGSS Science & Engineering Practices	Disciplinary Core Ideas	NGSS Cross Cutting Concepts
Kindergarten	Unit 2: Exploring Properties 3.1b, 3.1c, 3.1d, 3.1e, 3.1f	RI.K.1, RI.K.2, RI.K.4, RI.K.7, RI.K.10, SL.K.3, SL.K.5, SL.K.6, MP.2, K.MD.A.1, K.MD.A.2	<p>Motion & Stability: Forces & Interactions K-PS2-1, K-PS2-2</p> <p>Engineering Design K-2ETS1-1, K-2ETS1-2, K-2ETS1-3</p>	<p>Forces & Motion PS2.A</p> <p>Types of Interactions PS2.B</p> <p>Relationship Between Energy & Forces PS3.C</p> <p>Defining & Delimiting Engineering Problems ETS1.A</p> <p>Developing Possible Solutions ETS1.B</p> <p>Optimizing the Design Solution ETS1.C</p>	<p>Cause & Effect (K-PS2-1, (K-PS2-2)</p> <p>Structure & Function (K-2-ETS1-2)</p>

Activity: Paper Clay Creations

Grades: Kindergarten – Grade 1

Objective:

After reading the book *The Great Paper Caper* by Oliver Jeffers, students will learn where paper comes from, explore the texture and properties of a paper pulp mixture called paper clay to make a sculpture to demonstrate the importance of recycling.

Grade	Learning Objectives	Key Vocabulary
Kindergarten	<p><i>Students will be able to:</i></p> <ul style="list-style-type: none">• Observe, compare and describe the physical properties of trees and their structure.• Recognize trees as a source for paper.• Understand the importance of recycling paper.	<p><i>Paper</i></p> <p><i>Trees</i></p> <p><i>Paper Pulp</i></p> <p><i>Trunk</i></p> <p><i>Branches</i></p> <p><i>Design</i></p> <p><i>Sculpture</i></p>
Grade 1	<p><i>Students will be able to:</i></p> <ul style="list-style-type: none">• Understand how paper is made from trees.• Identify steps in the recycling process and investigate the importance of conservation.• Explore new materials and utilize tools.	

Activity: Paper Clay Creations



Materials

- *My Design* worksheet
- *Paper Pulp* recipe (see page 18)
- *Paper Clay* recipe (see page 20)
- Smocks or aprons
- Measurement cups: 1/8, 1/2 and 1 cup
- Kitchen tools: Blender, mesh strainer, plastic spoons and plastic cups
- Flour
- Wax paper
- Basin or deep tray
- Warm water

Activity Tips

- For this activity, you will need to make paper pulp first in order to make paper clay.
- The paper clay making process is a wet one; plan to use a workspace that won't be harmed by moisture.
- It is recommended that teachers pre-make the paper pulp before the lesson. This will help minimize the cleanup and setup time needed, especially with younger students. See the Paper Pulp recipe on page 18 for instructions on how to make paper pulp.
- Do not pour any excess paper pulp down the drain, as it may become clogged. Instead, squeeze as much water as possible from the paper pulp and throw it in a trash receptacle.

Activity: Paper Clay Creations

Paper Pulp Recipe

Materials

- *Paper scraps (office paper, construction paper, newspaper, etc.) Make sure to remove any plastic or staples from the scrap paper.*
- *Warm water*
- *Blender (or hand mixer)*
- *Mesh strainer*
- *Plastic container*
- *Paper towels*

Step 1:

Tear paper scraps (office paper, construction paper, newspaper, etc.) into small 1–inch squares or pieces.

Step 2:

Put the pieces of paper into a large bowl and add enough warm water to cover them. Let the pieces soak for several minutes to soften the paper fibers.

Step 3:

Fill the blender halfway up with warm water and the soaked paper scraps. Put the top of the blender on and run blender for about a minute, or until the paper inside is cut up and the mixture has an oatmeal consistency. This is the paper pulp.

Step 4:

Pour the paper pulp into a basin or deep tray. Put the screen in the bottom and slowly lift it up through the paper pulp. Take your time. The water will strain through the mesh, leaving a layer of paper pulp on the frame.

Step 5:

Store the paper pulp in a container and cover with a moist paper towel.

Activity: Paper Clay Creations

Introduction

1. Read *The Great Paper Caper* by Oliver Jeffers.
2. Have a discussion with students to review what happened in the story.
 - *What are the forest animals trying to find out?*
 - *What is the problem in the story?*
 - *How do Bear's feelings change from the beginning to the end of the story? Have you ever felt that way before?*
 - *How did the pictures and words in the story help you understand how Bear was feeling (scared, happy, excited, etc.)?*
3. Introduce the engineering challenge that relates to the story with the following prompt: *Bear wants to say "thank you" to the animals in the forest for helping him win the paper plane competition. He decides to recycle the leftover paper to make a gift. Suddenly, it begins to rain and all the paper becomes wet and mushy. Help Bear recycle the mushy, wet paper to design and make a thank you gift for the animals in the forest.*

Materials Exploration and Design

1. Introduce the concept of recycling to students.
 - *What happens to garbage after you put it in the garbage can?*
 - *Why do we need to recycle things?*
 - *What are some things we can recycle?*
 - *How do you help with recycling at home?*
 - *How might we be able to recycle and reuse paper?*
 - *What did the characters in the story do with the leftover paper?*
2. Use the Paper Clay recipe on the following page to pre-make a sample of paper clay. Show students the paper clay and describe what it is, where it comes from, and how it is made. To follow are recommendations for making paper clay with Kindergarten and first grade students.

Activity: Paper Clay Creations

Paper Clay Recipe

Materials

- $\frac{1}{2}$ to 1 cup of premade paper pulp
- Plastic cups (one per child)
- $\frac{1}{8}$ measuring cup (1-2 per group table)
- Spoons
- Flour
- Wax paper

Step 1:

Put $\frac{1}{2}$ - 1 cup of premade paper pulp into a plastic cup. (Teacher can do this ahead of time.)

Step 2:

Add $\frac{1}{8}$ of a cup of flour.

Step 3:

Add $\frac{1}{8}$ of a cup of water.

Step 4:

Mix ingredients together. This is paper clay!

Step 5:

Place paper clay on top of a sheet of wax paper.

Step 6:

Roll the paper clay back and forth several times.

Step 7:

Build with the paper clay!

Activity: Paper Clay Creations

For Kindergarten:

Give students a small ball of paper clay and allow them to explore its properties (texture, size, weight, flexibility, etc.).

- *What word would you use to describe the paper clay?*
- *What does paper clay remind you of?*
- *What could you make with paper clay?*
- *How can we make different shapes with the paper clay?*

For Grade 1:

Introduce the materials available for students to make their own paper clay and allow students to explore them. As a class, review the paper clay recipe instructions for making paper clay. Allow each student to make their own (if more practical, have students work in small groups) and encourage them to explore its different properties (texture, size, weight, flexibility, etc.).

- *Look to a partner and describe how paper clay feels.*
- *How do the ingredients change when you mix them together?*
- *What do you think would happen if you increased or decreased the amount of one of the ingredients?*
- *What does paper clay remind you of?*
- *How is it different from other types of clay you've see/ touched before?*

3. Ask students to twist, roll and pull their paper clay into different shapes.
 - *How does the paper clay change when you twist/pull/roll it?*
 - *How will twisting, rolling, pulling, etc. help you make your sculpture?*
4. Students can begin making their paper clay gift.
 - *What would make a useful gift for animals that live in the forest?*
 - *What will it look like?*

Test and Reiterate

1. Students will test the consistency of their paper clay as they build their design.
 - *Does it have too much water?*
 - *Is the paper clay too dry? Too hard?*
 - *How can we improve your paper clay to help you make your design?*
2. Encourage students to use the paper clay creatively.
 - *How can you improve on your original design?*
 - *What other materials in the classroom could you use to improve your design*
 - *How can you prevent your design from falling, breaking, etc.?*

Activity: Paper Clay Creations

3. Ask students to draw, label and describe their gift on the *My Design* worksheet.
4. Once all students have finished, have them leave their design and thank you gift on their tables so that everyone in the class can see their design. Ask students to walk around the classroom and using complete sentences to explain what they like best about other students gifts. Students will engage with their classmates in explaining, clarifying and justifying what they have made.

Extensions

- Have students search the classroom for different kinds of recyclables (the teacher can extend the search and include the cafeteria). Students will make and present posters with sentences and drawings describing the items they found. Hang posters throughout the classroom.
- Look at the pages in the book that have illustrations, but no words. Ask students to write some sentences to describe what is happening.
- Give students the opportunity to share creative ideas of how to reuse materials. Ask them to express their ideas either through drawings or writing sentences and sharing them with the class. Encourage the use of new vocabulary words as they describe recycled materials, such as plastic, glass, metal or paper.
- Students will design a poster to announce the next great paper plane competition. Introduce who, what, where and when style questions. Ask students to include those answers in their posters in complete sentences.

Activity: Paper Clay Creations

What's Happening?

Trees are familiar natural resources for young children. As such, they can help motivate children to learn about and understand how paper is made and the need to recycle paper.

Paper starts out as a tree on a tree farm and is taken to a mill where the raw wood is turned into a pulp. The pulp looks a lot like a soup, but it is made up of cellulose fibers (main structural component of plants), water and lignin (a substance that makes the plant rigid). When the pulp is reshaped or molded, the cellulose fibers and lignin in the pulp bind together again and the pulp is transformed into paper.

Recycling paper is important because it can help keep paper from clogging up landfills and help conserve trees. Paper can be turned into new things such as, cardboard, toilet paper and tissues, by adding water and turning it into pulp.



Paper Clay Creations Standards Alignment

Grade	NYC Scope & Sequence Standards	Common Core Standards	NGSS Science & Engineering Practices	Disciplinary Core Ideas	NGSS Cross Cutting Concepts
Kindergarten	<p>Unit 1– Trees Through the Seasons LE 1.1b, LE 1.2a, LE 4.2a, LE 3.1c</p> <p>Unit 2 – Exploring Properties PS 3.1b,c, PS 3.1b,c, e</p> <p>Unit 3 – Animals LE 1.1a, LE 1.2a, LE 4.1g, LE 4.2a, LE 5.2e, LE 5.2f</p>	RI.K.1, RI.K.2, RI.K.7, RI.K.10, W.2, W.K.2, SL.K.3, SL.K.5, K.MD.A.1, MP.2, MP.4	Engineering Design: K-2-ETS-1, K-2-ETS-2, K-2-ETS-3	<p>Defining & Delimiting Engineering Problems: ETS1.A</p> <p>Developing Possible Solutions: ETS1.B</p> <p>Optimizing the Design Solution: ETS1.C</p>	<p>Cause & Effect: K-PS2-1, K-PS2-2, K-PS3-1, K-PS3-2</p> <p>Structure & Function: K-2-ETS1-2</p>
Grade 1	<p>Unit 1– Animal Diversity LE 3.1a, LE 3.1c,</p> <p>Unit 2– Properties of Matter PS 3.2a, PS 3.1f, PS 3.2c, PS 3.1c,d, e, g</p> <p>Unit 3 – Weather and Seasons PS 1.1a, PS 2.1a</p>	RI.1.1, RI.1.2, RI 1.7, SL.1.1, SL.1.2, SL.1.3, MP.2, MP.5	Engineering Design: K-2-ETS1-1, K-2-ETS1-2, K-2-ETS1-3	<p>Structure & Function: LS1.A</p> <p>Defining & Delimiting Engineering Problems: ETS1.A</p> <p>Developing Possible Solutions: ETS1.B</p> <p>Optimizing the Design Solution: ETS1.C</p>	<p>Cause and Effect: 1-PS4-1, 1-PS4-2, 1-PS4-3</p> <p>Structure & Function: 1-LS1-1, K-2-ETS1-2</p>

Activity: Build a Bath Toy

Grades: Kindergarten – 2

Objective:

After reading the book *The Pigeon Needs a Bath!* by Mo Willems, students will create a bath toy that motivates Pigeon to take a bath. Students will explore the buoyancy of the materials before building their bath toy. After building their bath toy they will work in small groups to test and make observations to see if they sink or float in the water.

Grade	Learning Objectives	Key Vocabulary
Kindergarten	<p><i>Students will be able to:</i></p> <ul style="list-style-type: none">• Observe and describe properties of matter (buoyancy).• Describe properties of the building materials and their bath toys.• Sort building materials and bath toys according to whether they sink or float.	<p><i>Observation</i></p> <p><i>Buoyancy</i></p> <p><i>Sink</i></p> <p><i>Float</i></p> <p><i>Gravity</i></p> <p><i>Force</i></p>
Grade 1	<p><i>Students will be able to:</i></p> <ul style="list-style-type: none">• Sort building materials and bath toys according to whether they sink or float.• Observe and describe properties of their building materials and bath toys.	
Grade 2	<p><i>Students will be able to:</i></p> <ul style="list-style-type: none">• Describe the location in the water of the building materials and bath toys relative to other building materials and bath toys.• Describe how gravity affects objects in water.	

Activity: Build a Bath Toy



Suggested Materials

- Foam pieces
- Sponge pieces
- Plastic spoons
- Craft sticks
- Pipe cleaners
- Clean recyclables, i.e. small water bottles, yogurt containers, plastic lids, paper/plastic cups
- Aluminum foil
- Plastic straws
- Rubber bands
- Binder clips
- Clothes pins
- Natural materials, i.e. seashells, twigs, pinecones
- Soap pieces and/or soap bars
- Erasers

Note: Be sure to select materials that represent a balanced combination of items that sink and items that float.

Materials Necessary for Testing

- *My Design* worksheet
- Large container filled with water (This can be per pair, group or table of students.)

Introduction

1. Read *The Pigeon Needs a Bath!* by Mo Willems.
2. Have a discussion with students to review what happened in the story.
 - *What are some ways that we know Pigeon needs a bath?*
 - *Why do you think Pigeon wants to stay out of the bath?*
 - *What happened when Pigeon finally got into the bath?*
 - *What do you like the most about taking a bath?*

Activity: Build a Bath Toy

3. Introduce the engineering challenge that relates to the story with the following prompt: *Momma Pigeon needs our help to convince Pigeon to take a bath. Can you build a bath toy to get him excited to take a bath?*

Materials Exploration and Design

1. Introduce the materials available for building and allow students to explore the different properties. Have students make predictions about the available materials and sort them into what they think will sink or float. Students should gently place the materials they are testing into the containers of water on their tables and share their observations with other students.

For Grade 2:

- *If your object floats, what force is pushing or holding the object up at the surface of the water?*
 - *If your object sinks, what force is pulling the object down to the bottom of the container?*
2. Inform students that they will be using these objects to build their bath toys to encourage Pigeon to take a bath. Tell students they will get to decide whether they want their bath toy to sink or float.
 3. Allow students time to build their toys. Have students think about the types of bath toys they might have at home as they begin designing.
 - *What kind of toys do you like to take into the bath?*
 - *Do your favorite bath toys sink or float? Why do you think they sink or float?*
 - *Why are those toys your favorite?*

Test and Reiterate

1. Once students have completed their bath toy, have them test their toys in the containers of water on the tables.
2. Have students observe each other's bath toys and describe the position of the bath toys in the water. *Are they sinking to the bottom, floating at the surface, or somewhere in the middle?*
3. Discuss with students what changes they might make to their toys. If time permits, allow students to make the changes and test again.

Activity: Build a Bath Toy

4. Have students draw, describe and label their bath toy on the *My Design* worksheet.

Extensions:

- Have students rewrite the end of the story to show how their bath toy helped motivate Pigeon to take a bath.
- Have students write a new story describing the adventures of their new bath toy with new characters.
- Have students write a step-by-step description of how they came up with their toy idea, designed it, tested it, and modified it.
- Assign students different animals to create bath toys for. Then, have them write about why this toy will work for that specific animal.
- Have students write a persuasive letter to convince Pigeon to use the bath toy that they created.

What's Happening?

One of the many properties of any object is buoyancy, or the ability of an object to sink or to float. Combining objects that sink and float together to create something like the bath toy in this activity will have an effect on the buoyancy of the whole object.

Buoyancy is the upward force on an object that is produced by the liquid or gas surrounding that object, like water. When the downward force of gravity is stronger than the upward force of the water, an object in that water will sink. When the upward force of water is stronger than the downward force of gravity, an object in that water will float.

Build A Bath Toy Standards Alignment

Grade	NYC Scope & Sequence Standards	Common Core Standards	NGSS Science & Engineering Practices	Disciplinary Core Ideas	NGSS Cross Cutting Concepts
Kindergarten	Unit 2: Exploring Properties 3.1b, 3.1c, 3.1e, 3.1g, 3.1f	RI.K.1, RI.K.2, RI.K.7, RI.K.10, MP.2, K.MD.A.1, K.MD.A.2	Engineering Design: K-2-ETS1-1, K-2-ETS1-2, K-2-ETS1-3	Defining & Delimiting Engineering Problems: ETS1.A Developing Possible Solutions: ETS1.B Optimizing the Design Solution: ETS1.C	Structure & Function: K-2-ETS1-2
Grade 1	Unit 2: Properties of Matter 3.2c, 3.1c, 3.1e, 3.1f, 3.1g	RI.1.1, RI.1.2, RI.1.10, L.1.5.A, SL.1.1, MP.2, MP.5	Engineering Design: K-2-ETS1-1, K-2-ETS1-2, K-2-ETS1-3	Defining & Delimiting Engineering Problems: ETS1.A Developing Possible Solutions: ETS1.B Optimizing the Design Solution: ETS1.C	Structure & Function: K-2-ETS1-2
Grade 2	Unit 2: Forces and Motion 5.1a, 5.1c, 5.2a	RI.2.7, W.2.8, SL.2.1, MP.2, MP.4, MP.5	Matter & Its Interactions: 2-PS1-1, 2-PS1-2, 2-PS1-3 Engineering Design: K-2-ETS1-1, K-2-ETS1-2, K-2-ETS1-3	Structure & Properties of Matter: 2-PS1-1, 2-PS1-2, 2-PS1-3 Defining & Delimiting Engineering Problems: ETS1.A Developing Possible Solutions: ETS1.B Optimizing the Design Solution: ETS1.C	Patterns: 2-PS1.1 Cause & Effect: 2-PS1-4, 2-PS1-2 Energy & Matter: 2-PS1-3 Influence of Engineering, Technology and Science, on Society and the Natural World: 2-PS1-2 Structure & Function: K-2-ETS1-2

Activity: Winding Water Pipelines

Grades: Kindergarten – Grade 2

Objective:

After reading the book *All the Water in the World* by George Ella Lyon, students will design and make a pipe system to carry water throughout their town. They will test their design by releasing a marble to represent the water into their system, and observing if the water reaches all of the designated areas in their system. Students will explore gravity, the forces of motion, and systems thinking as they design a model of a water system to bring the “water” into the locations in their town.

Grade	Learning Objectives	Key Vocabulary
Grade 2	<p><i>Students will be able to:</i></p> <ul style="list-style-type: none">• Describe the effects of forces (push and pull) on their design.• Explore the effect of gravity on different materials and apply this knowledge to their design.• Investigate how a system is dependent on its parts to be successful.• Explore and go through each step of the design process.	<p><i>Water Source</i></p> <p><i>System</i></p> <p><i>Flow</i></p> <p><i>Leak</i></p> <p><i>Push</i></p> <p><i>Pull</i></p> <p><i>Gravity</i></p>



Activity: Winding Water Pipelines



Materials

- *My Design* worksheet
- Tri-fold cardboard (to act as panel for attaching “pipes”)
- Paper towel tubes (some cut in half to represent “pipes”)
- Toilet paper tubes (some cut in half to represent “pipes”)
- Tape
- Plastic spoons
- Cups
- Rubber bands
- Cardstock paper/chipboard paper

Materials Necessary for Testing

- Marbles, table tennis balls or small rubber balls, etc. (to represent water)

Introduction

1. Read *All of the Water in the World* by George Ella Lyon.
2. Have a discussion with students to review what happened in the story.
 - *How do we get water into our homes?*
 - *Where does the water travel throughout the story?*
 - *Describe how the water flows through the pipes. (right, left, up, down, etc.)*
3. Introduce the engineering challenge that relates to the story with the following prompt: *Water is constantly flowing around us through pipe systems to get into our homes and school. It’s your turn to be a city engineer and design a pipe system to carry the water from the reservoir to all of the people in the city. Make sure that the water travels to three different places on your map.*

Materials Exploration and Design

1. Introduce the materials available for building and allow students to explore the different properties (weights, durability, etc.).
 - *Which ball will you use to represent the water?*
 - *Which direction do you want the ball to “flow” in?*
 - *How will you get the system to change directions?*

Activity: Winding Water Pipelines

2. As a class, decide on three different locations around your school that they would like to represent in their water pipe systems (park, library, etc.). These three locations will serve as “checkpoints” that should be marked on the tri-fold with the aim of having the pipe system connect them together. The “water” must be able to flow through each checkpoint in your system before it reaches the endpoint of the school.
3. Have students start designing their pipe system using the materials. Make sure that the three checkpoints are spread out on the tri-fold and conducive to the downward movement of the water. Providing guiding questions such as:
 - *Where/how will you place the locations within your pipe system?*
 - *How will you connect the different locations?*
 - *How will you place the materials so that the water will flow from the top to the bottom?*

Test and Reiterate

1. Once students have completed their pipe system, have them test their design by releasing a ball at the beginning or “reservoir.” They can test the success of their system by observing if it reaches and flows through each location or “checkpoint.”
2. Discuss with students what they could change to improve their system. If time permits, encourage them to make modifications and then test again.
3. Have students draw, label and describe their pipe system on the *My Design* worksheet.

Activity: Winding Water Pipelines

Extensions

- Have students imagine that they were a single drop of water and write about where they would travel throughout the day.
- Identify all of the words that describe the ways in which water flows throughout the book (wobbles, cascades, meandered, swirls, stampede, etc.). Students can act out the different words to describe and discuss their different meanings. Post the words around the classroom for inspiration for their water systems.
- Why is water important? Brainstorm all of the ways in which we depend on water in our daily lives. Students can write about why water is important to their family.
- Have students release multiple marbles into the pipe system to create a “flow,” and ask them to notice how this overflow effects their system. Students can write about how to make their pipe system more efficient when real life issues like flooding and heavy rainstorms occur.
- Have teams work together to try and brainstorm a way to connect their systems to create a larger system.

What’s Happening?

Force is a push or pull on an object that changes the object’s position or direction of motion. Different forces have different effects on Earth’s surface including our water supplies. Gravity is the main force that helps us manipulate the flow of water into our towns and homes. A watershed is the land that water flows through and it acts like a funnel to direct water from sources like rivers and bays all over Earth’s surface. Most watersheds exist at higher elevation to allow gravity to support the flow wherever it needs to go.

Winding Water Pipeline Standards Alignment

Grade	NYC Scope & Sequence Standards	Common Core Standards	NGSS Science & Engineering Practices	Disciplinary Core Ideas	NGSS Cross Cutting Concepts
Grade 2	Unit 2 – Forces and Motion 5.1, 5.1a, 5.1b, 5.1c,	RI.1, RI.2, RI.4, RI.6, RI.7, RI.10	Matter & Its Interactions: 2-PS1-1, 2-PS1-2, Engineering Design: K-2-ETS1-1, K-2-ETS1-2, K-2-ETS1-3	Structure & Properties of Matter: PS1.A Defining & Delimiting Engineering Problems: ETS1.A Developing Possible Solutions: ETS1.B Optimizing the Design Solution: ETS1.C	Structure & Function: K-2-ETS1-2 Patterns, Cause & Effect: 2-PS1-2, K-2-ETS1-2



Activity: Scratch That Itch!

Grade: 1

Objective:

After reading the book *Big Smelly Bear* by Britta Teckentrup, students will explore the properties of a variety of materials and design a scratching device to help Smelly Bear reach the itch in the center of his back. Students will test their design on their own back and compare its effectiveness to the other scratching device designs. Students will explore the materials they will recognize how matter has various properties that can be observed, identified and described by using their senses.

Grade	Learning Objectives	Key Vocabulary
Grade 1	<p><i>Students will be able to:</i></p> <ul style="list-style-type: none">• Explore the properties of everyday materials.• Practice using nonstandard units of measurement.• Compare and contrast textures using their senses.• Explore and go through each step of the design process.	<p><i>Properties</i></p> <p><i>Five Senses</i></p> <p><i>Texture</i></p> <p><i>Hard</i></p> <p><i>Soft</i></p> <p><i>Rough</i></p> <p><i>Smooth</i></p> <p><i>Length</i></p> <p><i>Measure</i></p> <p><i>Scratch</i></p> <p><i>Support</i></p>

Activity: Scratch That Itch!

Materials:

- *My Design* worksheet
- Stickers
- Masking tape
- Scrap cardboard
- Paper towel rolls (cut into smaller pieces and halved)
- Sand paper
- Pipe cleaners
- Popsicle sticks
- Extra wide straws
- Bind-it Flags™ binder clips (available at www.staples.com)
- Rubber bands
- Bubble wrap
- Index cards
- Toothbrushes
- Sponges

Introduction

1. Read *Smelly Bear* by Britta Teckentrup.
2. Have a discussion with students to review what happened in the story.
 - *What was the problem that Smelly Bear faced?*
 - *What were the ways that Smelly Bear tried to scratch his itch in the story?*
 - *How could Smelly Bear scratch his itch if Big Fluffy Bear was not there?*
3. Introduce the engineering challenge that relates to the story with the following prompt: *Big Smelly Bear has not bathed in days and now has a new pesky itch on the center of his back that he cannot reach to scratch. His friend, Big Fluffy Bear, is not around to help him. Can you invent a scratching device for Smelly Bear to use to reach the center of his back?*



Activity: Scratch That Itch!

Materials Exploration and Design

1. Introduce the materials available for building and engage students in discussions on the different properties of each material (texture, lengths, etc.)
 - *Which materials could be used to reach around to the center of your back?*
 - *Which materials have a texture that could scratch an itch?*
2. Inform students that they will be testing their scratching devices on their back. Have them decide on a location for the itch and have a classmate help place a sticker on their backs to represent the target or location of the itch. Encourage students to think about which materials will be sturdy enough or how to make it sturdy enough to reach the center of their back and which textures will work best to alleviate the itch.
3. Have students start designing and building their scratching device using the materials. Provide guiding questions such as:
 - *Have you ever had an itch that you couldn't reach? How did you try to scratch it?*
 - *Test some of the materials on your hands, which creates a better "scratch?"*
 - *Which of the materials will be long enough to reach the itch?*
 - *Which of the materials will be sturdy enough to go all the way around to the spot?*
 - *Which of the materials will be rough enough to scratch the itch?*

Test and Reiterate

1. Once students have completed their scratching device, have them test their design with a partner to see if the device (a) reaches the location that they decided on and (b) is coarse enough to scratch/alleviate an itch. Students are encouraged to test their scratching device on their arm or hands if they cannot reach their backs.
2. Discuss with students what they could change to improve their scratching device. If time permits, encourage them to make modifications and then test again.
3. Have students draw, label and describe their scratcher on the *My Design* worksheet.

Activity: Scratch That Itch!

Extensions

- Students can tally and graph the total number of “scratches” the device must make in order to alleviate the itch.
- Instead of designating a spot to scratch on your back, assign specific criteria that the device needs to meet for length, width and weight.
- Similar to how students used everyday materials to create a new tool, have them brainstorm other tools that they can create using the same or other materials. Students can write about how to use their newly designed tool.
- Have students take turns describing their designs to a partner using only their senses. The partner can draw a sketch of the design based on the description given by the designer.

What’s Happening?

All matter has properties that can be observed and described through the five senses. We can make observations based on sight, hearing, smell, taste and touch. Observations can be made and/or measured on an object’s mass, texture, shape, flexibility, width and length. While these features often determine the function of an object, we can usually maneuver an object in a new way to change its function (i.e. a spoon can be used as a shovel, paper can be folded into a box). Engineers are people who design and build products, systems and structures. Using your five senses to observe and analyze properties can help us design better products, functional systems and stronger structures.

Scratch That Itch Standards Alignment

Grade	NYC Scope & Sequence Standards	Common Core Standards	NGSS Science & Engineering Practices	Disciplinary Core Ideas	NGSS Cross Cutting Concepts
Grade 1	<p>Unit 2 – Exploring Properties PS 3.1b, 3.1c, 3.1d, 3.1g, 3.1f</p> <p>Unit 3 – Animals 3.1a, 5.2e, 5.2f</p>	RI.K.1, RI.K.2, RI.K.4, RI.K.7, RI.K.10, SL.K.5, SL.K.6, MP.2, MP.4, K.MD.A.1, K.MD.A.2, K.CC	<p>Motion and Stability: Forces and Interactions: K-PS2-1, K-PS2-2</p>	<p>Forces & Motion: PS2.A</p> <p>Types of Interactions: PS2.B</p> <p>Defining Engineering Problems: ETS1.A</p>	<p>Cause and Effect: K-PS2-1, K-PS2-2</p>



Activity: Strong and Sturdy Shelters

Grades: 1 – 2

Objective:

After reading the book *Storm is Coming* by Heather Tekavec, students will build a shelter to keep the barn animals safe from the storm. They will test their design by simulating different weather conditions and observing if their structure protects the animals inside. Students will explore force and motion and accurately describe different weather changes and conditions as they test their design.

Grade	Learning Objectives	Key Vocabulary
Grade 1	<p><i>Students will be able to:</i></p> <ul style="list-style-type: none">• Learn about different safety precautions to take during severe weather conditions.• Discover the effect wind has on objects and apply this knowledge to explore ways to anchor their designs.• Practice using weather terminology.	<p><i>Weather</i></p> <p><i>Wind</i></p> <p><i>Storm</i></p> <p><i>Thunder</i></p> <p><i>Structure</i></p> <p><i>Safety</i></p> <p><i>Shelter</i></p>
Grade 2	<p><i>Students will be able to:</i></p> <ul style="list-style-type: none">• Describe the effects of forces (push and pull) on their design.• Explore and go through each step of the design process.• Practice addition and subtraction by staying within a budget given to make their design.	<p><i>Roof</i></p> <p><i>Door</i></p> <p><i>Floor</i></p> <p><i>Support</i></p>

Activity: Strong and Sturdy Shelters

Materials

- *My Design* worksheet
- Popsicle or craft sticks
- Pipe cleaners
- Clothespins
- Paper clips
- Binder clips
- Index cards
- Cardstock
- Wax paper
- Any other classroom materials suitable for building
- Budget worksheet (for Grade 2 math extension), included at end of activity



Materials Necessary for Testing

- Hair dryer or fan (to simulate wind)
- Spray bottles with water (to simulate rain)
- Animal counters or small animal figures

Introduction

1. Read *Storm is Coming*, by Heather Tekavec.
2. Have a discussion with students to review what happened in the story.
 - *What types of weather did the animals face in the story?*
 - *How do we protect ourselves from the wind, rain, and thunder?*
 - *Where would you seek shelter during a storm like the one we read about in the story?*
 - *How did the different animals react to the different types of weather in the story?*
3. Introduce the engineering challenge that relates to the story with the following prompt: *The storm was stronger than the farmer and animals expected. Can you help the farmer build a stronger shelter to protect the animals from the next storm?*

Activity: Strong and Sturdy Shelters

Materials Exploration and Design

1. Introduce the materials available for building and allow students to explore the different properties (weights, durability, etc.).
 - *Which materials could protect your shelter in the rain?*
 - *Which materials could protect your shelter from the wind?*

For Grade 2:

- *Think about the weather we will be testing. Are these forces pushing on the shelter or pulling on the shelter?*
 - *How can you secure your shelter from a pushing force?*
 - *How can you secure your shelter from a pulling force?*
2. Inform students that they will be using a spray bottle to simulate rain and a hair dryer to simulate wind to test their shelter once it is built. Encourage students to think about which materials will best withstand these different tests.
 3. Have students start designing and building their shelter using the materials. Provide guiding questions such as:
 - *Think about the different animals in the story. What can you include in your shelter to protect each of their different needs?*
 - *What features are you adding to protect the animals?*
 - *How many animals can you fit inside?*
 - *Which of the materials can you use to support the walls?*

Test and Reiterate

1. Once students have completed their shelter, have them test their design with the spray bottle and hair dryer. They can also test the number of animals that fit in their shelter by placing the animal counters inside.
2. Discuss with students what they could change to improve their shelter. If time permits, encourage them to make modifications and then test again.
3. Have students draw, describe and label their shelter on the *My Design* worksheet.

Activity: Strong and Sturdy Shelters

Grade 2 Math Extension

1. Before students get started designing their shelters, inform students that the farmer has a \$20 budget for materials. Hand out the budget worksheet and explain how to keep track of the money that they are spending by using the budget worksheet.
2. Ensure that students are checking off and tracking each material they are adding to their shelter, especially if they are using more than one of each material.
3. As they test and revise their shelters, students should be encouraged to review their total dollar amount spent and make the appropriate mathematical revisions to reflect modifications to their shelters.

What's Happening?

Weather is the condition of the outside air at a particular moment. Weather can be described and measured by temperature, wind speed and direction, amount of rain, snow or other precipitation, and general sky conditions (cloudy, sunny, partly cloudy).

Force is a push or pull on an object that changes the object's position or direction of motion. A pushing force occurs when you press upon or against another object. A pulling force occurs when you draw or haul an object toward yourself. Different weather conditions have different effects on Earth's surface, resulting in different types of forces that can push or pull on an object.

Thunder is the explosive sound wave resulting from the extreme heat generated by a lightning flash. Wind is a stream of air that moves across earth's surface. Rain occurs when the water vapor from Earth's surface becomes too heavy to be held in the clouds and it is released as liquid droplets. When these forces occur simultaneously, it is called a storm.

Strong and Sturdy Shelters Budget Worksheet

Choose Materials to Build With:

- \$2: Popsicle Sticks
- \$1: Index Cards
- \$1: Pipe Cleaners
- \$2: Binder Clips
- \$1: Cardstock
- \$__: _____
- \$__: _____
- \$__: _____
- \$__: _____
- \$__: _____
- \$__: _____

Example:

\$1 per Material 1 + 1 + 1 + 1 + 1 =	\$5
+	
\$2 per Material 2 + 2 + 2 + 2 + 2 =	\$10
Total	\$15

Add It Up!

- \$2 per Popsicle Stick _____ = \$ _____
- \$1 per Index Card _____ = \$ _____
- \$1 per Pipe Cleaner _____ = \$ _____
- \$2 per Binder Clip _____ = \$ _____
- \$1 per Cardstock _____ = \$ _____
- \$5 per Binder Clip _____ = \$ _____
- \$ _____ = \$ _____
- \$ _____ = \$ _____
- \$ _____ = \$ _____
- \$ _____ = \$ _____
- \$ _____ = \$ _____

Did you spend more than \$20?

Total = \$ _____

Strong and Sturdy Shelters Standards Alignment

Grade	NYC Scope & Sequence Standards	Common Core Standards	NGSS Science & Engineering Practices	Disciplinary Core Ideas	NGSS Cross Cutting Concepts
Grade 1	<p>Unit 1 – Animal Diversity LE 3.1a, LE 1.1a</p> <p>Unit 3- Weather and Seasons PS 1.1a</p>	RI.1.1, RI.1.2, RI.1.6, RI 1.7, L1.5.B, SL.1.1, MP.2	<p>Waves & Their Applications in Technology for Information Transfer: 1-PS4-1, 1-PS4-2, 1-PS4-3, 1-PS4-4</p> <p>Engineering Design: K-2-ETS1-1, K-2-ETS1-2, K-2-ETS1-3</p> <p>From Molecules to Organisms: Structures & Processes: 1-LS1-1, 1-LS1-2</p> <p>Earth’s Place in the Universe: 1-ESS1-1, 1-ESS1-2</p>	<p>Wave Properties: PS4.A</p> <p>Structure & Function: K-2-ETS1-1, K-2-ETS1-2, K-2-ETS1-3</p>	<p>Cause and Effect: 1-PS4-1, 1-PS4-2, 1-PS4-3</p> <p>Patterns: 1-LS1-2, ESS1-1, 1-ESS1-2</p> <p>Structure & Function: 1-LS1-1, K-2-ETS1-2</p>
Grade 2	<p>Unit 2 – Force and Motion PS 5.1a, PS 5.1, PS 5.1c</p>	W.2.8, SL.2.1, L.2.3, MP.2, MP.4	<p>Matter & Its Interactions: 2-PS1-2</p> <p>Ecosystems: Interactions, Energy & Dynamics: 2-LS2-2, 2-LS2-1</p> <p>Earth’s Systems: 2-ESS-1, 2-ESS-2</p> <p>Engineering Design: K-2-ETS-1, K-2-ETS-2, K-2-ETS-3</p>	<p>Structure & Properties of Matter: 2-PS1-2, 2-PS1-3</p> <p>Developing Possible Solutions: 2-LS2-2</p> <p>Structure & Function: K-2-ETS1-1, K-2-ETS1-2, K-2-ETS1-3</p>	<p>Cause & Effect: 2-PS1-4, 2-PS1-3, 2-LS2-1, 2-LS2-2</p> <p>Structure & Function: 1-LS2-2, K-2-ETS1-2</p>

Activity: Magnificent Riders

Grade: 2

Objective:

After reading the book *The Most Magnificent Thing* by Ashley Spires, students will build a vehicle to transport the characters down a ramp. They will test their design by determining if the characters fit and remain inside the vehicle and whether it will move down the ramp. Students will explore force and motion and the effect of weight distribution within a vehicle.

Grade	Learning Objectives	Key Vocabulary
Grade 2	<p><i>Students will be able to:</i></p> <ul style="list-style-type: none">• Explore the effect a ramp has on different materials and apply this knowledge to secure their design.• Practice using standard units of measurement.• Describe the effects of forces (push and pull) on their design.• Explore and go through each step of the design process.	<p><i>Imagination</i></p> <p><i>Perseverance</i></p> <p><i>Inventor</i></p> <p><i>Tinker</i></p> <p><i>Design</i></p> <p><i>Test</i></p> <p><i>Gravity</i></p> <p><i>Ramp</i></p>

Activity: Magnificent Riders

Materials:

- *My Design* worksheet
- Rubber bands
- Paper clips
- Cardboard
- Mini skateboards ($\frac{1}{2}$ inch x $1\frac{7}{8}$ inch x $\frac{1}{2}$ available from (www.orientaltrading.com))

Materials Necessary for Testing:

- Ramps
- Measuring tools (ruler, tape, etc.)

Introduction

1. Read *The Most Magnificent Thing* by Ashley Spires.
2. Have a discussion with students to review what happened in the story.
 - *How did the girl get started on making her magnificent thing?*
 - *What steps did she take before she got to the final product?*
 - *How does the girl feel when she cannot get the magnificent thing to work?*
 - *What helps the girl get back on track to making her magnificent thing?*
3. Introduce the engineering challenge that relates to the story with the following prompt: *The girl needs help designing a vehicle for her and the dog to ride together. Can you help the girl build a vehicle to fit both her and the dog that can carry them down a ramp? The vehicle must travel 10 inches off of the ramp with both riders safely inside.*

Materials Exploration and Design

1. Introduce the materials available for building and allow students to explore the different properties (weights, size, etc.). Assist students in examining the properties of the skateboards and explain how they will serve as a base for the vehicle that they design.
 - *Which materials can be redesigned or joined together to make a vehicle that can securely fit both the girl and her dog?*
 - *Which materials could propel your vehicle at least 10 inches off of the ramp?*



Activity: Magnificent Riders

2. Inform students that they will be testing their vehicle on the ramp once it is built. Using a ruler and tape, measure 10 inches off of the ramp, having the students count along to get to 10. Encourage students to think about the different angles of the ramps and the size that their vehicle must be to fit both riders.
3. Have students start designing and building their vehicle using the materials. Provide guiding questions such as:
 - *What causes objects to move?*
 - *How can you secure the riders inside the vehicle?*
 - *What will cause the vehicle to travel 10 more inches off of the ramp?*

Test and Reiterate

1. Once students have completed their vehicle, have them test their design on the ramp. Remind them that both riders must remain inside their vehicle and it must travel at least 10 inches off of the ramp.
2. Discuss with students what they could change to improve their vehicle. If time permits, encourage them to make modifications and then test again.
3. Have students draw, label and describe their vehicle on the *My Design* worksheet.



Activity: Magnificent Riders

Extensions

- Brainstorm a list of synonyms for the word “magnificent.” Examples: brilliant, fantastic, marvelous, super, etc. Post in the classroom for visual reminders when writing to use a variety of adjectives.
- Have students think about a problem that they have that could be solved by designing a magnificent thing. Students with similar ideas can work together to create a new product that could help them in real life.
- Students can measure and record the distances of their vehicle during the testing phase to help them compare their designs and make adjustments to improve distance.
- As a class, create a chart to measure the distances traveled by the vehicles to keep track of the total distance the students have covered. This can be used to compare and contrast with distances they are familiar with. (i.e. the height of a student, length of the classroom, distance to the main office, etc.)

What’s Happening?

Force is a push or pull on an object that changes the object’s position or direction of motion. A pushing force occurs when you press upon or against another object. A pulling force occurs when you draw or haul an object toward yourself.

Energy and matter interact through forces that result in changes in motion. Exploring the observable effects of the force of gravity may help a student’s understanding of the reason for the direction of an object's motion. Students can explore the relationship between forces and motion on simple machines to gather evidence in order to describe patterns, causes and effects.

Magnificent Riders Standards Alignment

Grade	NYC Scope & Sequence Standards	Common Core Standards	NGSS Science & Engineering Practices	Disciplinary Core Ideas	NGSS Cross Cutting Concepts
Grade 2	Unit 2 – Forces & Motion 5.1a, 5.1, 5.1b, 5.1c	RI.2.7, W.2.2, W.2.8, SL.2.1, L.2.3, L.2.4, MP.2, MP.4, MP.5	Matter & It's Interactions: 2-PS1-1, 2-PS1-2, Engineering Design: K-2-ETS1-1, K-2-ETS1-2, K-2-ETS1-3	Structure & Properties of Matter: PS1.A Defining & Delimiting Engineering Problems: ETS1.A Developing Possible Solutions: ETS1.B Optimizing the Design Solution: ETS1.C	Patterns, Cause & Effect: 2-PS1-2, K-2-ETS1-2



Activity: The Great Fish Rescue

Grades: 1 – 2

Objective:

After reading the storybook *I Can Save the Ocean* by Alison Inches, students will build a flotation device that will maintain the fish close to the surface of the water. They will test their design by determining that the fish is near the surface while still touching the water. Students will investigate density, displacement and buoyancy, while exploring properties of materials to design a device to make a weighted plastic fish float just at the surface of water.

Grade	Learning Objectives	Key Vocabulary
Grade 1	<i>Students will be able to:</i> <ul style="list-style-type: none">• Learn about ocean pollution and possible solutions.• Discover the effect of weight on an object's buoyancy.• Explore the different properties of water.	<i>Sink</i> <i>Float</i> <i>Buoyancy</i> <i>Density</i> <i>Displacement</i>
Grade 2	<i>Students will be able to:</i> <ul style="list-style-type: none">• Describe the effects of pollution on ocean life.• Explore and go through each step of the design process.• Investigate how an object's composition indicates its function.	<i>Surface</i> <i>Pollution</i>

Activity: The Great Fish Rescue



Suggested Materials

- Foam pieces
- Sponge pieces
- Plastic spoons
- Craft sticks
- Pipe cleaners
- Clean recyclables, i.e. small water bottles, yogurt containers, plastic lids, paper/plastic cups
- Aluminum foil
- Plastic straws
- Rubber bands
- Binder clips
- Clothes pins
- Natural materials, i.e. seashells, twigs, pinecones
- Soap pieces and/or soap bars
- Erasers

Note: Be sure to select materials that represent a balanced combination of items that sink and items that float.

Materials Necessary for Testing

- *My Design* worksheet
- Large container filled with water (This can be per pair, group or table of students.)
- Plastic Fish Counters (available from www.amazon.com)

Introduction

1. Read *I Can Save the Ocean*, by Alison Inches.
2. Have a discussion with the students to review what happened in the story.
 - *What are some of the things that Max saw in the ocean?*
 - *Have you ever seen trash on the beach or in the ocean?*
 - *Why is pollution dangerous to the ocean animals?*
 - *What happens to the water when there is pollution in the ocean?*
 - *What are some ways that we can stop pollution from getting into the ocean?*

Activity: The Great Fish Rescue

3. Introduce the engineering challenge that relates to the story with the following prompt: *While Max is out at sea cleaning up the pollution, Max meets Maria and Jose — marine biologists that just found an injured fish and need to take it to their boat for medical attention. Design a device to help the fish float near the surface of the water until the rescue boat arrives. Since fish need to breathe in the water, make sure the fish is always touching the water!*

Materials Exploration and Design

1. Introduce the materials available for building and allow the students to explore the different properties (buoyancy, weight, flexibility, etc.).
2. Inform students that in order for their device to be successful, the fish has to be floating at the surface of the water while still touching the water.
3. Have students start designing and building their flotation device using the materials. Provide guiding questions such as:
 - *Which materials will allow the fish to float?*
 - *How can you make sure that the fish is still touching the water?*
 - *What features are you adding to your flotation device to secure the weight of the fish?*

Test and Reiterate

1. Once the students have completed their design, have them test if it is successful by placing it in the water. A successful design will float and keep the fish touching the water.
2. Discuss with students what they could change to improve their flotation device. If time permits, encourage them to make modifications and then test again.
3. Have students draw, label and describe their flotation device on the *My Design* worksheet.

Activity: The Great Fish Rescue

Extension

- Read the book *Polluted Oceans* by Ellen Lawrence to compare and contrast fiction and nonfiction text features.
- Have students identify and define new science vocabulary from the nonfiction book.
- Have students create a poster to promote “Cleaning Pollution” efforts.
- Have students research/read about local efforts to minimize and address pollution issues and develop a plan on how they can help their community.
- Have students write a persuasive essay to convince a friend why pollution is bad for the oceans.

What’s Happening?

There are various factors that can influence whether an object will sink or float, including shape, size, weight, etc. Objects with hollow spaces, such as boats and canoes, can float even though they're big and heavy.

Displacement explains why objects sink or float. Displacement occurs when you place something in a fluid, or any substance that flows, and it moves the fluid out of its way. You can watch displacement at work when you drop an object in a cup of water and the water level rises. The object pushes the water out of its way, making the water rise. An object will sink if it weighs more than the water it displaces, and an object will float if it weighs less than the water it displaces.

Shape can also help an object float. A ball of clay will sink, but a canoe shape made from the same amount of clay can float because it pushes more fluid out of its way in relation to its weight. The amount of air inside of an object can also help it float. Boats can float despite the heavy and dense materials used to build them because of the large amount of air inside the hull. Hollow objects, such as table tennis balls or an empty plastic bottle, are able to float better than solid objects like baseballs or filled water bottles.

The Great Fish Rescue Standards Alignment

Grade	NYC Scope & Sequence Standards	Common Core Standards	NGSS Science & Engineering Practices	Disciplinary Core Ideas	NGSS Cross Cutting Concepts
Grade 1	Unit 2 – Properties of Matter: 3.2a, 3.2c, 3.1e, 3.1f, 3.1c, 3.1d, 3.1g	RI.1.1, RI.1.2, RI.1.4, RI.1.7, RI.1.10, L.1.4, SL.1.1, SL.1.2, SL.1.3	From Molecules to Organisms: Structures and Processes: 1-LS1 Engineering Design: K-2-ETS1-1, K-2-ETS1-2, K-2-ETS1-3	Structure & Function: LS1.A Defining & Delimiting Engineering Problems: ETS1.A Developing Possible Solutions: ETS1.B Optimizing the Design Solution: ETS1.C	Structure & Functions: 1-LS1-1, K-2-ETS1-1-2 Influence of Science, Engineering and Technology on Society and the Natural World: 1-LS1-1
Grade 2	Unit 1 – Earth Materials: 3.1c, 3.1d, 3.1e, 3.1f, 3.1g	RI.2.3, RI.2.4, RI.2.10, SL.2.1, SL.2.3, L.2.3, L.2.4	Matter and Its Interactions: 2-PS1-1, 2-PS1-2, 2-PS1-3 Engineering Design: K-2-ETS1-1, K-2-ETS1-2, K-2-ETS1-3	Structure & Properties of Matter: PS1.A Defining & Delimiting Engineering Problems: ETS1.A Developing Possible Solutions: ETS1.B Optimizing the Design Solution: ETS1.C	Cause & Effect: 2-PS1-4, 2-PS1-2 Energy & Matter: 2-PS1-3 Influence of Engineering, Technology and Science, on Society and the Natural World: 2-PS1-2 Structure & Functions: K-2-ETS1-1-2

Activity: Little Rocket Launchers

Grade: Kindergarten

Objective:

After reading the storybook *Roaring Rockets* by Tony Mitton and Ant Parker, students will design and build a model rocket to launch. They will test their design by simulating a rocket launch and trying to hit designated targets. Students will explore force and motion and accurately describe the characteristics and functions of rockets as they test their design.

Grade	Learning Objectives	Key Vocabulary
Kindergarten	<p><i>Students will be able to:</i></p> <ul style="list-style-type: none">• Explore the properties and effect of a push force on various materials.• Describe the characteristics and function of rockets.• Practice scientific inquiry through questioning, making predictions, observations, recording, interpreting data and communicating results.• Apply the content learned to design, make and launch air rockets.	<p>Rocket</p> <p>Body</p> <p>Nose Cone</p> <p>Fins</p> <p>Launch</p> <p>Force</p> <p>Motion</p> <p>Design</p> <p>Predict</p> <p>Test</p> <p>Astronaut</p>

Activity: Little Rocket Launchers



Materials

- *My Design* worksheet
- Tissue paper
- Aluminum foil
- ½ inch by 6 foot pipe wrap foam insulation pre-cut into 6-inch pieces (Available at Home Depot, Lowe's or other home improvement stores.)
- Scissors
- Tape
- Materials to decorate (stickers, color tape, etc.)
- Construction paper (pre-cut into triangles)
- Laminated image of any planet

Materials Necessary for Testing:

- Stomp Rocket Launcher from Stomp Rocket Ultra kit (available at www.amazon.com)

Introduction

1. Read *Roaring Rockets*, by Tony Mitton and Ant Parker.
2. Have a discussion with the students to review what happened in the story.
 - *What are the different parts of a rocket?*
 - *Who is inside of the rocket?*
 - *Can a rocket move by itself?*
 - *What helps the rockets get into space?*
3. Introduce the engineering challenge that relates to the story with the following prompt: *You and the animal astronauts want to go up in space to visit a new planet, but you need a new rocket. Can you design a model rocket that can launch you and the animals far into space?*

Activity: Little Rocket Launchers

Materials Exploration and Design

1. Introduce the materials available for building and allow the students to explore the different properties (weight, flexibility, etc.). Review the different parts of a rocket and predict which material is best to use for each part.
 - *Which materials could be used as the different parts of a rocket? The rocket's body? Nose cone? Rocket fins?*
 - *Which materials could support the body of the rocket?*
 - *What are features on the rocket or the shape of the rocket that you see in the book that you think might help it launch? (Nose cone, body, fins)*
2. Inform students that they will be using a stomp rocket launcher to test their rockets once they are built. Demonstrate how the stomp rocket launcher works by placing it near a pile of lightweight objects (confetti, cotton balls, etc.) and stepping on the pump. The air pressure will cause the confetti to move in the direction of the air flow. This will allow the students to visualize how the force of air pressure will cause their rocket to move. As they are planning their design, encourage students to think about which materials will best support the rocket's distance and direction.
3. Place the image of a planet on a wall, preferably across the room. Inform students that this will be their target.
4. Have students start designing and building their rocket using the material. Provide guiding questions such as:
 - *What features are you adding to your rocket to help move it through the air?*
 - *Which materials will help your rocket launch far?*
 - *Which materials will help your rocket hit the target?*

Rocket Building Tip:

The 6-inch foam insulation piece works well as the main body of the rocket as long as the hole on one end is covered with tape, stuffed with a piece of tissue paper, or has an airtight nose cone on top. This will create the air pressure needed to launch the rocket when the stomp rocket launcher is inserted into the open end. If there are holes on the top of the rocket, it will not launch. Aluminum foil can be used to create a nose cone for the top of the rocket to secure the open end.

Activity: Little Rocket Launchers

Test and Reiterate

1. Set-up a method for measuring the distance from launching area to the target. This can be done by counting the floor tiles from where they are standing to where the rocket landed, analyzing a premeasured numeric strip of tape on the floor, and/or using tape measures/yardsticks to measure how close their rocket landed in proximity to a target.
2. Once students are ready to test their rocket, help them put their rocket into the tube and permit them to launch. Ask students to measure how far their rocket launched. Did it hit their target? Why do they think their rocket did or didn't hit its target?
3. Discuss with students what they could do to improve their rocket. If time permits, encourage them to make modifications and then test again.
4. Have students draw, label and describe their rocket on the *My Design* worksheet.

Extensions

- Have students write a creative story about their rocket's journey through space.
- Create a word wall of creative words to use in writing to represent the rocket's motion. (soared, flew, propelled, etc.)
- Have students write a step-by-step description of how they came up with their rocket idea, designed it, tested it, and modified it.
- Have students create and write about a new space animal or creature that they may find once they reach the new planet.

What's Happening?

A force is a push or a pull. In order for an object to move, it must be pushed or pulled along. Forces can make things move or change their speed. In this activity, the air pressure released from the rocket launcher is the force that pushed the model rocket. Since the air is contained in a small space, the air pressure is greater creating a stronger force or push of air that can launch the rocket further. Rocket fins help provide stability during flight so that it maintains its direction. A nose cone helps prevent air from slowing the rocket down.

Little Rocket Launchers Standards Alignment

Grade	NYC Scope & Sequence Standards	Common Core Standards	NGSS Science & Engineering Practices	Disciplinary Core Ideas	NGSS Cross Cutting Concepts
Kindergarten	Unit 2 – Exploring Properties 3.1c, 3.1d, 3.1e, 3.1f	RI.K.1, RI.K.2, RI.K.7, RI.K.10, MP.2, K.MD.A.1, K.MD.A.2	Motion & Stability: Forces & Interactions: K-PS2-1, K-PS2-2 Energy: K-PS3-1, K-PS3-2 Engineering Design: K-2-ETS1-1, K-2-ETS1-2, K-2-ETS1-3	Forces & Motion: PS2.A Types of Interactions: PS2.B Relationships Between Energy & Forces: PS3.C Defining Engineering Problems: ETS1.A	Cause & Effect: K-PS2-1, K-PS2-2, K-PS3-1, K-PS3-2 Structure & Function: K-2-ETS1-2





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