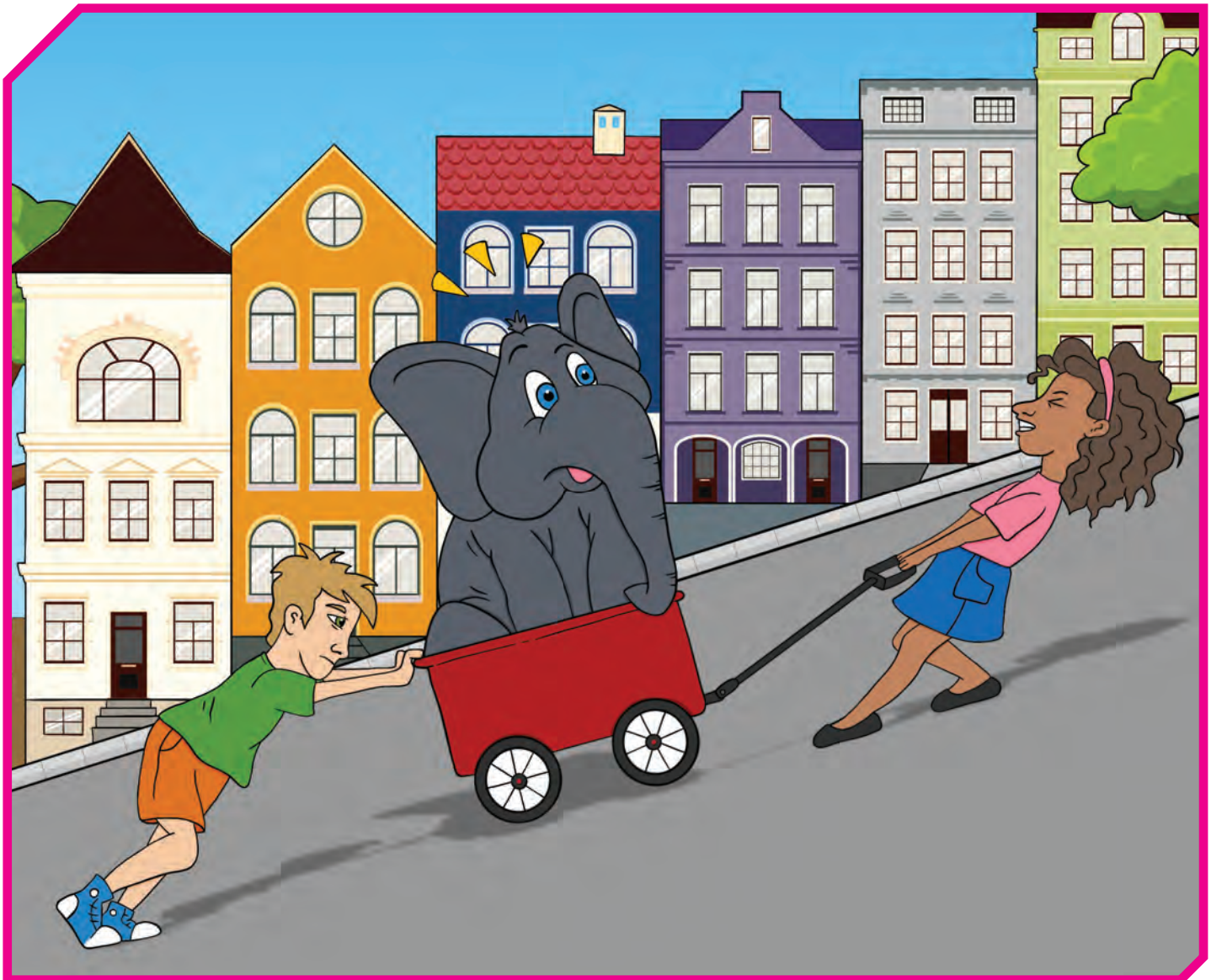
CEREAL CITY SCIENCE™ by BCAMSC

Teacher Guide and Student Journal
Sample Activity and Planning Pages

Motion: Pushes and Pulls
KPNG



SECOND EDITION

A kindergarten unit supporting Next Generation Science Standards
and Michigan Science Standards

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Motion: Pushes and Pulls KPNG

A kindergarten unit supporting **Next Generation Science Standards** and the **Michigan Science Standards** developed and written by the Battle Creek Area Mathematics and Science Center for

CEREAL CITY SCIENCE™
by BCAMSC

Motion: Pushes and Pulls

Pre-activity Informational Pages

Activities

Appendix

NEXT GENERATION SCIENCE STANDARDS

Disciplinary Core Ideas	Activities
PS2.A: Forces and Motion • Pushes and pulls can have different strengths and direction. • Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. **PS2.B: Types of Interactions** • When objects touch or collide, they push on one another and can change motion.	1,2,3,4,5,6
K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.	1,2,3,6
K-PS2-2. Analyze data to determine if a design solution works as intended to change the speed or direction of an object.	1,2,3,5,6
PS3.C: Relationship Between Energy and Forces • A bigger push or pull makes things go faster.	1,2,3,6
K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.	1,2,3,6
ETS1.A: Defining Engineering Problems • A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions.	5
K-PS2-2. Analyze data to determine if a design solution works as intended to change the speed or direction of an object.	1,2,3,5

NEXT GENERATION SCIENCE STANDARDS

Science and Engineering Practices	Activities
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. • With guidance, plan and conduct an investigation in collaboration with peers.	1,2,3,5
K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.	1,2,3,5
Analyzing and Interpreting Data Analyzing data in k-2 builds on prior experiences and progresses to collecting, recording, and sharing observations. • Analyze data from tests of an object or tool to determine if it works as intended.	1,2,3,5,6
K-PS2-2. Analyze data to determine if a design solution works as intended to change the speed or direction of an object.	1,2,3,5

NEXT GENERATION SCIENCE STANDARDS

Crosscutting Concepts	Activities
Cause and Effect • Simple tests can be designed to gather evidence to support or refute student ideas about causes.	1,2,3,5,6
K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object	1,2,3,5,6
K-PS2-2. Analyze data to determine if a design solution works as intended to change the speed or direction of an object.	1,2,3,5,6
Patterns • Patterns in the natural world and human design can be observed and used as evidence.	1,2,3,6

COMMON CORE STATE STANDARDS - READING

Reading Standards for Informational Text—Kindergarten	Activities
Key Ideas and Details	
RI.K.1 - With prompting and support, ask and answer questions about key details in a text.	1,3,6
RI.K.2 - With prompting and support, identify the main topic and retell key details of a text.	1,2,3,6
RI.K.3 - With prompting and support, describe the connection between two individuals, events, ideas, or pieces of information in a text.	2,3
Craft and Structure	
RI.K.4 - With prompting and support, ask and answer questions about unknown words in a text.	1,6
RI.K.5 - Identify the front cover, back cover, and title page of a book.	1
RI.K.6 - Name the author and illustrator of a text and define the role of each in presenting the ideas or information in a text.	
Integration of Knowledge and Ideas	
RI.K.7 - With prompting and support, describe the relationship between illustrations and the text in which they appear (e.g., what person, place, thing, or idea in the text an illustration depicts).	1,3
RI.K.8 - With prompting and support, identify the reasons an author gives to support points in a text.	3
RI.K.9 - With prompting and support, identify basic similarities in and differences between two texts on the same topic (e.g., in illustrations, descriptions, or procedures).	3
Range of Reading and Level of Text Complexity	
RI.K.10 - Actively engage in group reading activities with purpose and understanding.	1,2,3,6

COMMON CORE STATE STANDARDS - WRITING

Writing Standards–Kindergarten	Activities
Text Types and Purposes	
W.K.1 - Use a combination of drawing, dictating, and writing to compose opinion pieces in which they tell a reader the topic or the name of the book they are writing about and state an opinion or preference about the topic or book (e.g., My favorite book is…).	1,5
W.K.2 - Use a combination of drawing, dictating, and writing to compose informative/explanatory texts in which they name what they are writing about and supply some information about the topic.	1,2,4,6
W.K.3 - Use a combination of drawing, dictating, and writing to narrate a single event or several loosely linked events, tell about the events in the order in which they occurred, and provide a reaction to what happened.	2,3,6
Production and Distribution of Writing	
W.K.4 - (Begins in grade 3)	
W.K.5 - With guidance and support from adults, respond to questions and suggestions from peers and add details to strengthen writing as needed.	1,2,4,5
W.K.6 - With guidance and support from adults, explore a variety of digital tools to produce and publish writing, including in collaboration with peers.	
Research to Build and Present Knowledge	
W.K.7 - Participate in shared research and writing projects (e.g., explore a number of books by a favorite author and express opinions about them).	1,2,3,4,5
W.K.8 - With guidance and support from adults, recall information from experiences or gather information from experiences or gather information from provided sources to answer a question.	1,2,3

COMMON CORE STATE STANDARDS - LANGUAGE

Language Standards—Kindergarten	Activities
Conventions of Standard English	
L.K.1 - Demonstrate command of the conventions of standard English grammar and usage when writing or speaking. a. Print many upper- and lowercase letters. b. Use frequently occurring nouns and verbs. c. Form regular plural nouns orally by adding /s/ or /es/ (e.g., dog, dogs; wish, wishes). d. Understand and use question words (interrogatives) (e.g., who, what, where, when, why, how). e. Use the most frequently occurring prepositions (e.g., to, from, in, out, on, off, for, of, by, with). f. Produce and expand complete sentences in shared language activities.	1,2,3,4,5,6
L.K.2 - Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing. a. Capitalize the first word in a sentence and the pronoun. b. Recognize the name end punctuation. c. Write a letter or letters of most consonant and short-vowel sounds (phonemes). d. Spell simple words phonetically, drawing on knowledge of sound-letter relationships.	1,2,3,4,5,6
Vocabulary Acquisition Use	
L.K.4 - Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on kindergarten reading and content. a. Identify new meanings for familiar words and apply them accurately (e.g., knowing duck is a bird and learning the verb to duck). b. Use the most frequently occurring inflections and affixes (e.g., -ed, -s, re-, un-, pre-, -ful, -less) as a clue to the meaning of an unknown word.	1,2,3,4,5,6

COMMON CORE STATE STANDARDS - LANGUAGE

Language Standards—Kindergarten	Activities
Vocabulary Acquisition Use	
L.K.5 - With guidance and support from adults, explore word relationships and nuances in word meanings. a. Sort common objects into categories (e.g., shapes, foods) to gain a sense of the concepts the categories represent. b. Demonstrate understanding of frequently occurring verbs and adjectives by relating them to their opposites (antonyms). c. Identify real-life connections between words and their use (e.g., note places at school that are colorful). d. Distinguish shades of meaning among verbs describing the same general action (e.g., walk, march, strut, prance) by acting out the meanings.	1,2,3,4,5,6
L.K.6 - Use words and phrases acquired through conversations, reading and being read to, and responding to texts.	1,2,3,4,5,6

COMMON CORE STATE STANDARDS - MATHEMATICS

Counting and Cardinality - K.CC	Activities
Know number names and the count sequence.	
K.CC.1: Count to 100 by ones and by tens.	1
K.CC.2: Count forward beginning from a given number within known sequence (instead of having to begin at 1).	
K.CC.3: Write numbers from 0 to 20. Represent a number of objects with a written numeral 0 to 20 (with 0 representing a count of no objects).	1
Count to tell the number of objects.	
K.CC.4: Understand the relationship between numbers and quantities; connect counting to cardinality. a. When counting objects, say the number names in the standard order, pairing each object with one and only one number name and each number name with one and only one object. b. Understand that the last number name said tells the number of objects counted. The number of objects counted is the same regardless of their arrangement or the order in which they were counted. c. Understand that each successive number name refers to a quantity that is larger than one.	
K.CC.5: Count to answer "how many" questions about as many as 20 things arranged in a line, a rectangular array, or a circle, or as many as 10 things in a scattered configuration; given a number from 1 to 20, count out that many objects.	
Compare numbers.	
K.CC.6: Identify whether the number of objects in one group is greater than, less than, or equal to the number of objects in another group (e.g., by using matching and counting strategies).	
K.CC.7: Compare two numbers between 1 and 10 presented as written numerals.	
Measurement and Data - K.MD	
Describe and compare measurable attributes.	
K.MD.1: Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object.	
K.MD.2: Directly compare two objects with a measurable attribute in common to see which object has "more of"/"less of" the attribute, and describe the difference.	
Classify objects and count the number of objects in each category.	
K.MD.3: Classify objects into given categories; count the numbers of objects in each category and sort the categories by count.	

UNIT AT A GLANCE

Activity	Time to Complete	Lesson Level Learning Goals	Phenomena/ Engineering Challenge	Summary: Students Will…
1 **It's Not Junk!**	Preparation: 15 min. Activity: 3 classes Lesson 1A: 45–50 min. Lesson 1B: 75–80 min. Lesson 1C: 45–50 min 2 class periods Lesson 1D: 45-50 min.	Make purposeful observations of the motion of a variety of balls. Plan and conduct simple investigations into changes in motion due to pushes and pulls.	Engineering challenge: Design and build an "A-mazing Game" to make a ball travel to a specific ending point and change direction as it travels.	• Read a story about a child that uses collected items to develop a game. • Raise questions and share ideas about motion, direction, and changes in motion. • Brainstorm ideas about the engineering challenge. • Plan and carry out investigations into the motion of balls. • Use observations from investigations to find evidence of patterns in motion. • Read a storybook about motion.
2 **Collisions! Collisions!**	Preparation: 15 min. Activity: 6 classes Lesson 2A: 45-50 min. 2 class periods Lesson 2B: 45-50 min. Lesson 2C: 45-50 min. 2-3 class periods	Design an investigation to collect data to determine the effect of collisions. Use information to solve a problem.	Engineering challenge: Design and build an "A-mazing Game" to make a ball travel to a specific ending point and change direction as it travels. A rolling ball collides with a wall, desk, or chair and changes motion.	• Investigate the effect of: - a moving ball colliding with a not moving ball of the same size and weight. - a moving ball colliding with another moving ball of the same size and weight. - a moving ball colliding with a not moving ball of different size and weight. - a moving ball colliding with another moving ball of different size and weight.
3 **Explaining Motion**	Preparation: 10 min. Activity: 3 classes Lesson 3A: 45–50 min. 2 class periods Lesson 3B: 45–50 min.	Determine changes in thinking and new ideas about motion based on evidence.	Engineering challenge: Design and build an "A-mazing Game" to make a ball travel to a specific ending point and change direction as it travels.	• Review and compare information recorded from initial thinking and investigations. • Make connections among information gained through their investigations and information in text.

UNIT AT A GLANCE

Students Figure Out How To:	Practices/Crosscutting Concepts	Assessment
• Plan and carry out an investigation into motion and changes in motion. • Change the direction of a push or a pull (force). • Use barriers to change the direction of a moving ball. • Draw and label their ideas to solve the engineering problem to share with a team. • Develop rules of motion based on their evidence from investigations into motion. • Relate information in a storybook to findings from their motion of balls investigations.	Asking Questions and Defining Problems Planning and Carrying Out Investigations Obtaining, Evaluating, and Communicating Information Patterns Cause and Effect	**Formative Assessment:** What We Think chart Science Talk Journal Entries Journal Entry revision Respond to Text Classroom Motion charts
• Design multiple investigations into collisions between balls: - moving/not moving, same size and weight - moving/not moving, different size and weight - moving/moving, same size and weight - moving/moving, different size and weight • Use symbols to show direction and speed of the balls. • Develop a model to explain the effect of the colliding balls. • Construct explanations regarding the effect of collisions on motion.	Planning and Carrying Out Investigations Analyzing and Interpreting Data Developing and Using Models Constructing Explanations and Designing Solutions Cause and Effect Patterns	**Formative Assessment:** Activity Page Science Talk Classroom Data charts **Summative Assessment:** Classroom Data Charts (2C) Presentations Science Talk Journal Entry
• Determine changes in previous thinking based on observation and evidence. • Compare evidence from investigation to evidence presented in text. • Summarize their thinking about motion and forces based on new evidence.	Constructing Explanations and Designing Solutions Developing and Using Models Obtaining, Evaluating, and Communicating Information	**Formative Assessment:** What We Think chart **Summative Assessment:** Team models and presentations Science Talk Journal Entry

UNIT AT A GLANCE

Activity	Time to Complete	Lesson Level Learning Goals	Phenomena/Engineering Challenge	Summary: Students Will…
4 Where Is It? Where Is It Going?	Preparation: 10 min. Activity 4: 2 classes Lesson 4A: 45–50 min. Lesson 4B: 45–50 min.	Analyze observations to describe the position of an object in relation to other objects. Compare and contrast the description of an object's motion from different observers' views.	Engineering challenge: Design and build an "A-mazing Game" to make a ball travel to a specific ending point and change direction as it travels.	• Consider position of observer in relation to moving object when describing motion. • Make observations of motion from different positions. • Apply vocabulary related to the motion of different moving objects.
5 Setting Things in Motion	Preparation: 10 min. Activity 5: 4-6 classes Designing and Building: 2-3 classes Presentations: 2-3 classes	Design and build a game that will make a ball travel from one specific starting point to an end point and make changes in direction.	Engineering challenge: Design, test, and refine devices to make improvements to their product.	• Use information about forces, collisions, and motion to design a device that will make the ball move from point A to point B. • Evaluate their own and each other's devices to make improvements and adjustments.
6 Motion on the Playground	Preparation: 15 min. Activity: 6 classes Lesson 6A: 45–50 min. 2 class periods Lesson 6B: 75–80 min. 2 class periods Lesson 6C: 45–50 min 2 class periods	Plan and conduct an investigation into the motion on a swing. Apply ideas about motion to a different kind of motion.	Video: Children on swings: • One child pumps and keeps going. • Another child does not pump and slows down and stops.	• Brainstorm ideas of the different kinds of motion on the playground. • Make observations of motion on different equipment in the playground. • Look for patterns in the forces to identify pushes and pulls.

UNIT AT A GLANCE

Students Figure Out How To:	Practices/Crosscutting Concepts	Assessment
• Make observations of the motion and position of objects from different points of view. • Compare and contrast the description of an object's motion from different observers' views. • Collaborate to determine the best descriptions of motion and position.	Obtaining, Evaluating, and Communicating Information	**Formative Assessment:** Science Talk Activity Page **Summative Assessment:** Science Talk Journal Entry
• Make decisions as to material and design to accomplish the task. • Evaluate the design and make adjustments based on evidence and feedback. • Work as a team using the Engineering Design Process	Constructing Explanations and Designing Solutions Cause and Effect	**Summative Assessment:** Activity Page Journal Entry Engineering Design Solution
• Construct explanations of the concept of force (pushes and pulls) through observation and investigation. • Determine if the force is a push or a pull.	Developing and Using Models Asking Questions and Defining Problems Planning and Carrying Out Investigations Analyzing and Interpreting Data Constructing Explanations and Designing Solutions Obtaining, Evaluating, and Communicating Information Cause and Effect Patterns	**Formative Assessment:** What We Think chart Initial Models Science Talk **Summative Assessment:** Journal Entry/Respond to Text Science Talk

PARENT LETTER

Dear Parent,

Your child is beginning a unit created at the Battle Creek Area Mathematics and Science Center. This unit was designed to promote science and engineering literacy and integrate reading and writing skills into high-interest science content. During the next twelve weeks, your child will be actively involved with the Kindergarten unit *Motion: Pushes and Pulls*. This unit is geared for kindergarten students and focuses on the "big ideas" of describing motion and exploring motion in terms of the forces that affect motion. At the end of the unit, students should be able to:

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1. Describe and compare an object's position in relation to other objects around it.
2. Describe an object's motion from different observers' views.
3. Plan and conduct investigations into different strengths of forces that change the motion of objects.
4. Analyze data to determine that objects initially at rest will move in the direction of the push or pull.
5. Analyze data to determine how pushes and pulls can change the speed and direction of moving objects.
6. Plan and conduct an investigation to determine how the shape, size, and weight of an object can affect motion.
7. Analyze observations to determine that objects fall toward the earth.

Kindergarten students are also encouraged to think and act like scientists and engineers and begin to develop observation and communication skills in science. They will need to:

1. Make purposeful observations of motion and forces.
2. Generate questions based on their observations.
3. Plan and conduct simple investigations into how things move.
4. Manipulate simple tools that aid observation and data collection.
5. Construct simple charts from data and observations of moving objects.
6. Share ideas about forces and motion through purposeful conversation.
7. Communicate and present findings of observations.
8. Develop strategies for information gathering.
9. Demonstrate scientific concepts through illustrations, performances, models, exhibits, and/or activities.

In this unit the activities are geared to build on the inherent knowledge and experiences that five-year-olds have already acquired and use their knowledge in a wider range of tasks. Students will be given the opportunity to examine, measure, reflect upon, describe, and discuss how forces of various origins are used to produce and affect motion. Within the content of motion students begin to recognize and apply the nature of science.

Suggestions for activities to do at home are included with this letter. These activities will reinforce the concepts taught during this unit's instruction.

May you enjoy quality time with your child while discussing the concepts involved with the Kindergarten Motion unit. Let us know if we may be of assistance.

The Outreach Staff
Battle Creek Area Mathematics and Science Center
(269) 213-3907 or (269) 213-3905

ACTIVITIES TO DO AT HOME

1. Take your child for a walk around the neighborhood to find different examples of things that are moving. Have your child describe the motion of the moving object (fast, slow, up, down, around, etc.) and the position of the objects in relation to where he/she is observing (ahead of, behind, toward, away from, between, etc.).
2. Play games with your child that require movement, such as acting out how different animals move, guessing what animal, then describing its motion.
3. Help your child find pictures of moving objects in magazines and glue them into a notebook. Assist your child in labeling the moving objects with descriptions of the motion.
4. Visit the school playground or a local park and have your child describe the motion in using the playground equipment. Ask him/her to identify when they use a push or a pull to start the motion of the playground equipment.
5. Play a "What would happen if…" game with your child. Possible question: What would happen if I dropped a spoon off the counter? Have your child predict what would happen, and then investigate and describe the motion of the spoon.
6. Test the way different objects fall from the same height. Does a tennis ball drop the same way as a spoon? Find different household items and toys that are safe for your child to investigate.
7. Encourage your child to make ramps out of different boxes and cardboard and test the speed of balls and different objects rolling down the ramp.
8. Go to the library and check out books about motion:

   Forces Make Things Move, Kimberly Brubaker Bradley

   Gravity is a Mystery, Franklyn M. Branley

   Forces and Motion, Catherine A. Welch

   Forces and Motion, Clint Twist

ACTIVITY 1

IT'S NOT JUNK!

Teacher Background Information
In the following introductory lessons, students explore motion-related phenomena through science investigation to figure out how to solve an engineering design challenge. The lessons begin with a story that introduces an engineering design challenge through the eyes of a child. After students have had the opportunity to listen to the story and discuss their ideas of how the child acted like an engineer, they are engaged in sharing what they think and questions they have about motion, changes in motion, speed, and engineering.

Considerations for Students with Special Needs
In the initial lessons of the unit, students are invited to investigate the motion of balls and ramps to solve the engineering challenge. Some students may need extended clarification on the challenge and the use of the balls and ramps as a tools for figuring out motion. It may be helpful to pair students that have difficulty focusing or following directions with an adult helper or other students that are able to focus on the task at hand.

Read all Student Journal prompts aloud to students. Students may need to complete some of the Student Journal responses as a whole class instead of individually. Allow students to dictate written responses and labels for their drawings.

Engage the Learner

This stage of learning introduces and activates prior knowledge regarding motion. Students make connections between what they have observed and the engineering design challenge. Before exploring the motion of balls, the class will brainstorm ideas about what they already know and have observed when playing with different kinds of balls and raise questions about the motion of the balls. .

LESSON 1A: IT'S NOT JUNK! AN ENGINEERING DESIGN CHALLENGE - UNDERSTANDING THE PROBLEM

Advance Preparation
Prepare a What We Think chart to record students' initial ideas, questions, and what they figured out throughout their explorations into motion.

ESTIMATED TIME
Lesson 1A: 45–50 minutes
Lesson 1B: 75–80 minutes
Lesson 1C: 45–50 minutes
2 classes
Lesson 1D: 45-50 minutes

LESSON LEVEL LEARNING GOALS
- Make purposeful observations of the motion of a variety of balls.
- Plan and conduct simple investigations into changes in motion due to pushes and pulls.

MATERIALS NEEDED
For each student:
student page
For the class:
story: *It's Not Junk!*
tennis ball
golf ball
Teacher provides:
chart paper
markers

PS3.C: RELATIONSHIP BETWEEN ENERGY AND FORCES
- **A bigger push or pull makes things go faster.**

PS2.A: FORCES AND MOTION
- **Pushes and pulls can have different strengths and direction.**
- Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it.

TEACHING TIP
Throughout the activities in the Teacher Guide, you will notice that specific student instructions from the Student Journal pages are given first and italicized. Additional information for the teacher follows the italicized instructions in plain print.

READING
Key Ideas And Details
RI.K.1: With prompting and support, ask and answer questions about key details on a text.
RI.K.2: With prompting and support, identify the main topic and retell key details of a text.
Craft And Structure
RI.K.4: With prompting and support, ask and answer questions about unknown words in a text.
RI.K.5: Identifying the front cover, back cover, and title page of a book.
Integration Of Knowledge And Ideas
RI.K.7: With prompting and support, describe the relationship between illustrations and the text in which they appear (e.g., what person, place, thing, or idea in the text an illustration depicts).

What We Think: Focus on Motion				
What We Think About Motion	What Questions Do We Have?	What We Did	What We Figured Out	How Does That Help Us to Figure Out the Motion of the Swings?

Preview the story, *It's Not Junk!* and review the passages where it is important to stop and discuss.

Set up an area in the classroom for the start and end points of the engineering design challenge. Be sure that there is room for the students to include a couple of changes in direction in the ball and space to knock over some blocks or other items.

Procedure
Engage the learner.
Read the story, *It's Not Junk!* aloud to the class.

At the conclusion of the story, encourage students to respond to the reading and share experiences they have had with balls, mazes, and games.

Ask:

- Can someone explain what this story is about?
- Who can retell the purpose of the game that Edmund made?
- Can someone add to what _____ said?
- What does Granddad mean when he said "it looks like a maze"? Has anyone ever played a game where there was a maze to travel through?
- What pictures in the story help you to understand what a maze is?
- In the story, Marie wins the game. What did she have to know about motion to win?
- Can anyone describe their own experience when playing with balls? Has anyone played a similar game?
- How do you think the players of Edmund's game started the ball rolling?
- What makes you think that? Can you retell the part of the story that led you to think that?
- What do you think you would need to know to make a similar game?

Introduce the Engineering Design Challenge.

The class, like Edmund in the story, is going to act like engineers and design and build an "A-mazing Game". Challenge students to think of different ways to make a ball roll from one place to another without touching it with their bodies. Explain that the ball must travel to a specific ending point, change direction as it travels, and knock something down in the end.

Conduct a whole-class discussion on what students believe is the role of an engineer. Listen for ideas that relate to building and designing things. Explain that engineers design things that help to solve a problem, experiment with their design, and then make changes to make their design better. Include that engineers solve problems using information that they know about science.

Ask:

- What do we need to know about the motion of balls to solve the engineering challenge?
- What did Edmund in the story need to know to make his game?
- How can we find out more about motion?

Show the class the area prepared with the start and end point. Take time for students to take turns using the tennis ball and rolling the ball from the start position to get an idea of the challenge of getting it to change direction and roll to the finish and knock over some blocks or other items. Listen to their ideas and reactions to the motion of the ball.

Display the Focus on Motion: What We Think chart. Explain that the chart will become a record of their thinking and what they figured out about motion as they begin to explore how things move. Review each column of the chart:

What We Think: Focus on Motion				
What We Think About Motion	What Questions Do We Have?	What We Did	What We Figured Out	How Does That Help Us to Figure Out the Engineering Challenge

Record students' initial ideas about motion and their thoughts about how Edmund in the story acted like an engineer and what he had to know about how things move to develop his game. Use words, symbols and drawings to aid in students' ability to "read" the chart.

TEACHING TIP

Keep the What We Think chart visible and refer to it often as the unit progresses. At this point in their learning, most students are non or emergent readers and writers. Be sure as you record their ideas that they are in their words and reflect their ideas and questions. Review and read the chart often to help students to hear their learning story unfold. A key to student understanding is the ability to recognize and verbalize when and why they have had a shift in their thinking about different concepts.

CAUSE AND EFFECT

- Simple tests can be designed to gather evidence to support or refute student ideas about causes.

ASKING QUESTIONS AND DEFINING PROBLEMS

Asking questions and defining problems in K–2 builds on prior experiences and progresses to simple descriptive questions that can be tested.

- **Ask questions based on observations to find more information about the natural and/or designed world(s).**
- Ask and/or identify questions that can be answered by an investigation.

TEACHING TIP

Preview the *Word Sort Card* set and as students use words from the set, tape them in the appropriate column of the chart.

TEACHING TIP
At this age, students may have difficulty phrasing their ideas and wonderings in the form of a question. Assist the students by asking them:
- Is this the question you are asking ... ?
- Do I hear you asking...?

TEACHING TIP
When writing ideas and questions on the What We Think chart, use short sentences that capture the students' thinking and wonderings. If possible include pictures and drawings to help them to "read" the chart. Draw a sketch of a swing and use arrows to show students' ideas of motion.

Review the motion symbols from the engineering challenge and motion of the balls. Discuss how the symbols can be used in other drawings of motion.

To help the students draw a swing, make a model using a string and a small object tied to one end. Have the students observe the motion of the object moving back and forth.

Roll the tennis ball across the floor and allow it to bump into things and have students observe until it comes to a rest. Repeat the demonstration with the golf ball.

Science Talk
Ask the students to gather in a circle and discuss their ideas about how things move. Review the story "It's Not Junk!" and what the students think and wonder about. Assist the students in posing their ideas and wonderings into questions and add them to the What Questions Do We Have? column. Ask:

- _____, I heard you say that it would be useful to understand what causes the ball to change direction. Can you put that in the form of a question for our chart?
- Does anyone have any questions about the motion of the different balls? What questions do you have about how the tennis ball moves? What about the golf ball?
- How do you think you can start the ball moving? What questions do you have about how things start moving?
- Can someone explain what happened at the end of the "A-mazing Game"?
- What do you think about what happens when the ball collides with objects in its way?
- Can you say that idea in the form of a question?
- How can we figure out the answer to our questions?

Review the questions with the class and ask students for their ideas for investigating how balls move. Add their ideas to the What We Think column. Inform the class that in the following lessons, students will be given the opportunity to investigate how balls move and gather information to use to solve the engineering design challenge. Review the challenge to help keep the students focused on what they are trying to figure out and solve.

Assessment: Formative
Use the What We Think chart and Science Talk to assess the students' initial ideas about how things move. Check for early ideas about pushes and pulls and strengths of forces to start and change motion.

LESSON 1B: BALLS IN MOTION - UNDERSTANDING THE PROBLEM

Teacher Background Information

In this activity students continue to explore the concept of motion. They are narrowing their focus to the motion of balls, specifically if the motion and direction of a ball is affected by the strength and direction of a push or a pull. Students are also given the opportunity to use cardboard pieces and tubes to use as they choose in their investigations into the motion of balls.

Balls come in many sizes, weights, and materials. Their bounces and rolling action differ due to a variety of factors that influence motion, such as the force used to set the ball in motion, the material the ball is made of, the weight of the ball, and the shape of the ball. This activity draws on students' prior knowledge about the variety of shapes and sizes of balls and what they already have observed about the motion of balls.

Explore the Concept

This phase of learning provides students with the opportunity to observe and investigate the motion of balls and build a common base of experiences within the concept of motion. Students actively explore, observe, and record the motion of a variety of balls, collisions of balls, and the effect of gravity. They begin developing concepts, questions, and recognizing patterns in the motion of the balls.

Advance Preparation

Your kit is packed with a variety of balls of different sizes. If possible, collect a couple of larger balls, such as a basketball or dodge ball, to compare with the motion of the smaller balls. The addition of a football is a good example of a "ball" of a different shape to use in the observations. The addition of Nerf balls to the kindergarten exploration will also add interest and discovery to the investigations.

Make arrangements to use the gym or a larger space if your kindergarten classroom is too small for bouncing and rolling activities.

Collect a variety shapes and sizes of blocks that students can choose to use in completing the engineering task in lesson 2C.

Set up a materials table for students to have the assortment of balls and ramps to choose from to complete their investigations and engineering projects. Set up the balance for students to compare the weight of their balls. (See Materials Needed, For the class)

MATERIALS NEEDED

For each student:

2 student pages

For the class:

assortment of balls: tennis balls, golf balls, ping-pong balls, bouncy balls, wood balls, marbles
14 ramps
1 beach ball
2 alcohol swabs
1 primary balance

Teacher provides:

chart paper
scissors
tape
wooden blocks
Nerf balls (optional)
basketball
dodge ball
football

PS2.A: FORCES AND MOTION

- Pushes and pulls have different strengths and direction.
- Pushing and pulling on an object can change the speed or direction of its motion and can start or stop it.

Create a classroom list of a variety of familiar balls. Example:

Different kinds of balls	Characteristics
tennis ball	yellow, rough, bouncy
bowling ball	hard, heavy, no bounce
rubber ball	bouncy, smooth, colorful

PLANNING AND CARRYING OUT INVESTIGATIONS

Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.

- **With guidance, plan and conduct an investigation in collaboration with peers.**

Keep the What We Think chart visible and refer to it often to revisit what students have done and what they have figured out.

The What We Think chart serves as a record of their learning and as a tool for vocabulary building.

Procedure

Engage the learner.

This activity introduces and activates prior knowledge regarding the motion of different sizes of balls. Students connect what they figure out with the engineering challenge. Before exploring the motion of balls, the class is going to brainstorm ideas about what they already know and have observed when playing with balls.

Tell students that they are going to continue their investigations into motion and focus on the motion of a variety of balls. Review the What We Think chart with students and revisit ideas and questions about the motion of balls in terms of speed, direction, and distance. Review the motion of the tennis ball and golf ball in the previous lesson and story.

Make a classroom chart that lists a variety of familiar balls that the children have seen or used. When the classroom chart or list is complete, have students stand in a circle and introduce the beach ball. Add the beach ball to the student-generated list if it is missing.

Toss the beach ball to a child. Allow time for students to toss the ball to one another until all students have had the opportunity to catch and handle the ball. Ask students to describe the ball. Look for answers that describe the size, weight, and shape of the ball. Ask:

- What caused the ball to start to move?
- Who can add to _____'s idea?
- What caused the ball to stop? What do you mean when you say_____?
- What if we used a different ball? How could we start, change, or stop the motion of a different ball?
- What makes you think that?

Use the What We Think chart to record student thinking and ideas for investigation into the motion of different types of balls.

To help students begin their brainstorming and discussion, show the class the ramp and pick two different balls and ask students if they think the balls would roll down the ramp at the same speed. Ask why they think that? How can we find out? Record their ideas on the What We Think chart. Roll the balls down the ramp. Continue the discussion allowing students to share what they think and begin to raise questions and ideas of how to investigate the motion of different sizes of balls.

Explore the concept.
Show students the variety of balls provided in the kit and any other balls you may have added to the collection. Tell students that they are going to see if size and weight of different balls has an effect on how the balls move. As a class, determine the wording of the questions they are investigating. Example:

- Does the size of the ball make a difference in how it moves? (speed, distance, direction)
- Does the weight of the ball make a difference in how it moves? (speed, distance, direction)

Take this opportunity to demonstrate the use of the balance to compare the weight of different balls. Give students the opportunity to predict and test their predictions using the balance. Discuss weight or how heavy the balls are and the size or how big or small the different balls are.

Invite students to choose a partner to explore the motion of balls. Have each team choose two different balls.

Show students the additional material (ramps and blocks) they may use in their teams as they explore the motion of different balls. Allow them to choose their material. Note: To be sure all teams have the opportunity to mess about with the material, limit the number of items each team uses.

Allow teams to combine their ideas and materials if they are able to work well in a team of four.

As the teams appear to have decided on what they are exploring and have set up an area for exploration, circulate among the groups and ask questions that help them to clarify what they are doing and why they are doing it.

Sample questions to develop scientific thinking
To check student progress, you may ask:

- What question(s) are you trying to answer?
- Can you explain what you have done so far?

INQUIRY TIP
As facilitator of the exploration into the motion of balls, be prepared to listen and record student discoveries and questions. Allow sufficient time for students to discuss what they would like to try with the balls, use materials through trial and error, and settle into a discovery of their own.

CAUSE AND EFFECT
- Simple tests can be designed to gather evidence to support or refute student ideas about causes.

MATH
K.MD.1: Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object.
K.MD.2: Directly compare two objects with a measurable attribute in common to see which object has "more of"/"less of" the attribute, and describe the difference.

TEACHING TIP
Do not direct the student procedures or choice of materials at this time. Allow students to explore in their teams what is real and important to them.

TEACHING TIP

To help students with their response in the Student Journal, take time to discuss how artists and illustrators use arrows to show the motion of objects. Give examples and draw pictures of balls on the whiteboard and use action arrows to show direction, speed, and distance.

TEACHING TIP

As you circulate among the teams, carry a clipboard and paper to record some of their ideas to refer to during the Science Talk. Be aware of the language students use to describe the motion of the balls and ask them to explain what they mean using those terms in the Science Talk.

CONSTRUCTING EXPLANATIONS AND DESIGNING SOLUTIONS

Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions.

- **Use information from observations (firsthand and from media) to construct an evidence-based account for natural phenomena.**

- What do you notice when…?
- What do you think caused that to happen?
- Why did you decide to use this procedure/material?
- What is different about the two balls? What is the same?
- Have you used the balance to see if there is a difference in the weight of the two balls? Which ball is heavier? How do you know that?

To encourage questioning and hypothesizing, ask:

- What would happen if…?
- What are some other possibilities?

To help students who are stuck, ask:

- What have you tried so far?
- Could you change one thing in your investigation? Will that cause something else to change?

To make connections to the engineering challenge, ask:

- How do your observations of the motion of the different balls give you information about how things move?
- How does that help in giving you ideas for the engineering challenge of developing a game?
- Do you think that Edmund in the story, *It's Not Junk!*, investigated the motion of the balls from his collection box?
- What do you think he figured out?

After you have visited all the groups, check to see if students appear to be near completion of their investigations. They may already have become engaged in changing variables to test further questions.

When you feel it is not too disruptive in their own discovery process, stop students and tell them that they will be going around the room and looking at what all the groups have set up and discovered.

As a group, take a walk around the room to view the various setups and investigations that were going on. Allow time for students to share their results of how the balls traveled and if there was a difference. Ask the groups to clarify what they were testing by asking:

What did you want to find out? What balls did you test?

What do you think caused them to travel differently?

Science Talk

In their groups, have students return to their area of exploration and talk about what they did. To keep students focused on talking it through, you may have to ask for all balls to be still for 5 minutes of talking about their experience.

After their team talk, conduct a whole-class discussion on what they observed and learned in their ball investigations. Record student ideas on the What We Think chart. Make a list of the vocabulary words they use during the discussion. Be sure to include the terms *cause* and *effect* in the list of motion terms the students develop. To collectively make sense of the concept of the motion of balls and construct explanations, ask:

- Was anyone successful in causing the a change in the direction of one or both of the balls? Can you say more about what it means to change direction?
- What do you think about what _____ said?
- Do the rest of you agree? What did you see that makes you think differently?
- Did anyone discover the same thing but can explain it differently?
- Tell us why your idea makes sense.
- _____, I heard you say _____when you were testing the balls. Can you say more about that?
- Did anyone else have a similar result? Why do you think that?
- What can we say about the motion of the balls of different sizes? Weights?
- What did you discover about the ramps and starting the balls in motion?
- What do you mean when you say _____?
- Do the rest of you agree? Why or why not?

Pre-writing Strategy

Read and discuss the Journal Entry as a class. Assist the students in drawing their investigations and what they figured out by giving them examples of how to show the ramp, ball, motion, and direction. Introduce the terms *push* and *pull*. Ask students to describe or act out what it means to push or pull to get an object moving. Ask students how they started the ball rolling. Did it take a push or a pull? Was it big or small?

Ask students to draw and/or write about their investigations in their Student Journals. Ask them to draw what they observed.

LANGUAGE

Conventions of Standard English

L.K.1: Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

a. Use frequently occurring nouns and verbs.
b. Form regular plural nouns orally by adding /s/ or /es/ (e.g., dog, dogs; wish, wishes).
c. Understand and use question words (interrogatives) (e.g., who, what, where, when, why, how).
d. Use the most frequently occurring prepositions (e.g., to, from, in, out, on, off, for, of, by, with).
e. Produce and expand complete sentences in shared language activities.

CAUSE AND EFFECT

- Simple tests can be designed to gather evidence to support or refute student ideas about causes.

WRITING

Text Types And Purposes

W.K.2: Use a combination of drawing, dictating, and writing to compose informative/ explanatory texts in which they name what they are writing about and supply some information about the topic.

Research To Build And Present Knowledge

W.K.7: Participate in shared research and writing projects.

W.K.8: With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.

Journal Entry

1. *Draw a picture of one of the balls you used to find out how it moves. Show how it moved.*
2. *Label your picture with words that describe your ball. small, large, heavy, light.*
3. *Label your picture with words that tell how your ball moved.*
   up, down, fast, slow, push, pull.

Assessment: Formative

Use the Science Talk and Journal Entry to assess students' understanding of how size and weight affect the motion of balls and that to change the motion of the balls there must be a force acting on the ball.

LESSON 1C: HOW THINGS MOVE - UNDERSTANDING THE PROBLEM

Teacher Background Information

This lesson provides the opportunity for students to recognize patterns in motion and develop "rules" of motion based on their own investigations and observations. As lessons progress they will be asked to use their "rules" of motion to solve the engineering design challenge.

Explain the concept and define the terms.

This phase focuses on developing an explanation for the motion of the balls and attaching vocabulary and principles of motion to their observations. Students verbalize their understanding of motion and listen to the ideas of others. Introduce formal terms, definitions, and explanations regarding motion at this time.

Advance Preparation

Find an area where teams of two students can sit on the floor and roll the balls back and forth.

Prepare four charts and write headings: Chart #1, Chart #2, Chart #3 and Chart #4.

Procedure

Explain the concept and define the terms.

Ask students to work with a partner. Have each team find a space in the classroom where they can roll the ball back and forth. Distribute one ball to each team of two students. Tell students to simply place the ball on the floor in front of them.

Ask: "Does the ball move?" (no) "What is necessary to start the ball moving?" (a push or a pull) Write the following statement at the top of a piece of chart paper or whiteboard:

To start a ball moving, there must be a push or a pull.

List examples of pushes and pulls. Ask: "Is this statement true for more things than the balls that we have been testing?" (Accept reasonable responses at this time.) Ask students to demonstrate a push and a pull to get the ball moving.

Ask for student volunteers to explain how they got their ball moving in the previous activity. Record their responses and save them to refer to in their Journal Entries at the end of the activity.

Ask students for other ways they can think of to start the ball moving without touching the ball with their hands. Give students a few minutes to brainstorm and investigate ways to push the ball without touching it with their hands. Ask: Is it still a push or pull, even if you did not use your hands?

MATERIALS NEEDED

For each student:
student pages

For the class:
assortment of balls

Teacher provides:
chart paper or whiteboard space

PS2.A: FORCES AND MOTION

- Pushes and pulls have different strengths and direction.
- Pushing and pulling on an object can change the speed or direction of its motion and can start or stop it.

Motion Chart #1

To start a ball moving, there must be a push or a pull.

Examples:
- kick the ball
- strike the ball with a bat or other object
- etc.

CAUSE AND EFFECT

- **Simple tests can be designed to gather evidence to support or refute student ideas about causes.**

LESSON 1C

Motion Chart #2

A ball will move in the direction of the push or pull.

Examples:

- push left = move left
- push right = move right
- push up = move up
- push down = move down
- etc.

LANGUAGE

Conventions Of Standard English

L.K.1: Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

a. Use frequently occurring nouns and verbs.
b. Form regular plural nouns orally by adding /s/ or /es/ (e.g., dog, dogs; wish, wishes).
c. Understand and use question words (interrogatives) (e.g., who, what, where, when, why, how).
d. Use the most frequently occurring prepositions (e.g., to, from, in, out, on, off, for, of, by, with).
e. Produce and expand complete sentences in shared language activities.

Motion Chart #3

To change the direction of the ball there must be a push or a pull.

Examples:

- ball strikes another object or barrier
- push the ball in a different direction

After the teams have explored different ways of pushing or pulling the ball, conduct a whole-class discussion and make a list on the chart paper of the different ways to push the ball. Check for ideas of getting the ball moving without touching it at all.

Ask students what direction the ball moved. (The ball moved in the direction it was pushed.) Write the following statement on the top of a second piece of chart paper:

A ball will move in the direction of a push or a pull.

List examples of pushing, pulling, and direction. Ask a student volunteer to demonstrate how the ball moved in the direction of the push.

Conduct a whole-group discussion on what they observed in the demonstration and record their answers on the chart.

Ask students if they can think of any ways to change the direction of the ball after it is in motion. Give students time to think and try their ideas in their teams. Hold a whole-class discussion about changing the direction of the ball that is in motion. Give students the opportunity to demonstrate ways they have discovered to change the direction of the ball. Ask students what they might call the action they took to change the direction of the ball. Ask:

- What would happen if you did that again to a different ball?
- Can someone describe the pattern we are discovering?

Write the following statement on the top of a new piece of chart paper:

To change the direction of a moving ball, there must be a push or a pull.

List examples of changing direction with a push or pull. Read the statement and ask the class if they agree with the statement. Give students an opportunity to start the ball moving and test the concept.

After students have had sufficient time to try to change the direction of the moving ball, ask them to share what they tried and record their ideas on the chart paper. Ask if they can think of a time when the ball changed direction without observing a push or a pull on the ball. Where did that push come from? (Record their ideas and save to return to later in the unit.)

Tell students that there is one more thing a push or a pull can do to a moving ball or object. Ask students to talk to their partners and brainstorm what other effect a push or a pull can have on a moving object.

Science Talk

Ask the teams of two students to join another team and talk about what they know about motion and pushes and pulls. Tell them that they can demonstrate their ideas to one another using the balls. Facilitate their collaboration by listening to their conversation and, if necessary, becoming a part of their group.

Facilitate the small group by asking:

- What have you talked about so far?
- Do you all agree with what _____ said?
- If a push or pull is necessary to cause a ball to move and change the direction of the ball, I wonder what else might a push or a pull do to the moving ball?

After listening to the student conversation, bring students back together for a whole-group discussion. Ask the groups to share their ideas from their group discussion. If students do not offer the idea of a push or a pull causing a change in the speed of a moving ball, roll a ball across the floor and ask:

- What would I have to do to make the rolling ball go faster or go slower?" (apply a push or a pull)
- Would that happen every time? Can someone explain the pattern?

Ask students to help you word the next statement you are going to write on a piece of chart paper:

To speed up, slow down, or stop a moving ball, there must be a push or a pull.

List examples of pushes and pulls that sped up, slowed down, or stopped the motion of the ball. Give students the opportunity to mess about with their balls and investigate what it would take to slow down or speed up the ball.

When students have had sufficient time to investigate the slowing down and speeding up of their moving balls, hold a whole-group discussion and record their ideas about pushes and pulls and how they affect the speed of a ball on the chart paper.

If students offer ideas that relate to the previous statements, point out that their idea is more like one of the other statements and write it on the appropriate chart. Ask students to identify any patterns or common ideas across all four charts. Listen for ideas indicating that students recognize that a push or a pull is necessary for motion and changes in motion.

TEACHING TIP

Kindergarten students have a natural curiosity that can be nurtured into a sense of wonder to help them question their observations and become curious about phenomena. You may ask:

- I wonder why some balls travel farther than other balls.
- What do you wonder about?
- Have you ever wondered…

Motion Chart #4

To speed up, slow down, or stop a ball moving, there must be a push or a pull

Examples:

- touch or push the ball to speed up
- touch or pull the ball to slow down
- collide with another object to change speed

CAUSE AND EFFECT

- **Simple tests can be designed to gather evidence to support or refute student ideas about causes.**

PATTERNS

- **Patterns in the natural world and human design can be observed and used as evidence.**

CONSTRUCTING EXPLANATIONS AND DESIGNING SOLUTIONS

Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions.

- Use information from observations (firsthand and from media) to construct an evidence-based account for natural phenomena.

WRITING

Text Types And Purposes

W.K.2: Use a combination of drawing, dictating, and writing to compose informative/explanatory texts in which they name what they are writing about and supply some information about the topic.

Research To Build And Present Knowledge

W.K.7: Participate in shared research and writing projects.

W.K.8: With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.

Tell the class that they have learned four important concepts about motion. Review the four charts together with the class. Ask the class to read the statements together. Ask students if they have questions about any of the new concepts they have learned. Record their questions on the appropriate chart. As a class review the terms push and pull and how they have used them when investigating motion of balls in the classroom. Decide on a class definition of the terms push and pull.

Return to the What We Think chart and record the student ideas and findings on the What We Did, What We Figured Out columns. Discuss how the four motion statements help to figure out the engineering challenge.

Invite students to revisit their Journal Entry from the previous lesson and make adjustments or additions if they have new information and ideas from classroom charts.

Journal Entry (Lesson 1B)

1. *Draw a picture of one of the balls you used to find out how it moves. Show how it moved.*
2. *Label your picture with words that describe your ball. small, large, heavy, light.*
3. *Label your picture with words that tell how your ball moved.*
   up, down, fast, slow, push, pull.

Assessment: Formative

Use the Science Talk and revisions to their Journal Entries (Lesson 1B) to assess their understanding of the effect of pushes and pulls (forces) on motion.

LESSON 1D: AND EVERYONE SHOUTED, "PULL!"

Teacher Background Information

This lesson provides a strong connection for students to develop and deepen their understanding and explanations through a reading integration. *Everyone Shouted "Pull!"* is an important reading integration for helping children extend and deepen their understanding about how things move that was developed in the previous lessons while supporting literacy learning and reading comprehension.

Advance Preparation

Preview the book, *And Everyone Shouted, "Pull!"* prior to reading to the class. Determine passages and pages to stop and discuss the motion and what causes changes in motion.

Prepare a Motion Word Sort card set for each group of four students.

Procedure

Elaborate on the concept.

This lesson allows students to extend their learning and relate their findings in their investigations to a story about how farm animals moved a cart of fruits and vegetables.

Review the What We Think chart and how students have been using balls to study motion and pushes and pulls. Now you are going to read a story called *And Everyone Shouted, "Pull!"* to learn more about the motion of something very different than a ball.

Tell students that while reading and listening to the story, they are to look/listen for ideas that support or are examples of the four statements they have written on the classroom charts. Review the statements prior to reading the story.

Explain to the class that you will be using *And Everyone Shouted, "Pull!"* to learn more about pushes and pulls and how they are used to make things move. As a class, read and discuss the title and cover of the book.

Ask:

- Why do you think the author chose the title, *And Everyone Shouted, "Pull!"*?
- What do you think is going to get pulled?
- Who do you think will be doing the pulling?

MATERIALS NEEDED

For each student:
student pages

For the class:
Motion Word Sort cards (push, pull, stop, turn, uphill, downhill, change direction, force and move)
book: *And Everyone Shouted, "Pull!"*

Teacher provides:
chart paper or whiteboard space

READING

Key Ideas And Details

RI.K.1: With prompting and support, ask and answer questions about key details on a text.

RI.K.2: With prompting and support, identify the main topic and retell key details of a text.

Craft And Structure

RI.K.4 - With prompting and support, ask and answer questions about unknown words in a text.

RI.K.5: Identifying the front cover, back cover, and title page of a book.

Integration Of Knowledge And Ideas

RI.K.7: With prompting and support, describe the relationship between illustrations and the text in which they appear (e.g., what person, place, thing, or idea in the text an illustration depicts).

TEACHING TIP
It is crucial for young writers to be given the opportunity to write about topics that are of interest and topics where they feel they have a knowledge base. Students need to learn to write about the information that they find in text and use what is drawn from sources as evidence to support their own ideas and experiences.

PS2.A: FORCES AND MOTION
- Pushes and pulls can have different strengths and direction.
- Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it.

PS2.B: TYPES OF INTERACTIONS
- When objects touch or collide, they push on one another and can change motion.

PS3.C: RELATIONSHIP BETWEEN ENERGY AND FORCES
- A bigger push or pull makes things go faster.

CAUSE AND EFFECT
- **Simple tests can be designed to gather evidence to support or refute student ideas about causes.**

PATTERNS
- **Patterns in the natural world and human design can be observed and used as evidence.**

Ask students to give examples of when they pulled something. Have them think of experiences on the playground and their ball investigations and describe times when they used a pull.

Invite students to make predictions about the main idea of the book. Ask students if the pictures in the book stimulate any questions about motion. Record their questions.

Review the motion statements that are on the classroom charts and remind students that their statements can be used in explaining what is happening in the book.

Read *And Everyone Shouted "Pull!"* aloud to the class.

Stop to discuss when students recognize one of the motion "rules," or when there is the need for a push or a pull, or to pose "I wonder" questions. After reading, conduct a whole-class reading conference.

Revisit the student pre-reading predictions: What was getting pulled in the book? Who was doing the pulling? How do the illustrations support the text?

Reread different sections of the text and revisit different illustrations.

Science Talk
Examples of text revisited and discussed:

- Pages 6 and 7: Ask students to find an example of a push and a pull. Ask: What is needed to move the box of apples, milk can, or bag of potatoes? Review the statement on the first chart from Activity 1C.
- Pages 10 and 11: Reread the text on page 11. Ask students which classroom statement is similar to the reading on page 11.
- Pages 12 and 13: Ask students to look at the picture. What is happening in the picture? Can someone add to _____'s idea? (Listen for explanations that describe the push and pull. Students may also notice that the initial push or pull is a stronger force to get the wagon moving, but once it is in motion it is easier to pull along.)
- Who can think of a time when you had a problem similar to the one the animals had? How did you solve the problem? Does anyone else have something to share?
- Turn to pages 14 and 15 and ask why the animals no longer are pushing the cart. How do you know that? Do the rest of you agree? Why or why not?

- Pages 16 and 17: The donkey states, "We have to pull harder when we're going uphill." Ask students if they have ever had to pull or push harder because of a hill. What statement on the classroom charts does climbing the hill describe?
- Does anyone have a different idea?
- What do you think will happen when the cart starts to go downhill? What causes that to happen? Who can explain what _____ just described? Turn to pages 18 and 19 to confirm their predictions.
- Pages 20-21: What has happened to the motion of the cart? What force is applied to change the direction of the cart?
- What statement on the charts does this relate to? How is that similar to the way you changed the direction of the ball?
- Who can add on to _____'s idea?
- On pages 22 and 23 the animals encounter another problem. Ask a student volunteer to describe what is happening now. How do the animals solve the problem?
- How is this problem like one of the classroom statements?
- Page 28 and 29: Reread each section on the pages and ask students to which classroom statement each section relates.

Ask students how they think the animals' pushing and pulling a cart to market is similar to studying the motion of balls in the classroom.

Take this opportunity to have students respond to the text from *And Everyone Shouted, "Pull!"* in the Student Journal.

Pre-Writing Strategy: Model how to write a recollection or retelling of the text by asking students to describe or explain in their own words how the animals used a push or a pull and how it relates to the motion of the cart. Engage the class in a "Think Aloud" and give students time to orally express what they are going to write and listen to the ideas of others.

Respond to Text

1. *Choose one way that the animals moved the cart. Draw how the farm animals used a push or a pull to move the cart, stop the cart, or turn the cart.*
2. *Write about how the farm animals used a push or a pull to move the cart, stop the cart, or turn the cart.*

Tell students that they will be drawing and writing about what they have learned about motion and pushes and pulls from reading *And Everyone Shouted, "Pull!"*.

WRITING

Text Types And Purposes

W.K.2: Use a combination of drawing, dictating, and writing to compose informative/explanatory texts in which they name what they are writing about and supply some information about the topic.

Production And Distribution Of Writing

W.K.5: With guidance and support from adults, respond to questions and suggestions from peers and add details to strengthen writing as needed.

Research To Build And Present Knowledge

W.K.7: Participate in shared research and writing projects.

LANGUAGE

Vocabulary Acquisition And Use

L.K.4: Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on kindergarten reading and content.

a. Identify new meanings for familiar words and apply them accurately (e.g., knowing duck is a bird and learning the verb to duck).
b. Use the most frequently occurring inflections and affixes (e.g., -ed, -s, re-, un-, pre-, -ful, -less) as a clue to the meaning of an unknown word.

OBTAINING, EVALUATING, AND COMMUNICATING INFORMATION

Obtaining, evaluating, and communicating information in K–2 builds on prior experiences and uses observations and texts to communicate new information.

- Read grade-appropriate texts and/or use media to obtain scientific and/or technical information to determine patterns in and/or evidence about the natural and designed world(s
- Describe how specific images (e.g., a diagram showing how a machine works) support a scientific or engineering idea
- Obtain information using various texts, text features (e.g., headings, tables of contents, glossaries, electronic menus, icons), and other media that will be useful in answering a scientific question and/or supporting a scientific claim.
- Communicate information or design ideas and/or solutions with others in oral and/or written forms using models, drawings, writing, or numbers that provide detail about scientific ideas, practices, and/or design ideas.

Revisit selected pages from *And Everyone Shouted, "Pull!"* that relate to the classroom statements. Give students time to choose the statement that describes the situation most closely.

Engage in conversation about what they know and listen to what others know to help students make sense of their initial writing ideas. Students benefit when they are able to hear themselves and others aloud.

Ask students to take turns completing the following sentence, "The action in the book relates or connects to this statement because…"

Ask: "Why did you select that statement? Can you describe how the motion of the cart relates to that statement?

Make sure each child has a turn, but also allow students to pass if they wish and come back to them after they have heard other students share ideas.

Give students the option of writing their responses in pairs, with peer support. Distribute the Word Sort cards with the key motion words students can choose to use in their writing (push, pull, stop, turn, uphill, downhill, change direction, force and move).

Give sufficient time for students to share their writing with adults and/or peers and respond to their questions and suggestions.

Evaluate students' understanding of the concept.
Review the statements and have students give examples of motion from their investigations, reading, and other experiences with the examples on the charts. Revisit the What We Think chart and add new information from the reading and read the entries that have been made on the chart so far.

Discuss how scientists look for patterns or trends in their observations and then make scientific statements that can be applied to motion of many different objects.

Journal Entry

1. *Push or Pull? Write how you know it is a push or pull.*
2. *Push or Pull? Write how you know it is a push or pull.*

Assessment

Use the Respond to Text, classroom motion charts, and Journal Entry to assess students' understanding of pushes and pulls and the related changes in motion.

Examples of Classroom Charts

To start a ball moving, there must be a push or a pull.

- I pushed/pulled the ball with my hands.
- I pushed/pulled the ball with my foot.
- I pushed/pulled the ball with a ruler.
- I pushed the ball by blowing.
- I pulled the ball with some string.
- I pushed the ball with a book.

A ball will move in the direction of a push or a pull.

- When the ball is pushed in the direction of my partner, it rolls to my partner.
- When the ball is pushed toward the chalkboard, it rolls to the chalkboard.
- When the ball is pushed toward the door, it rolls toward the door.

To change the direction of the ball, there must be a push or a pull.

- I can change the direction of the ball by kicking it in another direction.
- I can change the direction of the ball by placing a ruler in its path and it bounces off and changes direction.

To speed up, slow down, or stop a ball there must be a push or a pull.

- I can push the ball hard in the direction it is rolling and make it go faster.
- I can slow the ball down by making it go uphill.
- I can stop the ball by catching the ball.

APPENDIX

ENGINEERING DESIGN PROCESS

The Engineering Design Process provides students with a series of steps to guide them as they solve problems and design and test products, models, and solutions. The process is cyclical, yet not necessarily in an order. Students are encouraged to evaluate as they progress through the process, revisit the mission often, and revise thinking and their plan multiple times as the process unfolds.

Engineers do not always follow the Engineering Design Process steps in order, one after another. It is very common to design something, test it, find a problem, and then go back to an earlier step to make a modification or change the design. Engineers must always keep in mind the mission or problem they are trying to solve and the limitations (cost, time, material, etc.) that are part of the solution to the problem. Two key elements in working as an engineer are teamwork and design-test-and-redesign.

Mission
- Defines the problem and what the engineers are trying to design or build.
- Describes the limitations within which the engineers must solve the problem.

Brainstorm Ideas
- Imagine, discuss, and sketch possible solutions.
- Conduct research into what has already been done.
- Discover what materials are available, time frame, and other limitations.

Plan and Design
- Draw and write a plan.
- Design your solution through drawing and manipulating materials.
- Develop a plan or steps and a schedule.

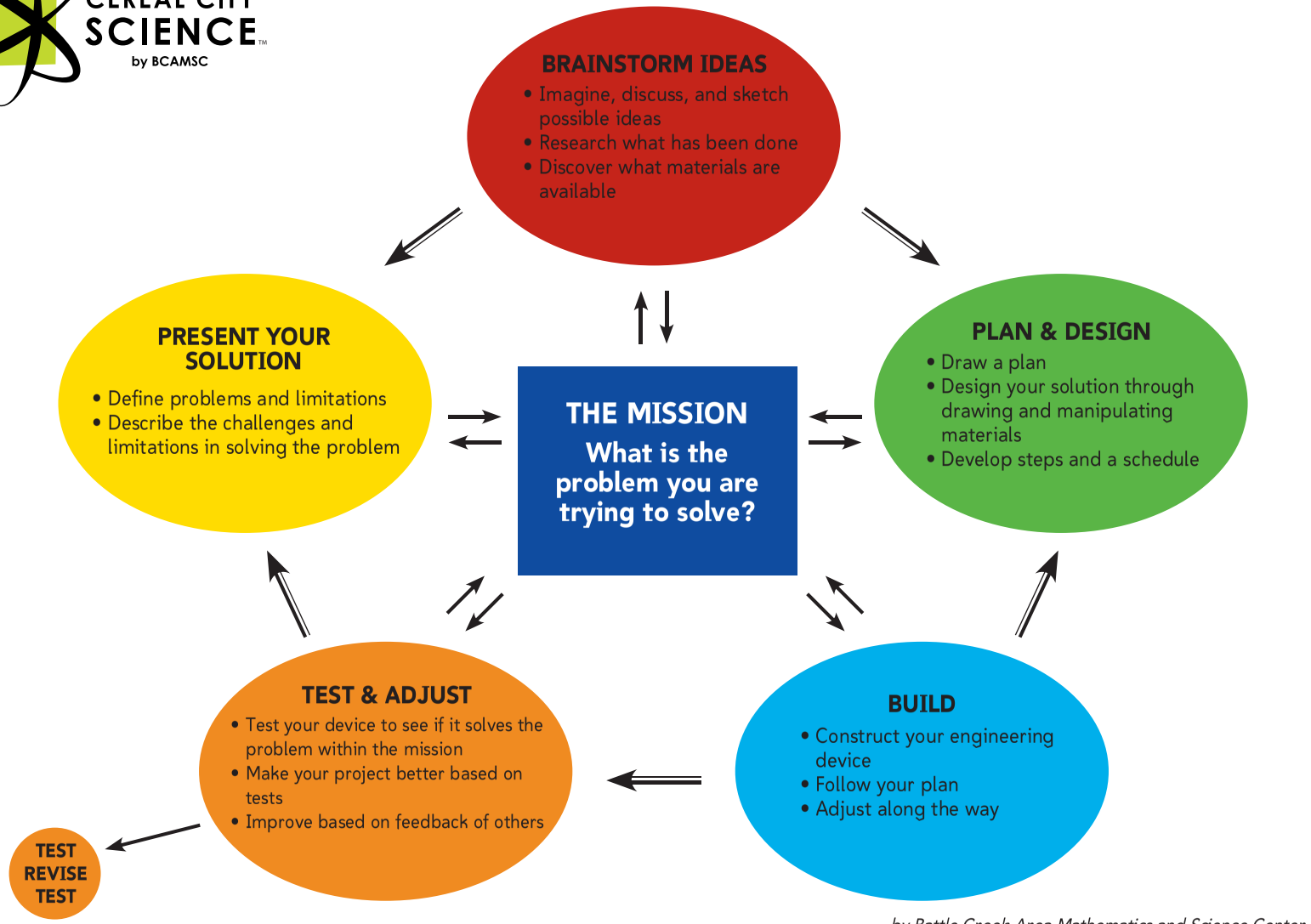
Build
- Construct your engineering device or project.
- Follow your plan.
- Adjust and test along the way.

Test and Adjust
- Test your device to see if it solves the problem within the mission and limitations.
- Make your project better based on tests: Test → Revise → Test.
- Improve based on feedback of others.

Present Your Solution
- Demonstrate how your solution solves the problem.
- Define problems and limitations.
- Describe the challenges and limitations in solving the problem.
- Describe additional revisions that could improve the device or project.

CEREAL CITY SCIENCE™ by BCAMSC

ENGINEERING DESIGN PROCESS



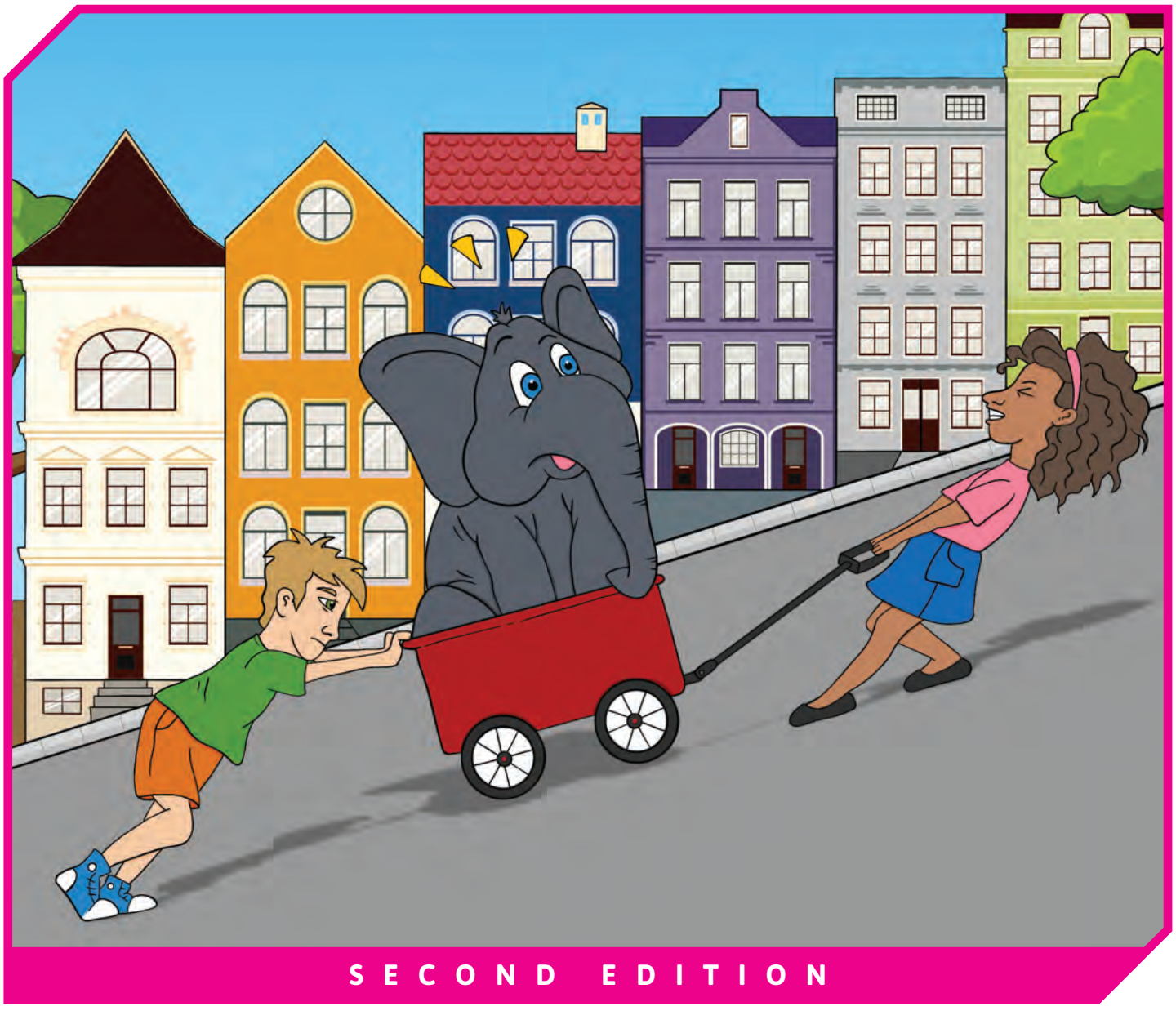
by Battle Creek Area Mathematics and Science Center
Cereal City Science
Adopted from the Carnegie Mellon Robotics Academy

APPENDIX

CEREAL CITY SCIENCE by BCAMSC

Student Journal
K.PS.NGSS

Motion: Pushes and Pulls
KPNG



SECOND EDITION

A kindergarten unit supporting Next Generation Science Standards
and Michigan Science Standards

Name:_____

Name _____

Date _____

1. Draw a picture of one of the balls you used to find out how it moves. Show how it moved.

2. Label your picture with words that describe your ball:

large small heavy light

3. Label your picture with words that tell how your ball moved:

up down fast slow push pull

1D RESPOND TO TEXT

And Everyone Shouted, "Pull!"

Name _____

Date _____

1. Choose one way that the animals moved the cart. Draw how the farm animals used a push or a pull to **move** the cart, **stop** the cart, or **turn** the cart.

move

stop

turn

Name _____

Date _____

RESPOND TO TEXT **1D**

And Everyone Shouted, "Pull!"

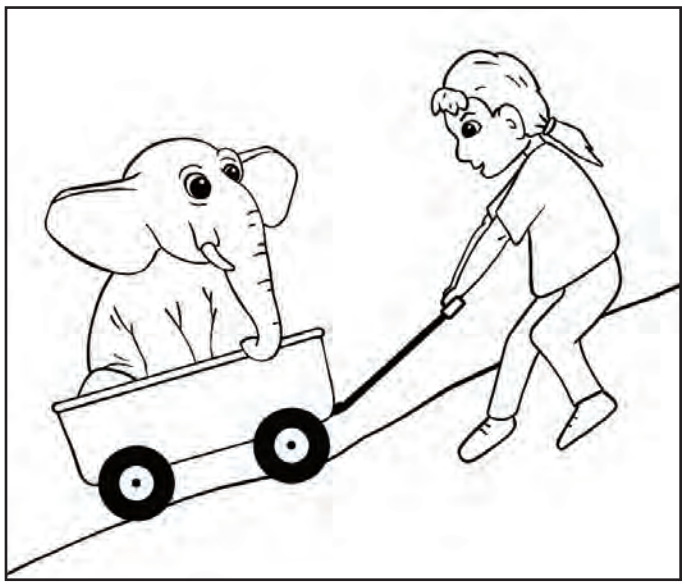
2. Write how the farm animals used a push or a pull to **move** the cart, **stop** the cart, or **turn** the cart.

1D JOURNAL
And Everyone Shouted, "Pull!"

Name _____

Date _____

1. Push or Pull?

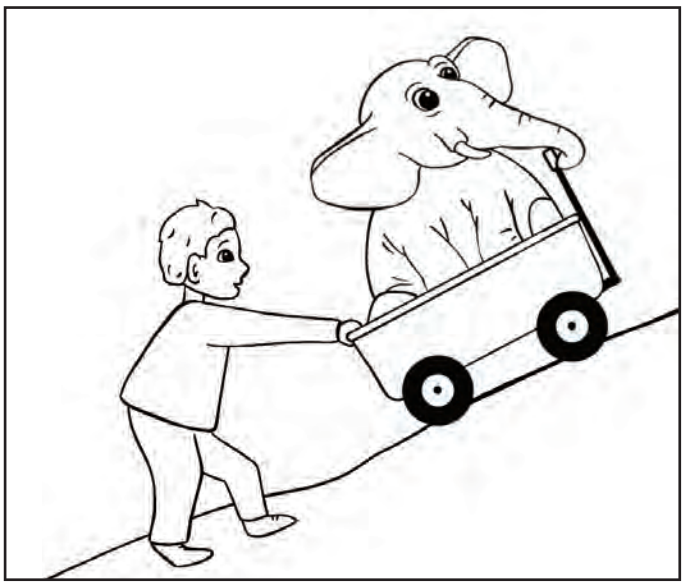


Write how you know that it is a push or pull.

Name _____

Date _____

2. Push or Pull?



Write how you know that it is a push or pull.

KEY TERMS

Name _____

Date _____