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Grade K Pushes and Pulls

Anchoring Phenomenon: Objects do not move on their own.

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Introduction

The California K–8 NGSS Early Implementation Initiative, developed by the K–12 Alliance at WestEd with close collaborative input on its design and objectives from the State Board of Education, the California Department of Education, and Achieve is a fast-start demonstration project to build local education agency (LEA) capacity to fully implement the Next Generation Science Standards (NGSS) as a core subject in the elementary grades (K–5) and as the SBE's preferred integrated model in grades 6–8.

The four-year Initiative provides teachers and administrators with in-depth, content-rich professional development to build leadership capacity and teacher acumen to deliver high-quality 3-dimensional learning for K–8 students. In addition, through collaborations among the K–12 Alliance, Achieve, and others, the LEAs in the Collaborative have opportunities to pilot test new NGSS-aligned tools, processes, assessment item prototypes, and digital and other instructional materials. The LEAs serve as resources for NGSS implementation across California, and in other NGSS-adopting states as well.

This resource presents the conceptual storyline for a unit of instruction at a specific grade level, then focuses on a portion of the storyline called a learning sequence. The learning sequence uses the three dimensions of the NGSS (disciplinary core ideas—DCI; science and engineering practices—SEP; and crosscutting concepts—CCC) to build and deepen student understanding of natural phenomena and design challenges.

Participants in the CA NGSS K–8 Early Implementation Initiative developed and field-tested the lessons in the learning sequence.

Overview

The anchoring phenomenon for this unit is “Objects do not move on their own.” In this unit, students investigate ways to move objects and describe their movement: pushes can be described by their strength and direction; pulls can be described by strength and direction; and when two objects collide, they will change direction or push against each other and stop.

The Performance Expectations addressed this unit are:

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.

K-PS2-2 Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.

K-2-ETS1-1 Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.
Learning Sequence Narrative

The Learning Sequence narrative briefly describes what students do in each lesson and links the learning between the lessons as a conceptual storyline. At the end of each learning sequence, students make connections to their understanding between the phenomenon/identified problem and the anchoring phenomenon.

The anchoring phenomenon for the learning sequence is “Objects do not move on their own.” This learning sequence uses a soccer game as a context for putting objects into motion. In Lesson 1, pushes and pulls are explored by moving motionless objects in a box. This leads to the understanding of the investigative phenomenon “Game balls do not move on their own.” In Lesson 2, students are presented with the coach’s problem of how to move the soccer materials to the field. Developing a design for moving the materials in one trip leads to the identified problem “Soccer materials do not move on their own to the field.” Lesson 3 explores the investigative phenomenon of “Discs move different distances” through playing a mini-shuffleboard game. Connections are made between the strength of a push and the distance a disc travels. This strength of the force contributes to understanding the cause and effect of pushes. Lesson 4 explores the investigative phenomenon of how “Windy days change how the ball moves in soccer.” This connects to kindergarten earth science observations of weather. Lesson 5 explores the investigation phenomenon of “A ball thrown against a wall changes directions.” Students play a game of wall ball and a game of mini wall ball to understand collisions, stopping, and changes in direction. Lesson 6 returns to the soccer game by planning a solution to the identified problem of “More goals are made in soccer with a plan.” This is a problem that requires all the concepts presented in the Learning Sequence to design the best solution for the problem.

Science and Engineering Practices (SEPs)

**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 worlds(s).
- Define a simple problem that can be solved through the development of a new or improved object or tool.

**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 that provide data to support explanations or design solutions.

- With guidance, plan and conduct an investigation in collaboration with peers.
Grade K Pushes and Pulls:
Introduction

- Evaluate different ways of observing and/or measuring a phenomenon to determine which way can answer a question.
- Make observations (firsthand or from media) and/or measurements to collect data that can be used to make comparisons.
- Make predictions based on prior experiences.

Analyzing and Interpreting Data
Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.

- Record information (observations, thoughts, ideas).
- Use and share pictures, drawings, and/or writings of observations.
- Compare predictions (based on prior experiences) to what occurred (observable events).
- Analyze data from tests of an object or tool to determine if it works as intended.

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.
- Use tools and/or materials to design and/or build a device that solves a specific problem or a solution to a specific problem.
- Generate and/or compare multiple solutions to a specific problem or a solution to a specific problem.

Obtaining, Evaluating, and Communicating Information

- 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.
- Obtain information using various texts, text features (e.g., heading, 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.

Disciplinary Core Ideas (DCIs)

PS2.A: Forces and Motion

- Pushes and pulls can have different strengths and directions.
- Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it.
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PS2.B: Types of Interactions
• When objects touch or collide, they push one another and can change motion.

PS3.C: Relationship Between Energy and Forces
• A bigger push or pull makes things speed up or slow down more quickly.

ESS2.D: Weather and Climate
• Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time.

ETS1.A: Defining and Delimiting 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.
• Asking questions, making observations, and gathering information are helpful in thinking about problems.

ETS1.B: Developing Possible Solutions
• Designs can be conveyed through sketches, drawings or physical models. These representations are useful in communicating ideas for a problem’s solution to other people.

Crosscutting Concepts (CCCs)

Patterns
• Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

Cause and Effect
• Events have causes that generate observable patterns.
• Simple tests can be designed to gather evidence to support or refute student ideas about causes.

The following Learning Sequence Narrative is based on the conceptual flow found at the end of this section.
Chapter 1: Exploration Box

Investigative Phenomenon: Game balls do not move on their own.

This lesson introduces students to a real-world context for how pushes and pulls are used to make objects (balls) move in soccer and other games.

In this first lesson, the investigative phenomenon (a motionless ball) is used to generate ideas and ask questions about the ways to move a soccer ball. (SEP) Students’ prior knowledge about how balls are made to move in soccer is used as a motivation for the discussion. (DCI) (CCC)

Once the motionless ball is moved, the investigation uses the motionless objects in the exploration box to figure out different methods for moving or stopping objects. (DCI, SEP) Movement or stopping of any object (effect) has a cause that can be described as a push or pull. (CCC) This learning experience offers opportunities for the teacher to support student use of words describing a push and pull that causes movement or stopping of movement. (Embedded vocabulary)

Understanding the investigative phenomenon “Game balls do not move on their own” will lead to understanding the anchoring phenomenon “Objects do not move on their own.” Realizing that the objects in the box are moved or stopped by pushes or pulls leads to an understanding of motion and the academic words used to describe the force. The lesson concludes with a class assessment opportunity by completing the “What do we know about moving objects such as soccer balls?” in the kindergarten science notebook. (DCI)

Chapter 2: Pullapalooza

Identified Problem: Soccer equipment cannot move to the field on its own.

At the conclusion of Lesson 1, students were presented with an engineering challenge. Soccer materials were displayed on the floor and students generated questions about what they needed to know to move the materials to the field. Students start this lesson with their list of questions. The students are then presented with some constraints to solve the problem: a set of materials that can be used for the move and the idea that their solution should require only one person making one trip. Plans are discussed, and partners develop a model of their solution on a poster to share with the class. (SEP) Class discussions focus on how different structures in the design cause objects to move differently. (CCC)

Designing a solution leads to a deeper understanding of how pushes and pulls are used to design solutions to problems.

The concepts of cause and effect related to pushes and pulls contributes to the understanding of the anchoring phenomenon of how pushes and pulls are used to move motionless objects such as soccer equipment to the field.

Chapter 3: Cruising Discs

Investigative Phenomenon: Discs move different distances.

At the conclusion of Lesson 2: Pullapalooza, students generated a list of other ideas they needed to figure out how to make a motionless ball score a goal. This lesson deepens their understanding of movement by describing the strength of a push. (DCI) The investigative phenomenon “Discs move different distances” is observed in a video of shuffleboard. Students
play a mini-shuffleboard game where the cause and effect of different-strength pushes result landing in different sections of the shuffleboard. They gather data about the push used and the distance traveled. (CCO) (SEP) Understanding that different pushes result in different distances traveled by a disc in the shuffleboard deepens understanding of the anchoring phenomenon that motionless objects won’t move on their own. Movement from pushes show patterns to predict distances.

Lesson 4: Huff, Puff, and Move the Ball

Investigative Phenomenon: Windy days change how the ball moves in soccer.

Lesson 3: Cruising Discs explored the force of the pushes used in a mini-shuffleboard game. In this lesson, understanding the strength of a push is deepened by changing the cause of the push. (CCO) This concept is introduced through a video that shows the phenomenon of high winds pushing on a ball. (CCC)

While we cannot see wind, we can see what wind does to objects. To explore this concept, students blow through two different-sized straws causing a small ball to move at different speeds. (DCI) By collecting and analyzing data, they deepen their understanding of ways to change the strength of a push. (SEP) When playing soccer, a strong wind can push the ball in a different direction.

The second part of this lesson extends the experiment with straw and ball. Students use the science and engineering practice of collaboratively designing and planning an investigation to determine how to change the direction that an object moves as well as changing the strength of the push. (SEP)

Lesson 5: When Two Objects Collide

Investigative Phenomenon: A ball thrown against a wall changes direction.

In the previous lessons, investigative phenomena using explorations with pushes and pulls established that pushes and pulls stop objects or move them in different directions. The force of the push or pull will impact the distance traveled during the movement. (DCI)

In this lesson, the investigative phenomenon is “A ball thrown against a wall changes direction.” It explores the question of how to get a ball around defenders in soccer. The activity for the investigation begins by observing how a ball moves in a wall ball game. Understanding how the ball moves in wall ball deepens the concept that when objects collide, the direction of the movement changes in predictable patterns. (DCI)

In this mini-wall ball exploration, a ball is rolled down a ramp to collect data about the effect of a ball colliding with a wall. (SEP) The ramp is used to keep the force of the ball consistent during the investigation. Data will be collected and recorded showing the effect of changing the angle of the ramp has on the collision of the ball with the wall. This data will be used to collaboratively discuss how the changes with the ramp cause predictable patterns of collisions with the wall. This leads to a deeper understanding of the effects and patterns. (CCC)

Wall ball helps build an understanding of how players on a soccer field are used as collision points that can change the direction and strength of a push on a soccer ball. This investigation adds to the knowledge of the anchoring phenomenon of how motionless objects can be made to move.
Lesson 6: Collision Goal!

Identified Problem: More goals are made in soccer with a plan.

In this final investigation, the data collected from observing and recording pushes that change direction in Lesson 5: When Two Objects Collide will be used to collaboratively design a solution or strategy for using collisions to move a ball around an obstruction. Materials available to design or engineer the plan for scoring are familiar materials used throughout the investigations: a ramp, a collision wall, a goal, and a ball. (SEP) (CCC) (DCI)

Students collaboratively plan, test, adjust their plan, and retest leading to the selection of the best plan or solution. Students use what they have figured out in Lesson 1: Exploration Box about pushes and pulls, combined with designing solutions in Lesson 2: Pullapalooza, strategic use of the strength of the force in Lesson 3: Cruising Discs, forces of pushes from wind in Lesson 4: Huff, Puff, and Move the Ball as well as changes due to collisions in Lesson 5: When Two Objects Collide to plan for collisions in the final explanation of how to move a motionless ball using the strength of force and collisions to score a goal in soccer.

An individual plan for scoring is evaluated on understanding how to get a motionless object (soccer ball) to move in predictable ways using the strength of a kick (ramp), placement of players for collisions or stopping motion, and direction of kicks to score goals.

Learning Sequence 3-Dimensional Progressions

SEP Progression

If SEPs are emphasized in a lesson, they are in the foreground. If they support the learning but are not primary to it, they are in the background.

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<td>Lesson 4</td>
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<td>Lesson 6</td>
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<tbody>
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<td>Lesson 1</td>
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<td>Lesson 2</td>
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<tr>
<td>Lesson 3</td>
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</table>
## Learning Sequence 3-Dimensional Progressions (continued)

### SEP PROGRESSION (continued)

### Planning and Carrying Out Investigations (continued)

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Lesson 4</td>
<td>Students build on their understanding of the strength of a push and collaboratively plan and conduct an investigation of the strength of different pushes on a small ball.</td>
</tr>
<tr>
<td>Lesson 5</td>
<td>Students deepen their understanding of planning and conducting investigations by using a model of wall ball to investigate the direction and force of a push.</td>
</tr>
<tr>
<td>Lesson 6</td>
<td>Students plan and conduct mini-games of soccer using what they know about collisions and ramps. This lesson is a culmination of understanding the phenomenon of scoring in soccer by designing collisions and ramps for getting around players.</td>
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</table>

### Analyzing and Interpreting Data

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Lesson 1</td>
<td>Students collect observations of how objects are moved by a push or a pull.</td>
</tr>
<tr>
<td>Lesson 3</td>
<td>Students compare predictions of how to score points in shuffleboard to collecting data from the mini-shuffleboard game.</td>
</tr>
<tr>
<td>Lesson 4</td>
<td>Students use observations of wind on a soccer field to collect data about how wind moves objects.</td>
</tr>
<tr>
<td>Lesson 5</td>
<td>Students collect data about how collisions are used in wall ball to change the direction of the ball.</td>
</tr>
<tr>
<td>Lesson 6</td>
<td>Students analyze data collected from the strength of pushes in lessons 3 and 4 and collisions in Lesson 5 to design a solution for scoring a goal on a soccer field.</td>
</tr>
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</table>

### Constructing Explanations and Designing Solutions

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Description</th>
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<tbody>
<tr>
<td>Lesson 1</td>
<td>Students use evidence (observations) to construct an explanation of how things move with a push or a pull.</td>
</tr>
<tr>
<td>Lesson 2</td>
<td>Students design and compare solutions to the problem of how to move equipment to the field.</td>
</tr>
<tr>
<td>Lessons 3 and 4</td>
<td>Students construct explanations about the relationship between the force and strength of a push.</td>
</tr>
<tr>
<td>Lesson 5</td>
<td>Students construct a model of collisions and use it to explain how collisions change direction of movement.</td>
</tr>
<tr>
<td>Lesson 6</td>
<td>Students apply what they know about strength of a force and change in direction through collisions to score a goal in soccer.</td>
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### Obtaining, Evaluating, and Communicating Information

<table>
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<tr>
<th>Lessons</th>
<th>Description</th>
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<tbody>
<tr>
<td>While this practice is not in the foreground of the learning sequence, it is in the background of most lessons where students are asked to communicate scientific information orally and/or in written format by making contributions to the Class Notebook and reading the chart. A list of nonfiction books is included in the lessons and should be read aloud to model obtaining information from books as well as modeling informational writing formats.</td>
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</tbody>
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### Learning Sequence 3-Dimensional Progressions (continued)

#### DCI PROGRESSION

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Description</th>
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</table>
| **Lesson 1** | Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. (PS2.A)  
Asking questions, making observations, and gathering information are helpful in thinking about problems. (ETS1.A) |
| **Lesson 2** | Pushes and pulls can have different strengths and directions (PS2.A)  
Asking questions, making observations, and gathering information are helpful in thinking about problems. (ETS1.A)  
Designs can be conveyed through sketches, drawings, or physical models. These representations are used in communicating ideas for a problem's solution to other people. (ETS1.B) |
| **Lesson 3** | Pushes or pulls have different strengths and directions. (PS2.A)  
Pushing or pulling on an object can change the speed or direction of an object and can start or stop it. (PS2.A)  
A bigger push makes things speed up or slow down more quickly. (PS2.C) |
| **Lesson 4** | A push on an object can change the speed or direction of its motion and can start or stop it. (PS2.A)  
A bigger push makes things speed up or slow down more quickly. (PS2.C)  
Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time (ESS2.D) |
| **Lesson 5** | When objects touch or collide, they push on one another and can change motion. (PS2.B)  
Pushing or pulling on an object can change the speed or direction of its motion. (PS2.A) |
| **Lesson 6** | Combines PS2.A, 2.B and 2.C  
A situation that people want to change or create (scoring goals in soccer) can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions (ETS1.A)  
Designs can be conveyed through sketches, drawings, or physical models. These representations are used in communicating ideas for a problem's solution to other people. (ETS1.B) |

#### CCC PROGRESSION

##### Cause and Effect

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Lesson 1</strong></td>
<td>Students explore the cause of movement through pushes or pulls.</td>
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<tr>
<td><strong>Lesson 2</strong></td>
<td>Students observe patterns of movement and consider structure and function to design a plan to move objects to a field for the effect of making the work easier.</td>
</tr>
<tr>
<td><strong>Lesson 3</strong></td>
<td>Students identify the cause of a change in the strength of the movement of an object.</td>
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Learning Sequence 3-Dimensional Progressions (continued)

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<thead>
<tr>
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<tbody>
<tr>
<td>Cause and Effect (continued)</td>
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</tr>
<tr>
<td>Lesson 4</td>
<td>Students observe the effect when the wind blows and identify patterns in the change of direction.</td>
</tr>
<tr>
<td>Lesson 5</td>
<td>Students identify the causes of change in direction of a ball due to collisions in wall ball.</td>
</tr>
<tr>
<td>Lesson 6</td>
<td>Students plan the cause and effect of scoring in soccer by using different pushes of strengths of force, direction, and collisions as part of the plan.</td>
</tr>
</tbody>
</table>

Patterns

| Lessons | The crosscutting concept of pattern is the background in most lessons in order to generalize what is common about objects that move fast, slow, greater or lesser distance, change direction, or stop. These patterns are part of the discussion but not the primary crosscutting concept driving the investigations. |

References


Grade K Pushes and Pulls Conceptual Flow

Anchoring Phenomenon

Objects do not move on their own.

Pushes and pulls cause objects to move.

Investigative Phenomena and Identified Problems

- **Game balls do not move on their own.**
- **Soccer equipment cannot move to the field on its own.**
- **Discs move different distances.**
- **Windy days change how a ball moves in soccer.**
- **A ball thrown against a wall changes direction.**
- **More goals are made in soccer with a plan.**

**Patterns**

**Pushes and Pulls Conceptual Flow**

**Motion can be described.** You can push or pull an object to start or stop it.

**Pulls can be described by strength and direction.**

**A bigger push makes things speed up and slow down more quickly. A bigger push makes things go farther.**

**When objects touch or collide, they push against each other and change motion (change direction). Objects stop when they push against each other.**

**Planning and carrying out investigations**

**Constructing explanations and designing solutions**

**Planning and carrying out investigations**

**Analyzing and interpreting data**

**Developing and using models**

Obtaining, evaluating, and communicating information

Patterns

Cause and Effect
Standards

Refer to Appendix K.1 for NGSS, CCSS (ELA), and California ELD Standards.
K.1 Exploration Box

Driving Question
How do balls move in games like soccer?

Storyline Link
The anchoring phenomenon is “Objects do not move on their own.” This lesson introduces students to a real-world context for how pushes and pulls are used to make objects (balls) move in soccer and other games. In this first lesson, the anchoring phenomenon (motionless ball) is used to generate ideas and ask questions about ways to move a soccer ball. (SEP) Students’ prior knowledge about how balls are made to move in soccer is accessed through discussion and a video of a soccer game. (DCI) (CCC)

Once the motionless ball is moved, then the investigative activity uses the motionless objects in the exploration box to figure out different methods for moving or stopping objects. (DCI, SEP) Movement or stopping of any object (effect) has a cause that can be described as a push or pull. (CCC) This learning experience offers opportunities for you to support student use of words describing a push or a pull that causes movement or stopping of movement. (Embedded vocabulary)

Understanding the investigative phenomenon “Game balls do not move on their own” will lead to understanding the anchoring phenomenon “Objects do not move on their own.” The objects in the box are moved or stopped by pushes or pulls, leading to understanding both the motion and the academic words used to describe the force. The lesson concludes with a class assessment opportunity by completing the “What do we know about moving objects such as soccer balls?” in their kindergarten science notebook (or the Class Notebook). (DCI)

This leads to the investigative problem presented in the next lesson, where the coach describes the problem of figuring out a way to move soccer equipment to the field in one trip. Students generate questions to understand the problem and design a solution.

Throughout the lesson, a flag (►) denotes formative assessment opportunities where you may change instruction in response to students’ level of understanding and making sense of phenomena.

Time
35 minutes
5 minutes Engage
15 minutes Explore
10 minutes Explain
5 minutes Elaborate/Evaluate
K.1 Exploration Box

Materials
Whole Class
- A soccer ball to display for Engage
- K.1.C1: Class Notebook
- K.1.R1: Students Playing Soccer
- K.1.R2: Soccer Equipment
- Zipper sandwich bags
- Index cards
- FC Barcelona video (https://www.youtube.com/watch?v=CvblAaEgKjc)
- Soccer supplies: soccer balls, ball bag, cones, water jug, chairs, snacks

Group
- Box or basket that contains various objects and materials to push and/or pull (one box per group)
- Objects: wooden blocks, wooden train cars, balls, counter bears, cars, soup cans, paper clips, pipe cleaners, rubber bands, straws, grooved ruler

Individual
- Kindergarten science notebook

Advance Preparation
1. This learning sequence can be done with additional support for classroom routines at the beginning of the kindergarten year by using the K.1.C1: Class Notebook as a guide to what could be in your class notebook. As the year continues, more of the notebooking can be done in student individual notebooks increasing literacy/reading connections. Later in the year, students will not need the model.
3. Place all the objects in a box or basket (one per group).

Image via Vista Unified School District [Used with Permission]
An Example of an Exploration Box
4. Prepare zipper sandwich bags with a label on an index card for each item the students will use in the basket/box of items. This will be used for a class word wall.

5. Take one set of objects out of the box and place each object in a zipper bag with a card that labels the name of the object. Place all the objects with their labels on a pocket chart or taped to the wall for student reference.

6. This lesson may need to be repeated for multiple days in order to solidify terms and motions with students such as moving an object by pushing or pulling and stopping an object by pushing or pulling. This learning sequence is designed for midyear in kindergarten after students have been able to link charted words with actions.

7. Review the FC Barcelona video (https://www.youtube.com/watch?v=CvblAaEqKjc)
K.1 Exploration Box

Procedure

Engage (5 minutes)

Observe a motionless ball, ask questions, and make predictions about what causes a ball to move.

1. Engage students in naming the games they play on the playground or at a park with their friends or family. How do they play? What do they like about playing? Does anyone play on a team? List the games on page 1 of the K.1.C1: Class Notebook.

TEACHER NOTE

Kindergarten students ask questions in the moment. They are not good at remembering those questions and sharing them at the end of an investigation. You should be prepared to collect questions you hear students asking as you check in with groups. Chart some of the observations made and new questions to explore on the K.1.C1: Class Notebook at the end of each lesson. As the lessons progress and students see their questions in writing, they will begin to remember and ask their own questions about the sequence of investigations.

2. Soccer is a game that children play around the world. Show the FC Barcelona video to remind students about the game of soccer. Place a soccer ball in the middle of the circle of students and ask students to tell the ball to move on the count of 3. Try this twice and see what happens.

3. Share ideas about actions that might make the soccer ball move. Record on the K.1.C1: Class Notebook ideas generated by students. Chart responses e.g. Can I kick the ball? Can I hit with my hand? Can I blow on the ball? Can I pull the ball?

Image via Vista Unified School District  
[Used with Permission]
4. Use the charted actions and ask students to decide which method they want to try first to move the ball. Select individual students to try out the methods and record the result on the K.1.C1: Class Notebook.

**TEACHER NOTE**
During step 4, use a think-aloud to model thinking about pushes and pulls. This think-aloud helps the students think on their own in step 7b and 7c and verbalize the results of the pushes and pulls in step 12.

5. Lead a discussion that identifies whether each method was a push or a pull. Record push or pull next to each method tried on the K.1.C1: Class Notebook.

**Explore (15 minutes)**

Plan and carry out an investigation and observe how objects move when pushed or pulled.

6. Display K.1.R1: Students Playing Soccer or take pictures at one of the kindergarteners’ soccer games to display. Students discuss with a partner what they noticed about how the players move the ball. Ask partners to share different ways in which the ball was moved.

7. We noticed the soccer ball was moved in several ways. Now we are going to figure out how smaller objects can be moved.
   a. Show the class a box of objects and explain that they will get a chance to test the different objects. Their goal is to cause the object to move without the object leaving the box.
   b. Ask partners to face each other knee-to-knee, using student-to-student discourse to talk about ideas of how to cause the objects to move.
   c. Ask partners to share ideas with the larger group while you chart the ideas on the K.1.C1: Class Notebook page titled Exploration Box.

**TEACHER NOTE**
Refer to Steps 4 and 5 in Advance Preparation to introduce the cards and materials for this part of the investigation. This will support the development of student language as well as concepts of print for communicating ideas, e.g. left to right, words versus letters, whole thoughts as sentences. Include words about the objects they will be using such as: train cars, balls, bears, cars, paper clips, pipe cleaners, soup cans, rubber bands, straws, ruler. See the pictures on page K.1.8 for examples.

8. Place each type of material from the exploration box on the pocket chart or front board ledge. Ask students which materials in the pocket chart they can match to the word on the 3-by-5 card with the name of the materials. (This is an opportunity for advanced readers to match or others to match beginning sounds).
9. Ask students to predict how each object might be moved. Record ideas on the K.1.C1: Class Notebook with a picture of the object and how to move the object. Leave space for results.

10. Place one box of objects on each table for a group of 2 to 4 students, and instruct students to explore how they can cause the objects to move.
   a. While walking around and observing what students are trying, ask students if their predictions were accurate or if they have new predictions about how to move the objects.
   b. Possible questions: "How can you move the object? Which way did the object move? Can you move the object another way? What caused the movement? Do all objects push or pull the same? Are some objects pushing or pulling differently? Can you use two objects to move one object? How is a pull different from a push?"

**Teacher Note**

As students are exploring, walk around and listen for prior knowledge of predictions, the position of objects, cause and effect (CCC), and vocabulary words such as push, pull, cause, and effect. Watch for the ways in which students observe and describe causes or patterns of how different pushes or pulls affect the movement of the ball. Listen to how the students explain their observations in order to build on their vocabulary for the next exploration. Use the words push, pull, cause, and effect to expand language for students who do not yet use the words. The labeled zipper bags/or word wall with objects also supports language for English Learners or students building schema.
K.1 Exploration Box

**Explain (10 minutes)**

*Analyze and interpret observations about the effects of a push or pull on movement.*

11. Ask students to return to the meeting area and be ready to use objects from their table to explain what they did to cause the object to move. Ask partners to pair share knee-to-knee (student-to-student discourse) of how they moved the objects. After practicing with a partner, ask partners to choose one or two moves to share with the whole group.

12. Return to the K.1.C1: Class Notebook and record next to the predictions made in Step 9 a statement about how the objects were actually moved. Add any new ideas suggested by the students.

13. Create a page in the K.1.C1 Class Notebook called “What causes movement?”. Use the object cards that you had placed in the pocket chart and move them over to the page in the K.1.C1: Class Notebook.

   a. Ask students to name an object that can be pushed. Ask them to explain how they pushed the object. Suggest the following sentence frame to communicate and demonstrate what they did:

   
   I pushed _____ by _____.
   
   Use a combination of pictures and words to record their explanations. For example, use arrows to show the direction the object moved.

   b. Ask students to name an object that can be pulled. Ask them to explain how they pulled the object. Suggest the following sentence frame to communicate and demonstrate what they did:

   
   I pulled _____ by _____.
   
   Continue to chart.

   c. Ask students to say how they stopped an object from moving:

   
   I stopped _____ by pulling or pushing the opposite direction.
   
   Chart ideas for stopping under the appropriate push or pull column.
14. Ask students to review all the objects that can be moved or stopped by pushing. Ask students to choral read all the objects that can be moved or stopped by pulling. Lead a discussion of which objects could be moved or stopped by either pulling or pushing.

**TEACHER NOTE**
The sentence frames are intended to be suggested by you only if students need scaffolds. Simpler sentence frames can be used if needed by a class. Kindergarteners are interacting with written text in the form of objects and pictures.

15. Ask the students to talk to a partner knee-to-knee about what causes something to move. Share ideas with the whole class. Chart ideas on the K.1.C1: Class Notebook.

**TEACHER NOTE**
Throughout the learning sequence, adapt for different abilities in reading charts by using individual readers, partner readers, or choral reading led by you.

16. Develop a class definition for a push and a pull. Ask students to think about what we do when we push. Write more than one idea on the chart and ask students to place a small sticky note by the one they agree with. Compare the number of sticky notes and decide which has more and which has less. Continue the same process for a pull. Rewrite final selections on a new notebook page.

**TEACHER NOTE**
The experience of understanding cause and effect will depend on the prior discussion in the class. Build on charted student responses to identify what causes something to move. Facilitate student responses to build understanding that there is a cause for all movement or stopping movement. The causes include either a push or a pull.

17. Select a title from the Literacy Links on page K.1.10 to read aloud at this point in the lesson. Any of the titles are appropriate now that students have some experience with the academic vocabulary.

18. Have students return to tables and take out their kindergarten science notebook or a piece of paper. Ask students to pick an object they either pushed or pulled. Have them use pictures, words, and arrows to show what they did (cause) and what happened to the object (effect).
Elaborate/Evaluate (15 minutes)

Construct an explanation about the cause of the movement of a motionless soccer ball.

19. Display the K.1.C1: Class Notebook and bring the students back to the meeting area with the soccer ball in the center. Ask, “Think about the way you moved the things in the box. What do we know about moving objects such as soccer balls? What did we figure out about how a motionless soccer ball is made to move?” Chart student ideas and record what they figured out about the movement of motionless objects (anchoring phenomenon) in the K.1.C1: Class Notebook.

20. Display the materials used in a soccer game (cones, balls, net, banner) or show K.1.R2: Soccer Equipment and explain that the coach has a problem. The coach needs help to figure out how to move all these objects to the field in one trip. What do we need to know to figure this out? Students generate a list of questions of things they need to know to solve the problem. Chart student questions on the K.1.C1: Class Notebook.

21. Tomorrow, we will work on the problem of getting materials to the field.

Literacy Links

It would be appropriate to have students interact with text to extend their understanding of pulls. These selections can be read aloud at any time after this lesson because students have experienced pushes and pulls. Suggested books include:

Fiction:

- The Gigantic Turnip by Alessio Tolstoy and Niamh Sharkey
- Grandma Lena’s Big Ol’ Turnip by Denia Lewis Hester and Jackie Unvanovic
- The Enormous Potato by Aubrey Davis and Dušan Petričić
- The Giant Carrot by Jan Peck and Barry Root
- The Giant Cabbage: An Alaska Folktale by Chérie B. Stihler and Jeremiah Trammell
- The Gigantic Sweet Potato by Dianne De Las Casas and Marita Gentry
- The Turnip by Jan Brett
K.1 Exploration Box

Nonfiction:

- *And Everyone Shouted “Pull”* by Claire Llewellyn and Simone Abel

References


Toolbox Table of Contents

K.1.C1  Class Notebook  K.1.13

K.1.R1  Playing Soccer  K.1.16

K.1.R2  Soccer Equipment  K.1.18
Class Notebook

Pushes and Pulls

Games We Play

How can we move the ball?

<table>
<thead>
<tr>
<th>Exploration Box</th>
<th>What causes movement?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Object</td>
<td>How to Move</td>
</tr>
<tr>
<td></td>
<td>Results</td>
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</tbody>
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|                         |                        |
| Pushes                  | Pulls                  |

A project of CA NGSS K–8 Early Implementation Initiative.
Class Notebook (continued)

What causes something to move?

Definitions

- Pushes
- Pulls

How do we get a motionless object to move?

How can the coach move all these projects to the field in one rip?
Class Notebook (continued)

Questions
Students Playing Soccer

Image by iStock.com/kali9

Image by iStock.com/Aksonov
Students Playing Soccer (continued)

Image by IStock.com/skynesher

Image by IStock.com/FatCamera
Soccer Equipment

Soccer Balls

Image by iStock.com/gemenacom

Soccer Net

Image by iStock.com/Liupco

Cones

Image by iStock.com/acrylik

Flags

Image by iStock.com/Dziurek

Water Jug, Food, and Umbrella

Image by iStock.com/Danni1185
Next Generation Science Standards (NGSS)

This lesson is building toward:

**PERFORMANCE EXPECTATIONS (PE)**

| 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. [Clarification Statement: Examples of pushes or pulls could include a string attached to an object being pulled, a person pushing an object, a person stopping a rolling ball, and two objects colliding and pushing on each other.] [Assessment Boundary: Assessment is limited to different relative strengths or different directions, but not both at the same time. Assessment does not include non-contact pushes or pulls such as those produced by magnets.] |


**SCIENCE AND ENGINEERING PRACTICES (SEP)**

**Analyzing and Interpreting Data**

- Record information (observations, thoughts, and ideas).
- Use and share pictures, drawings, and/or writings of observations.

**Planning and Carrying Out an Investigation**

- With guidance, plan and conduct an investigation in collaboration with peers.
- Make observations (firsthand or from media) and/or measurements to collect data that can be used to make comparisons.

**Constructing Explanations and Designing Solutions**

- Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena.

**Obtaining, Evaluating, and Communicating Information**

- 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.
- Obtain information using various texts, text features (e.g., heading, 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.

**DISCIPLINARY CORE IDEAS (DCI)**

**PS2.A Forces and Motion**

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

**ETS1.A: Defining and Delimiting an Engineering Problem**

- Asking questions, making observations, and gathering information are helpful in thinking about problems.
Appendix K.1

CROSSCUTTING CONCEPTS (CCC)

**Cause and Effect**
- Events have causes that generate observable patterns.

**Patterns**
- Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

*Disciplinary Core Ideas, Science and Engineering Practices, and Crosscutting Concepts* are reproduced verbatim from *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. DOI: [https://doi.org/10.17226/13165](https://doi.org/10.17226/13165). National Research Council; Division of Behavioral and Social Sciences and Education; Board on Science Education; Committee on a Conceptual Framework for New K–12 Science Education Standards. National Academies Press, Washington, DC. This material may be reproduced for noncommercial purposes and used by other parties with this attribution. If the original material is altered in any way, the attribution must state that the material is adapted from the original. All other rights reserved.

Common Core State Standards (CCSS)

**CCSS ELA READING**

CCSS.ELA-LITERACY.R1.K.1
With prompting and support, ask and answer questions about key details in a text.

**ELA SPEAKING AND LISTENING**

CCSS.ELA-LITERACY.SL.K.3
Ask and answer questions in order to seek help, get information, or clarify something that is not understood.

California English Language Development (ELD) Standards

**CA ELD**

Part I.K. 5 Listening actively and asking questions about what was heard

<table>
<thead>
<tr>
<th>EMERGING</th>
<th>EXPANDING</th>
<th>BRIDGING</th>
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<tbody>
<tr>
<td>P1.K.5 Demonstrate active listening to read-alouds and oral presentations by asking and answering yes-no and wh-questions with oral sentence frames and substantial prompting and support.</td>
<td>P1.K.5 Demonstrate active listening to read-alouds and oral presentations by asking and answering questions with oral sentence frames and occasional prompting and support.</td>
<td>P1.K.5 Demonstrate active listening to read-alouds and oral presentations by asking and answering detailed questions with minimal prompting and light support.</td>
</tr>
</tbody>
</table>

In addition to the standard above, you may find that you touch on the following standards in this lesson as well:

- P1.K.1 Exchanging information and ideas via oral communication and conversations
- P1.K.2 Interacting with written English (print and multimedia)
- P1.K.12 Selecting and applying varied and precise vocabulary and other language resources

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Anchoring Phenomenon
Objects do not move on their own.

Lesson Concept
Design a solution to a problem using structures that cause movement by pulling or pushing the object.

Identified Problem
Soccer equipment cannot move to the field on its own.

Standards
Refer to Appendix K.2 for NGSS, CCSS (ELA), and California ELD Standards.
Driving Question
How can equipment be moved to the field in one trip?

Storyline Link
In Lesson 1: Exploration Box, free explorations using the exploration box were made with pushes and pulls. Investigations included observing the effects that different pushes and pulls have on motionless objects. (CCC) At the conclusion of Lesson 1: Exploration Box, soccer materials were displayed in the classroom or on K.1.R2: Soccer Equipment. Students generated questions about what they need to know to move the materials to the field.

This challenge represents an engineering problem that will lead to planning an investigation to move many objects to the soccer field in one trip. (SEP) Students start with their list of questions about what they need to know to help the soccer coach move the objects to the field. (DCI) One of their questions might be what materials do we have to move them. They are then presented with a set of material in parents’ cars. The criteria for a successful plan includes making one trip to the field and moving by one person. Plans are discussed and partners develop a model of their solution on a poster to share with the class. (SEP) Class discussions focus on how different designs are more effective solutions. (CCC) The concepts of cause and effect related to pushes and pulls contributes to the understanding of the anchoring phenomenon.

During Lesson 3: Cruising Discs, students explore how to score by changing the strength of pushes and pulls resulting in objects going different distances. (DCI)

Throughout the lesson, a flag (🚩) denotes formative assessment opportunities where you may change instruction in response to students’ level of understanding and making sense of phenomena.

Time
30 minutes

10 minutes  Engage
10 minutes  Explore
5 minutes  Explain
5 minutes  Elaborate/Evaluate

Materials
Whole Class

- Soccer Supplies: soccer balls, ball bag, cones, water jug, chairs, snacks
- K.2.C1: Class Notebook (continuation of K.1.C1: Class Notebook started in Lesson 1: Exploration Box)
- K.2.R1: Trunk of Car
K.2 Pullapalooza

Individual

- Kindergarten science notebook
- pencil
- crayons

Advance Preparation

1. Place soccer objects in the center of the rug area to set the stage for the problem.
2. Prepare the continuation of the Class Notebook started in Lesson 1: Exploration Box. Review K.2.C1: Class Notebook that is described in the Toolbox for this lesson. Consider making the Criteria and Constraints page before the lesson.
3. Open the K.1.C1 Class Notebook to the page with questions about how to move the objects to the field started in Lesson 1: Exploration Box.
K.2 Pullapalooza

Procedure

Engage (10 minutes)

Identify the problem of needing a **structure** to move soccer equipment to the field.

1. Display the soccer materials on the meeting place carpet and display the charted questions recorded on the **K.2.C1: Class Notebook** (from Lesson 1: Exploration Box where the problem was introduced). Continue the discussion of the question "What do we need to know to solve the coach’s problem?" Chart any new responses or questions directly on the notebook.

2. Tell the students one of the parents has some things in their car that might help the coach. Take the students to a car to see the materials placed in the trunk for carrying materials or show **K.2.R1: Trunk of Car**. Discuss the things they see in the car: boxes, a wagon, rope, plastic garbage bags, a big duffle bag and a large board. Discuss how they might use the different objects to move the soccer equipment.

3. Introduce **K.2.C1: Class Notebook** page called Criteria and Constraints.
   - Criteria 1: Equipment must be moved in one trip.
   - Criteria 2: One person must move all the materials.
   - Constraints: Use materials in the trunk of the parent’s car.

4. Ask students to discuss knee-to-knee (student-to-student discourse) this question with a partner: “What could be done to get these objects moved in one trip by one person?” Share ideas using the sentence frame:
   - My partner says _____.

   Listen to several students share ideas from their partners.
   Chart student ideas.

   **TEACHER NOTE**
   Some students might suggest driving the car onto the field. Tell them this could not be done as there were buildings in the way, and we can’t drive on the grass. Listen to sufficient ideas to help all students realize there is more than one way to move the materials to the field.

Explore (10 minutes)

**Use patterns of movement to design a solution for transporting equipment to the soccer field.**

5. Tell students “Some of your ideas were to pull the equipment, and some of your ideas were to push the equipment. What direction does the pull move? How is that direction different from a push?” After a short discussion, turn to a page of **K.2.C1: Class Notebook** and tell students, “Let’s try to show what a push is and what a pull is with words and pictures.” Ask students for suggestions for words, symbols, and pictures to show movement.
6. Ask partners to design a way for the coach to move the materials to the field and make a poster by drawing their plan on a sheet of construction paper. Remind students that the move must be done in one trip with the materials from the parent’s car.
   a. Be sure and include arrows to show the direction you are moving the equipment.
   b. Use the words push or pull to show how you are using a force to move the equipment.

   Image via Vista Unified School District [Used with Permission]
   These students are working in their science notebook instead of construction paper.

**Explain (5 minutes)**

*Communicate a solution to the problem of moving equipment to the field identifying the structure to push or pull.*

7. Have students return to the meeting place with their plans. Ask partners to share their plans for moving the equipment to the field. Remind students to include whether they are pushing or pulling the equipment. Record each partner’s solutions on the K.2.C1: Class Notebook under A Plan to Move the Equipment.

**Examples of Student Work**

Images via WestEd (taken during field tests)
8. Using the recorded solutions, ask students which ideas are a push and which ideas are a pull. Have individual students take turns circling all the pushes in one color and circling all the pulls with another color.

9. Display the Criteria and Constraints page in the K.2.C1: Class Notebook with the recorded solutions. Ask partners to talk about which ideas meet the criteria and constraints.

**Elaborate/Evaluate (5 minutes)**

*Compare pictures (solutions) to determine the easiest structure to push or pull the equipment to the field.*

10. ▶ Ask students to review the list of different solutions they planned to move the equipment to the soccer field. Ask partners to pick the solution that they think will work the best, place a small sticky note on the plan, and explain why they think it will push or pull the equipment. Compare the numbers of sticky notes by each plan. Ask students to order the plans from the most selected to the least selected. Lead a discussion that includes the reasons for the selections.

**TEACHER NOTE**

Listen for the use of push and pull as well as logical cause and effect statements. If students do not use the academic language in the descriptions, continue the choice centers with the cards started in Lesson 1: Exploration Box.

11. Discuss the difference between a push and a pull. Read a selection from the Literacy Links listed below; for example, *And Everyone Shouted “Pull!”*

12. Ask students to think about the soccer game. “We know how to move equipment to the field and push or pull the motionless ball to play the game.” Brainstorm and chart what else you need to figure out to move the motionless soccer ball to score goals. Record student questions in the K.2.C1: Class Notebook under the heading; “What else do we need to figure out?” Questions might include: *How strong do we need to push? How do we stop the ball? How do we change the direction of the ball? Does weather ever make the ball move or stop moving?*

**Literacy Links**

It would be appropriate to have students interact with text to extend their understanding of pulls. These selections can be read aloud at any time after this lesson because students have experienced pushes and pulls. Suggested books include:

- *The Gigantic Turnip* by Alessio Tolstoy and Niamh Sharkey
- *Grandma Lena’s Big Ol’ Turnip* by Denia Lewis Hester and Jackie Unvanovic
- *The Enormous Potato* by Aubrey Davis and Dušan Petričić
- *The Giant Carrot* by Jan Peck and Barry Root
K.2 Pullapalooza

- *The Giant Cabbage* - An Alaska folktale by Chérie B. Stihler and Jeremiah Trammell
- *The Gigantic Sweet Potato* by Dianne De Las Casas and Marita Gentry
- *The Turnip* by Jan Brett

Nonfiction:
- *And Everyone Shouted, “Pull!”* by Claire Llewellyn and Simone Abel

References


Toolbox Table of Contents

K.2.C1  Class Notebook (continued from Lesson 1)  K.2.9

K.2.R1  Trunk of Car  K.2.11
Class Notebook (continued from Lesson 1)

Pushes and Pulls

What do you need to know to solve the coach’s problem?

Criteria and Constraints
1. Criteria 1: Equipment must be moved in one trip.
2. Criteria 2: One person must move all the materials,
3. Constraints: Use the materials in the trunk of the car.

Moving Ideas for One Trip by One Person

What is a push?

What is a pull?
Class Notebook (continued)

Pushes and Pulls

A Plan to Move the Equipment

What else do we need to figure out?
Trunk of Car

- Box
  Image via iStock.com/mgkaya

- Rope
  Image via iStock.com/baona

- Garbage Bag
  Image via iStock.com/Daniil Dubov

- Boards
  Image via iStock.com/akinbostinci

- Push Cart
  Image via iStock.com/Daddybit

- Wagon
  Image via iStock.com/joel-t
Next Generation Science Standards (NGSS)

This lesson is building toward:

<table>
<thead>
<tr>
<th>PERFORMANCE EXPECTATIONS (PE)</th>
</tr>
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<tbody>
<tr>
<td><strong>K-PS2-2</strong> Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.* [Clarification Statement: Examples of problems requiring a solution could include having a marble or other object move a certain distance, follow a particular path, and knock down other objects. Examples of solutions could include tools such as a ramp to increase the speed of the object and a structure that would cause an object such as a marble or ball to turn.] [Assessment Boundary: Assessment does not include friction as a mechanism for change in speed.]</td>
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<table>
<thead>
<tr>
<th>SCIENCE AND ENGINEERING PRACTICES (SEP)</th>
</tr>
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<tbody>
<tr>
<td><strong>Constructing Explanations and Designing Solutions</strong></td>
</tr>
<tr>
<td>• Use tools and/or materials to design and build a device that solves a specific problem or a solution to a specific problem.</td>
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<tr>
<td>• Generate and/or compare multiple solutions to a problem.</td>
</tr>
<tr>
<td><strong>Obtaining, Evaluating, and Communicating Information</strong></td>
</tr>
<tr>
<td>• 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.</td>
</tr>
<tr>
<td>• Obtain information using various texts, text features (e.g., heading, 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.</td>
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<table>
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<th>DISCIPLINARY CORE IDEAS (DCI)</th>
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<tbody>
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<tr>
<td>• Pushes and pulls can have different strengths and directions.</td>
</tr>
<tr>
<td><strong>ETS1.A: Defining and Delimiting an Engineering Problem</strong></td>
</tr>
<tr>
<td>• Asking questions, making observations, and gathering information are helpful in thinking about problems.</td>
</tr>
<tr>
<td><strong>ETS1.B: Developing Possible Solution</strong></td>
</tr>
<tr>
<td>• Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people.</td>
</tr>
</tbody>
</table>
CROSSCUTTING CONCEPTS (CCC)

Structure and Function
- The shape and stability of structures of natural and designed objects are related to their function(s).

Patterns
- Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

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Common Core State Standards (CCSS)

CCSS ELA READING

CCSS.ELA-LITERACY.R1.K.1
With prompting and support, ask and answer questions about key details in a text.

CCSS ELA SPEAKING AND LISTENING

CCSS.ELA-LITERACY.SL.K.3
Ask and answer questions in order to seek help, get information, or clarify something that is not understood.

California English Language Development (ELD) Standards

CA ELD

Part I.K. 5 Interacting with written English (print and multimedia)

EMERGING | EXPANDING | BRIDGING
--- | --- | ---
P1.K.2 Collaborate with the teacher and peers on joint composing projects of short informational and literary texts that include minimal writing (labeling with a few words), using technology where appropriate for publishing, graphics, etc. | P1.K.2 Collaborate with the teacher and peers on joint composing projects of informational and literary texts that include some writing (e.g., short sentences), using technology where appropriate for publishing, graphics, etc. | P1.K.2 Collaborate with the teacher and peers on joint composing projects of informational and literary texts that include a greater amount of writing (e.g., a very short story), using technology where appropriate for publishing, graphics, etc.

In addition to the standard above, you may find that you touch on the following standards in this lesson as well:

P1.K.1 Exchanging information and ideas via oral communication and conversations
P1.K.5 Listening actively and asking or answering questions about what was heard
P1.K.12 Selecting and applying varied and precise vocabulary and other language resources

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Anchoring Phenomenon

Objects do not move on their own.

Lesson Concept

Conduct an investigation to collect data about the effect of the strength of push on an object.

Investigative Phenomenon

Discs move different distances.

Standards

Refer to Appendix K.3 for NGSS, CCSS (ELA and Math), and California ELD Standards.
Driving Question
How can we change the distance a disc travels?

Storyline Link
In Lesson 2: Pullapalooza, students solved a soccer coach’s problem of moving soccer objects to the field. At the conclusion, students generated a list of questions they need a solution for to be able to make a motionless soccer ball score a goal.

This lesson answers student questions about how to push the ball harder or faster. This deepens their understanding of movement by describing the strength of a push. (DCI) The investigative phenomenon is “Discs move different distances.” The investigative phenomenon is observed in a video of shuffleboard. The investigation is a mini-shuffleboard game where the cause and effect of different-strength pushes result in what score you get. Students gather data about the push used and look for patterns to predict distances. (CCC) (SEP) Understanding that different pushes result in different distances traveled by a disc in shuffleboard deepens understanding of the anchoring phenomenon that motionless objects won’t move on their own.

This exploration leads to the next lesson, Lesson 4: Huff, Puff, and Move the Ball, an exploration of how the wind creates a push changing the speed and direction of an object.

Throughout the lesson, a flag (>>) denotes formative assessment opportunities where you may change instruction in response to students’ level of understanding and making sense of phenomena.

Time
115 minutes
Parts represent different sessions on different days for kindergarten.

Part I  45 minutes
10 minutes  Engage
25 minutes  Explore I
10 minutes  Explain I

Part II  30 minutes
20 minutes  Explore II
10 minutes  Explain II

Part III  30 minutes
20 minutes  Explore III
10 minutes  Explain III

Part IV  10 minutes
10 minutes  Elaborate/Evaluate
K.3 Cruising Discs

Materials

Whole Class
- Shuffleboard video ([https://www.youtube.com/watch?v=XBsj3HqYx9M](https://www.youtube.com/watch?v=XBsj3HqYx9M))
- Two cones to mark the finish line (outside)
- Two balls (soccer or playground balls)

Per Group (Groups of 2)
- Cruising Disc Game Board (see Advance Preparation)
- Disc (a washer approximately 1 to 2 inches in diameter)

Individual
- Science science notebook
- Pencil
- K.3.H1: Sandy and Diego
- Clothespin, clip, or sticky note with each student’s name written on it

Teacher
- K.3.R1: Cruising Disc Game Board

Advance Preparation

1. See K.3.R1: Cruising Disc Game Board which shows an actual game board and model of what you will be drawing. Prepare a Cruising Disc Game Board for each group by drawing three lines of different lengths 4 inches apart on 12” by 18” construction paper. Label them 1, 2, and 3. Draw and label a start line where students will begin pushing the disc. (For Parts I–II)

2. On the opposite end of the game board, draw a small rectangle about 2 inches by 4 inches wide and write GOAL inside it. (for use in Part III)

Laminate the game boards if possible.

3. Review the shuffleboard video ([https://www.youtube.com/watch?v=XBsj3HqYx9M](https://www.youtube.com/watch?v=XBsj3HqYx9M)) and select a short clip of students playing shuffleboard.

4. Prepare materials for predicting (step 10) by:
   a. making three different signs with words large enough for the class to read:
      i. Greater
      ii. Same
      iii. Lesser
   b. each student’s name written on an individual clothespin or clip, or use small sticky notes

6. Prepare K.3.C1: Class Notebook as described in the Toolbox for this lesson. You might want to pre-make the table for recording the results of the student's predictions and results.
Procedure

Part I

Engage (10 minutes)

Observe effects of pushing shuffleboard discs towards a goal.

1. Display the Class Notebook with a list of questions from Lesson 2: Pullapalooza. Circle a question about the speed or distance a ball travels from a kick and identify this question as the one to figure out today.

2. Place a disc (washer) on the floor or table in front of the students. Have students observe the disc and ask, “What do you need to know about this disc to make it move?” Chart student responses on K.3.C1: Class Notebook; e.g. Where can we move the disc? How far can it move? Can I move it with something?

3. Ask students if they have played games where a stick moves an object or ball. Share some ideas.

4. Show the shuffleboard video and ask students to watch closely to see how the shuffleboard disc is moved in the game. Ask students to share some ideas of how the game is played.
   a. Show the shuffleboard video again and ask students to see if they can figure out how the students score points.
   b. Ask the students to think about this question: “What would you like to ask the students in the video about how to play shuffleboard?” Chart ideas on the K.3.C1: Class Notebook.
   c. Answer student questions about playing shuffleboard.

TEACHER NOTE

You may want to pause the video a few times and ask the students questions about how the disc moved. “What did the boy use to move the disc? Did they push it or pull it? Did the disc move the same distance every time?”

Explore I (25 minutes)

Carry out an investigation to determine if different amounts of force cause a disc to move different distances.

5. We do not have a shuffleboard at our school, but we can play mini-shuffleboard to figure out some of the strategies the students in the video used. Show the students the Cruising Disc Game Board and point out the starting point for the disc. Explain that this a mini-shuffleboard game. The goal is to push the disc, using your finger, so that it stops exactly in Box 1 without touching the lines. Remind students of how the boy in the video moved the disc. They must release the disc in the start line.
6. Give students the disc and Cruising Disc Game Board and have them practice getting the disc into Box 1 for about 5 minutes.

7. Ask students to leave their materials at their tables and gather at the meeting place. Ask, “What did you notice about the movement of the disc? How did you cause the disc to move and stop in Box 1? When it did not go into Box 1, how did you change your push?” Record results of how to get the disc to Box 1 on a new page of the K.3.C1: Class Notebook.

8. Explain to them that they will get only one chance to push the disc into Box 2. Use this sentence frame:

   In order to get the disc to Box 2, I predict that I will _____.

9. Have students think-pair-share their predictions for how to push in order to reach Box 2.

10. Show the signs you prepared with the three words greater, lesser, and same on them. Students will attach their name clothespin on the paper that represents their prediction to get the disc to Box 2.

11. Count the number of responses in each category. Record the predictions for Box 2 on a page of the K.3.C1: Class Notebook, leaving a space for both prediction and results for Box 2.

12. Students return to their game boards and wait for you to say, “Go.” Each partner will get just one chance to get the disc into Box 2. Record the results for Box 2 on a page of the K.3.C1: Class Notebook next to the predictions.

**Teacher Note**

Once students have figured out how to get the disc in Box 1, their discussions should include greater push or lesser push rather than harder and weaker/softer. This is an opportunity to refine their language using push, and greater push, greatest push to show changes in force. The collaborative plan also supports English Learners as they share ideas to develop the plan.
**K.3 Cruising Discs**

**Explain I (10 minutes)**

*Compare data from observations that show the effect of different strength of pushes to the distance the disc traveled.*

13. Return to the meeting place and ask students to review the predictions and results for Box 2 on the K.3.C1: Class Notebook. Ask, “Was your prediction supported? How do you know? What is on the chart that would make you change your prediction if we did the test one more time?” Discuss with a partner. Share a few ideas.

**TEACHER NOTE**

Use the word *supported* because that is how scientists would describe the results of the test. The observations students made would support (or not support) their predictions. *Avoid words such as right/wrong or good/bad as these imply value judgments. Have a discussion with students about what the word accurate means.*

14. Have students repeat Steps 10, 11 and 12 for Box 3. Ask students to gather at the meeting place. Have a class discussion by asking students, “What did you have to do to make the disc slide to box 1? How was that different from Box 2? What did you have to do to get the disc to slide to Box 3? How was that different than sliding the disc to Box 2?” Record predictions for Box 3 on the K.3.C1: Class Notebook.

*Image via Emerson/Bandini Elementary, San Diego Unified School District [Used with permission]*
Part II

Explore II (20 minutes)

Carry out an investigation to determine if strength of a push affects speed.

15. To introduce measurement of time with the students, take the cruising disc activity outside. Set up an area with a start line and finish line at least 20 feet apart. Using two playground or soccer balls, have two students push the ball at the same time to see which ball goes faster by crossing the finish line first. Counting aloud, “1 and 2 and 3 . . . “ to measure how long it takes the first ball to cross the finish line. Repeat with other student pairs.

16. Return to the classroom and lead a discussion about how moving the soccer ball faster is like pushing the discs. Say, “Today we get to do a challenge of whether you or your partner can push the disc so see which disc is faster by determining the disc that crosses the end of the shuffleboard game board first. Each of you will get a disc.” Ask, “What do you need to know to find the faster disc?” Chart students’ questions in the K.3.C1: Class Notebook.

17. Set up two pairs of students in a group of four, and distribute two discs to the group. Two students will watch and be the referees to see which disc lands in goes over the end of the game board first. Have all pairs place their discs at the start line. When you call out, “Ready, Set, Go,” each student will push his disc, trying to go over the end of the game board first but make sure it does not go off the sides of the game board. The winning disc is the one that stays on the game board but crosses the end opposite the start line first.

18. After the first race, allow partners time to explain why one disc went faster than the other. Have students switch roles so that the referee pair gets a chance to play. Students can conduct multiple disc races and monitor to see if students try to change the strength of their push.

Explain II (10 minutes)

Compare data from observations that show the effect of different strength of pushes on the speed of the ball.

19. Ask, “What did you notice about the disc that won the race? Which disc moved faster? How do you know?” Have partners share ideas with the class and record results on a page in the K.3.C1: Class Notebook.

20. Review the results of the partner races. Ask, “How might knowing about pushes that are stronger help us to move a ball towards a goal in soccer?”

TEACHER NOTE

A bigger push or pull results in greater speed. In this case, speed is represented by the first disc to cross the line at the end of the shuffleboard. (using relative time appropriate to kindergarten.)

   a. Have students find the picture that goes with number 1 on their handout. Ask, “What kind of push (kick) would Sandy need to use to move the ball to the goal?” Tell students they can look around the room or in their notes for any words that will help them. Also tell them to draw and path of the ball from Sandy to the goal.

   b. Have students find the picture that goes with number 2 on their handout. Ask, “What kind of push (kick) would Sandy need to use to move the ball to Diego?” Write their response and draw the path of the ball from Sandy to Diego to the goal.

   **TEACHER NOTE**

   Monitor students while they work and look for examples of student work to share. Look for a couple of examples that show a greater push with a longer arrow. The game board for shuffleboard can be placed in the choice centers for at least a week to encourage the use of the academic language and comprehension that a greater push causes a longer distance traveled and a lesser push causes a shorter distance traveled. The choice centers could include words on cards such as greater push, greater distance, less push, less distance to encourage high-level students to read and label the results.

22. Share examples with the whole class. Encourage students to use a uniform way to show movement with arrows. Then allow students to return to update K.3.H1: Sandy and Diego.

**Part III**

**Explore III (20 minutes)**

*Predict and observe the cause of making an object stop its movement.*

23. Ask students to think-pair-share about a soccer game and what happens if someone kicks the ball toward the goal. “What might cause the ball to stop?” Chart student ideas in the K.3.C1: Class Notebook under the heading, “Stopping the Ball.”

24. Show Side 2 of the Cruising Disc Game Board. Tell students they will work in pairs. One student will try to make a goal with the disc, and the other will act as the goalie and try to stop the disc. Ask, “If you are the goalie, what can you do to stop the disc from going inside the goal?” Add ideas on the K.3.C1: Class Notebook.

25. Students can take turns being the goalie and kicker. They may also want to keep score by counting to 5 goals before switching roles.

**Explain III (10 minutes)**

*Compare predictions to observations of how pushing on an object can cause the object to stop.*

26. Come back to the meeting area. Facilitate a discussion using the following questions: “How did you stop the discs? What was the best way to stop the discs? What happened when you didn’t stop the disc?” Label a page of the K.3.C1: Class Notebook with the heading, “How to Stop a Disc or a Soccer Ball.” Record student ideas for stopping the ball.
27. Discuss the difference between strong and weak pushes and read the book *Duck in the Trunk* listed in the Literacy Link at the bottom of this page. Discuss the movement described in the book. Lead a discussion of what is real in the book and what is not real. (Fiction)

### Part IV

**Elaborate/Evaluate (10 minutes)**

Comparing observations linking the results of pushing with different strengths or stopping movement to soccer moves.

28. Say, “Let’s think about how we pushed the disc and stopped the disc. How can that help us in a real soccer game if we want to move the ball to the goal?” Have students draw a picture in their science notebook showing how to push the ball farther, push the ball closer, and stop the ball.

### Teacher Note

Place the game boards in the choice centers for several days. Listen to students using language that describes movement.

29. Review the **K.3.C1: Class Notebook** and talk about what we have figured out. We know how to make a motionless object move with a push or pull, how to move objects with a push or pull, how to make the push stronger or harder, and how to stop the ball. Ask, “What else do you think we need to know about playing soccer?” Chart ideas on a new page of the **K.3.C1: Class Notebook**. Student questions may include: How do we aim the ball? How do we push the ball harder? How do we get around another player? What else pushes the ball?

### Teacher Note

Encourage connections from the disc experience to soccer, especially harder kicks increasing speed and distance. The movement continues unless something stops the movement with a backward push. This might be another player or the goalie. Students still do not know to use other players (collisions) or factors like weather that might cause changes in the way the ball moves.

### Literacy Links

It would be appropriate to have students interact with text to extend their understanding of pushes. These selections can be read aloud at any time after this lesson where students have experienced pushes. Suggested books include the following:

- *Duck in the Truck* by Jez Alborough
- *Sheep in a Jeep: 5-Minute Stories* by Nancie Shaw and Margot Apple
- *Playground Day!* by Jennifer J. Merz
References


Toolbox Table of Contents

K.3.C1  Class Notebook (continued from Lesson 1)  K.3.13

K.3.H1  Sandy and Diego  K.3.16

K.3.R1  Cruising Disc Game Board  K.3.17
Class Notebook (continued from Lesson 1)

**Pushes and Pulls**

**What do you need to know about this disc to make it move?**

**What would you like to ask the students in the video about how to play shuffleboard?**

**How did you cause the disc to move and stop in Box 1? When it did not go into Box 1, how did you change your push?**

**Box 2**

<table>
<thead>
<tr>
<th>Prediction</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater</td>
<td></td>
</tr>
<tr>
<td>Same</td>
<td></td>
</tr>
<tr>
<td>Less</td>
<td></td>
</tr>
</tbody>
</table>

**Box 3**

<table>
<thead>
<tr>
<th>Prediction</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater</td>
<td></td>
</tr>
<tr>
<td>Same</td>
<td></td>
</tr>
<tr>
<td>Less</td>
<td></td>
</tr>
</tbody>
</table>
What did you have to do to make the disc slide to box 1? How was that different from Box 2? Box 3?

What do you need to know to find the faster disc?

What did you notice about the disc that won the race? Which disc moved faster? How do you know?

Stopping the Ball
How can we stop a disc or a soccer ball?

What else do you think we need to know about playing soccer?
Sandy and Diego

Name: _______________________________________

1

Sandy

push

2

Sandy

Diego

push
Cruising Disc Game Board

Make a board that will emulate a really shuffleboard.

Image by Vintrino via Wikimedia Commons [CC BY-SA 4.0]

Your side 1 result should look like this:

Image via Vista Unified School District [Used with Permission]
Cruising Disc Game Board (continued)

Below is a pattern for the two-sided Cruising Disc Game Board:

**Side 1:**

```
<table>
<thead>
<tr>
<th>Start</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4 Inches</td>
<td>4 Inches</td>
<td>4 Inches</td>
</tr>
</tbody>
</table>
```

**GOAL!**
### Next Generation Science Standards (NGSS)

This lesson is building toward:

<table>
<thead>
<tr>
<th>PERFORMANCE EXPECTATIONS (PE)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>K-PS2-1</td>
<td>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. [Clarification Statement: Examples of pushes or pulls could include a string attached to an object being pulled, a person pushing an object, a person stopping a rolling ball, and two objects colliding and pushing on each other.] [Assessment Boundary: Assessment is limited to different relative strengths or different directions, but not both at the same time. Assessment does not include non-contact pushes or pulls such as those produced by magnets.]</td>
</tr>
<tr>
<td>K-PS2-2</td>
<td>Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.* [Clarification Statement: Examples of problems requiring a solution could include having a marble or other object move a certain distance, follow a particular path, and knock down other objects. Examples of solutions could include tools such as a ramp to increase the speed of the object and a structure that would cause an object such as a marble or ball to turn.] [Assessment Boundary: Assessment does not include friction as a mechanism for change in speed.]</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>SCIENCE AND ENGINEERING PRACTICES (SEP)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Planning and Carrying Out an Investigation</strong></td>
<td></td>
</tr>
<tr>
<td>• With guidance, plan and conduct an investigation in collaboration with peers.</td>
<td></td>
</tr>
<tr>
<td>• Make predictions based on prior experiences.</td>
<td></td>
</tr>
<tr>
<td>• Make observations (first hand or from media) and/or measurements to collect data that can be used to make comparisons.</td>
<td></td>
</tr>
<tr>
<td><strong>Analyzing and Interpreting Data</strong></td>
<td></td>
</tr>
<tr>
<td>• Compare predictions (based on prior experiences) to what occurred (observable events).</td>
<td></td>
</tr>
<tr>
<td>• Record information (observations, thoughts, and ideas).</td>
<td></td>
</tr>
<tr>
<td><strong>Obtaining, Evaluating, and Communicating Information</strong></td>
<td></td>
</tr>
<tr>
<td>• 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.</td>
<td></td>
</tr>
<tr>
<td>• Obtain information using various texts, text features (e.g., heading, 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.</td>
<td></td>
</tr>
</tbody>
</table>
Appendix K.3

DISCIPLINARY CORE IDEAS (DCI)

PS2.A Forces and Motion
- Pushes and pulls can have different strengths and directions.
- Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it.

PS3.C: Relationship Between Energy and Forces
- A bigger push or pull makes things speed up or slow down more quickly.

CROSSCUTTING CONCEPTS (CCC)

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

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Common Core State Standards (CCSS)

CCSS ELA READING
CCSS.ELA-LITERACY.R1.K.1
With prompting and support, ask and answer questions about key details in a text.

CCSS SPEAKING AND LISTENING
CCSS.ELA-LITERACY.SL.K.3
Ask and answer questions in order to seek help, get information, or clarify something that is not understood.

MATH PRACTICES
CCSS.Math.MP2
Reason abstractly and quantitatively.

MATH MEASUREMENT AND DATA
CCSS.Math.K.MD.A.1
Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object.

CCSS.Math.K.MD.A.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.

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## California English Language Development (ELD) Standards

<table>
<thead>
<tr>
<th>CA ELD</th>
<th>Part I.K.5 Listening actively and asking questions about what was heard</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EMERGING</strong></td>
<td><strong>EXPANDING</strong></td>
</tr>
<tr>
<td>P1.K.5 Demonstrate active listening to read-alouds and oral presentations by asking and answering yes-no and wh-questions with oral sentence frames and substantial prompting and support.</td>
<td>P1.K.5 Demonstrate active listening to read-alouds and oral presentations by asking and answering questions with oral sentence frames and occasional prompting and support.</td>
</tr>
</tbody>
</table>

In addition to the standard above, you may find that you touch on the following standards in this lesson as well:

- P1.K.1 Exchanging information and ideas via oral communication and conversations
- P1.K.2 Interacting with written English (print and multimedia)
- P1.K.12 Selecting and applying varied and precise vocabulary and other language resources

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Huff, Puff, and Move the Ball

K.4

Anchoring Phenomenon
Objects do not move on their own.

Lesson Concept
Plan and carry out an investigation to determine the cause and effect (strength and direction) of a push on an object.

Investigative Phenomenon
Windy days change how the ball moves in soccer.

Standards
Refer to Appendix K.4 for NGSS, CCSS (ELA and Math), and California ELD Standards.
Driving Question
How does wind push a soccer ball?

Storyline Link
In Lesson 3: Cruising Discs, the force of the push was explored through the game of mini-shuffleboard. Different strengths of the force caused the disc to move lesser or greater distances in the game of mini-shuffleboard.

In this lesson, the students' understanding of the strength of pushes is deepened by changing the cause of the push. (CCC) This lesson explores the phenomenon of pushes on a ball from high winds. (CCC)

While we cannot see wind, we can see what wind does to objects. We can investigate the phenomenon that windy days change the way a ball moves. The phenomenon of wind moving things can be investigated by blowing through two different-sized straws, causing a small ball or pom-pom to move at different speeds. (DCI) Collecting and analyzing data from blowing through two different-sized straws deepens students' understanding of ways to change the strength of a push that, while invisible, can be felt by blowing through a straw. (SEP) When playing soccer, strong winds can push the ball in a different direction.

The second part of this lesson brings in the science and engineering practice of collaboratively designing and planning an investigation to determine how to change the direction that an object moves as well as how to change the strength of the push. (SEP)

This leads to Lesson 5: When Two Objects Collide. It explores how to use other players to get around a blocker. Investigations are used to figure out what happens when moving objects collide. Colliding objects change direction. (DCI)

Throughout the lesson, a flag (✓) denotes formative assessment opportunities where you may change instruction in response to students' level of understanding and making sense of phenomena.

Time
80 minutes
Part I  35 minutes
  10 minutes  Engage
  15 minutes  Explore 1
  10 minutes  Explain 1
Part II  45 minutes
  30 minutes  Explore II
  10 minutes  Explain II
  5 minutes  Elaborate/Evaluate
K.4 Huff, Puff, and Move the Ball

Materials

Whole Class

- Wind-Assisted Goal video (https://www.youtube.com/watch?v=BzutX8bm5mo)
- Fan with at least two different speed settings
- Soccer ball
- Bags with a set of materials for the wind investigation

Group (Groups of 2)

- Grooved ruler (one per group)
- Rubber bouncy ball (½ inch in diameter), ping pong ball, or pom-pom (Find a ball that will stay on the ruler.)
- 8½” by 11” piece of paper
- Different-colored markers
- Gallon-sized bag
- 12” by 18” construction paper for recording the movement of the ball

Individual

- 2 Coffee straws (small diameter)
- 2 Drinking straws (large diameter)

Teacher

- K.4.R1: Wind Investigation Set-up

Advance Preparation

1. Place two coffee straws, two drinking straws, one rubber ball or ping pong ball, two different-colored markers, and one piece of 8 ½” by 11” paper in a gallon-sized bag for each set of partners.
2. Make and display a set-up of the wind investigation. (See K.4.R1: Wind Investigation Set-up)
3. Review the Wind-Assisted Goal video. (https://www.youtube.com/watch?v=BzutX8bm5mo)
4. Prepare the K.4.C1: Class Notebook as described in the Toolbox for this lesson.
K.4 Huff, Puff, and Move the Ball

Procedure

Part I
Engage (10 minutes)

**Ask questions about how a soccer ball can move without a person pushing the ball.**

1. Ask students to think about a day when the weather was very windy (or have students stand in front of a fan). Students consider when they have been out on a windy day and describe how they felt and what they observed. Share ideas.

2. Show the Wind-Assisted Goal video and ask students to observe the movement of the soccer ball on a windy day. Share observations. Show the video one more time, and record observations on the left side of a page of the K.4.C1: Class Notebook with the heading “What Do We Notice?”

3. Ask, “What do we wonder about what is happening in the video?” Students can use the sentence frame: I wonder ______. Record their wonderings as questions on the right side of the same page of the K.4.C1: Class Notebook.

**TEACHER NOTE**

Kindergarteners may wonder if something or someone is flying above the field and hit the ball. Guide students toward another explanation for what is pushing the ball. If students do not suggest the wind, introduce that concept with the fan in the next step.

4. Display a fan and ask students, “How can we use this fan to test how windy weather might affect the soccer balls?” Record ideas in the K.4.C1: Class Notebook. Record ideas to test.

5. Test a few of the students’ ideas such as moving the direction of the fan or changing the speed of the fan by placing a ball in front of the fan so students can observe what happens to the ball. Record the results of these informal trials and any new student questions on the K.4.C1: Class Notebook.

**TEACHER NOTE**

Using air in this part of the sequence provides students with a better opportunity to control the strength of the push. Students are more readily able to recognize when the puff push is greater versus lesser than when they use their own fingers or hands. The use of air as a force potentially moves students beyond grade-level in the DCI as they don’t yet know that air is made of particles.
Explore I (15 minutes)

Conduct an investigation to observe how the size of straws affect the distance an object travels.

6. Ask students to remember how the strong wind blew the soccer ball backward in the video. Explain that we don’t have enough fans for everyone in the room. Ask, “How might we use two different-sized straws to figure out which straw would make a stronger wind that pushes the ball farther?” (Hold up the two different-sized straws). Chart ideas in the K.4.C1: Class Notebook.

7. Distribute the bags of materials to partners (4 straws, a ball, 2 different-colored markers, and a sheet of construction paper) and ask students to figure out which straw makes the stronger wind. Use your ideas from the K.4.C1: Class Notebook.

8. Debrief at the meeting place and ask students to report what they found out. Record the results on the K.4.C1: Class Notebook. Review the list and notice any patterns made by the wind from the large straw or the small straw. Students will report that the ball curved rather than going in a straight line.

9. Hold up a ruler with a groove down the center and tell students to go back to their work tables and figure out at least one way to use the ruler to guide the direction of the ball. Distribute a ruler to each group. Encourage practice with the ruler as a track for the object.

10. Ask students how they can figure out how to blow the same amount of air through each straw. As you walk around, listen for ideas from the students and record those ideas on the K.4.C1: Class Notebook.
   a. Encourage practice blowing for 3 seconds. This can be accomplished by counting aloud.
   b. Ask students to practice using the large straw and then the small straw to blow for 3 seconds. Encourage multiple practices making sure each puff is about the same strength.

11. Ask the students to remove the two different-colored markers from the bag and set up their track on construction paper. Think of a way to make marks to record how far the ball travels after each puff. Listen to several groups and record their ideas on the K.4.C1: Class Notebook to guide other groups.
12. Ask students to set up their track with the construction paper under the ruler on their work tables. If the ball is going off the end of the ruler, they should try to blow for 2-seconds and 1-second. Have them use a different-colored marker for the different-sized straws. Remind students they can record more than one puff for each straw to see if each puff is about the same.

13. Have the students put their materials back into the bag (their straws, the ball, the ruler, and markers) and put the baggie in their cubbies to use tomorrow. Have them bring the construction paper with their recorded results to the meeting place.

**TEACHER NOTE**

This is an ideal opportunity to introduce or reintroduce the word *pattern*. Remind them that when we notice when something happens over and over, it may be a pattern. For example, the wider straw allows more air to hit the ball, moving it a greater distance than the thinner straw.

Students may keep their own straws in a different place such as their desk so they can use them for the next part of the lesson. Otherwise, replace their straws so that they avoid sharing germs.

**Explain I (10 minutes)**

*Analyze and interpret data and look for patterns in the distance the ball traveled using two different-sized straws.*

14. Ask partners to share individual recording sheets and talk knee-to-knee about what they noticed in the distances the ball moved from the puffs from each straw. Ask each partner to tell their partner what they noticed.

15. Ask two or three partners to come to the front and place their recording sheets in front of the class. Ask them to trace a line from where they puffed to the landing places for the ball.

   a. Compare the student samples and ask the class what patterns they notice between the recording sheets.

   b. Ask, "What caused the ball to move farther with the large straw? What caused the ball to stop sooner with the small straw?"

   c. Ask, "What is the pattern between discs in the last lesson and how the ball moved in this lesson?" Record patterns on a page of the *K.4.C1: Class Notebook*, "Things We Figured Out About Pushes."
Part II

Explore II (30 minutes)

Plan and conduct an investigation to test the effects of air puffs to change the direction of the ball’s movement.

16. Display the K.4.C1: Class Notebook (Things We Figured Out About Pushes) and review what causes things to move farther. Share any patterns.

17. Review several pages of the Class Notebook to identify what we have figured out about what makes a ball move, how we increase the speed at which an object moves by pushing a disc, or by blowing in a straw, and how we stop a ball. Today we want to see if we can use the same materials and plan a way to make the ball go in a different direction.

18. Display one of the sets of the material used yesterday—the ball, the ruler, and the two straws. Tell students one player will push (kick) the ball with their fingers, and the other player will use a straw to be the wind blowing to try to change the ball’s direction (as we saw in the video). Ask partners to talk about how we can plan to make the ball go in different directions using the wind.

19. Display a new page in the K.4.C1: Class Notebook (Our Plan to Change Directions.) Ask students for ideas of how to change the direction the ball moves (using the straw) after the kick (the tap with the fingers). Also, discuss how they will record the path of their ball. Record all ideas on the top half of the K.4.C1: Class Notebook.

20. Guide students to select which of the ideas might work for the whole class to try. First, ask students to identify ideas that might work. Then establish an order in which to try the ideas. Record the ideas in order on the bottom of the page.

TEACHER NOTE

The guiding questions are designed to get the students to make the connection that a greater push of air causes the ball to travel a greater distance. A smaller push of air, or lesser push of air, causes the ball to travel a shorter distance. Students may notice that not all recorded distances are exactly the same. Lead a discussion of how the puffs might be different for different students.
21. Write “#1 Idea” on the K.4.C1: Class Notebook page and use pictures and or words to plan each step of the idea including recording the path of the ball. Remember one person is the kicker (using a tap) and one person is the wind (using a straw).

22. Ask students to use the bags of materials they put in their cubbies yesterday and a piece of construction paper. Have them set up the investigation according to the class plan.

   a. Record results directly on the construction paper. Use arrows to record the movement and direction the ball travels from the kick (tap) through the movement caused by the air puff (blowing through the straw).
   
   b. Repeat by conducting the investigation three times. Use a different-colored marker to record each trial on the construction paper.

Explain II (10 minutes)

*Analyze and interpret data to determine the effects of the air puffs on the movement of the ball.*

23. Have students return to the meeting place, bringing the construction paper. Share different recording sheets and ask each set of partners how they were able to change the direction of the ball. Ask the whole group, “What patterns do we see in the recording sheets?”

24. Review the other plans selected in the K.4.C1: Class Notebook page and discuss whether students need to do additional plans. If yes, additional plans can be explored during free-choice time and reported tomorrow.

25. Read *The Three Little Pigs* and talk about how the huff and puffs forced the homes to move or not move. Why do students think the brick house did not blow over? Discuss the differences between fiction and nonfiction.

Elaborate/Evaluate (5 minutes)

*Construct an explanation about what caused the soccer ball to change direction in the video.*

26. Play the Wind-Assisted Goal video, and ask students to think about how the video is like the plan for changing the direction of the ball using the straw and wind. Ask the group, “What is the same about the wind blowing the soccer ball and the puff of air blowing the balls in our plan? What is different?”
27. Review the “figuring out pages” created in the Class Notebook during the last four lessons. Which pages show what we have figured out? Go through the pages and check to see if the class has a clear understanding of:
   a. ways to make the ball move,
   b. ways to push or pull soccer materials to the field,
   c. ways to strengthen the distance of the movement of the ball,
   d. ways to stop the movement of the ball by pushing in the opposite direction,
   e. ways to direct the movement of the ball.

Develop a new page in the K.4.C1: Class Notebook with the heading: “What We Know for Sure About Pushes and Pulls in Soccer.”

**TEACHER NOTE**

Leave the materials out for practicing pushes and pulls with the wind and rulers at the choice centers until students all seem confident with predicting the pattern of the path of the ball or pom-pom using the ruler and blowing using their own personal straws saved in their cubbies.

28. Display the Class Notebook page of additional questions brainstormed at the end of Lesson 3: Cruising Discs. Focus on any questions about getting around a blocker or another player. Tomorrow we will work on figuring out how to get around other players to answer that question.

**Literacy Links**

Have students interact with text to extend their understanding of pushes. These selections can be read aloud at any time after this lesson. Suggested books include the following:

**Fiction:**
- *Duck in the Truck* by Jez Alborough
- *Sheep in a Jeep: 5-Minute Stories* by Nancie Shaw and Margot Apple
- *Playground Day!* by Jennifer J. Merz

**References**


# Toolbox Table of Contents

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<td>K.4.11</td>
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<tr>
<td>K.4.R1</td>
<td>Wind Investigation Set-up</td>
<td>K.4.14</td>
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### Class Notebook (continued from Lesson 1)

<table>
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<tr>
<th>What do we notice?</th>
<th>How can we use this fan to test how windy weather might affect the soccer balls?</th>
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<td>I wonder _____.</td>
<td>Results</td>
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<table>
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<tr>
<th>How might we use two different-sized straws to figure out which straw pushes the ball farther?</th>
<th>What happened when we blow into the straw:</th>
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<tbody>
<tr>
<td>What happened when we blow into the straw:</td>
<td>With different amounts of air?</td>
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<tr>
<td>With the same amount of air?</td>
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</tbody>
</table>
Patterns made by the wind with the large straw and small straw.

How can we mark the distance the ball travels on the ruler?

Things We Figured Out About Pushes

Our Plan to Change Directions

#1 Idea
Class Notebook (continued)

What we know for sure about pushes and pulls in soccer?
Wind Investigation Set-up

Set-up position for the straw and the ruler.

Mark the finish position of the ball on the ruler.

Images via Emerson/Bandini Elementary, San Diego Unified School District [Used with Permission]
Next Generation Science Standards (NGSS)

This lesson is building toward:

<table>
<thead>
<tr>
<th>PERFORMANCE EXPECTATIONS (PE)</th>
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<tbody>
<tr>
<td><strong>K-PS2-1</strong> 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. [Clarification Statement: Examples of pushes or pulls could include a string attached to an object being pulled, a person pushing an object, a person stopping a rolling ball, and two objects colliding and pushing on each other.] [Assessment Boundary: Assessment is limited to different relative strengths or different directions, but not both at the same time. Assessment does not include non-contact pushes or pulls such as those produced by magnets.]</td>
</tr>
<tr>
<td><strong>K-PS2-2</strong> Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.* [Clarification Statement: Examples of problems requiring a solution could include having a marble or other object move a certain distance, follow a particular path, and knock down other objects. Examples of solutions could include tools such as a ramp to increase the speed of the object and a structure that would cause an object such as a marble or ball to turn.] [Assessment Boundary: Assessment does not include friction as a mechanism for change in speed.]</td>
</tr>
<tr>
<td><strong>K-ESS2-1</strong> Use and share observations of local weather conditions to describe patterns over time. [Clarification Statement: Examples of the qualitative observations could include descriptions of the weather (such as sunny, cloudy, rainy, and warm): examples of quantitative observations could include number of sunny, windy, and rainy days in a month. Examples of patterns could include that it is usually cooler in the morning than in the afternoon and the number of sunny days versus cloudy days in different months.] [Assessment Boundary: (Assessment of quantitative observations is limited to whole numbers and relative measures such as warmer/colder.)]</td>
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<table>
<thead>
<tr>
<th>SCIENCE AND ENGINEERING PRACTICES (SEP)</th>
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<tr>
<td>Planning and Carrying Out an Investigation</td>
</tr>
<tr>
<td>• With guidance, plan and conduct an investigation in collaboration with peers.</td>
</tr>
<tr>
<td>Analyzing and Interpreting Data</td>
</tr>
<tr>
<td>• Use and share pictures, drawings, and/or writings of observations.</td>
</tr>
<tr>
<td>Asking Questions and Defining Problems</td>
</tr>
<tr>
<td>• Ask questions based on observations to find more information about the natural and/or designed world(s).</td>
</tr>
<tr>
<td>Obtaining, Evaluating, and Communicating Information</td>
</tr>
<tr>
<td>• 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.</td>
</tr>
<tr>
<td>• Obtain information using various texts, text features (e.g., heading, 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.</td>
</tr>
</tbody>
</table>
DISCIPLINARY CORE IDEAS (DCI)

PS2.A Forces and Motion
• Pushes and pulls can have different strengths and directions.

PS3.C: Relationship Between Energy and Forces
• A bigger push or pull makes things speed up or slow down more quickly.

ESS2.D Weather and Climate
• Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time.

CROSSCUTTING CONCEPTS (CCC)

Cause and Effect
• Simple tests can be designed to gather evidence to support or refute student ideas about causes.

Patterns
• Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

Common Core State Standards (CCSS)

CCSS ELA READING
CCSS.ELA-LITERACY.R1.K.1
With prompting and support, ask and answer questions about key details in a text.

ELA SPEAKING AND LISTENING
CCSS.ELA-LITERACY.SL.K.3
Ask and answer questions in order to seek help, get information, or clarify something that is not understood.

MATH PRACTICES
CCSS MP2
Reason abstractly and quantitatively.

MATH MEASUREMENT AND DATA
CCSS.Math.K.MD.A.1
Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object.

CCSS.Math.K.MD.A.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.

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## Appendix K.4

### California English Language Development (ELD) Standards

**CA ELD**

<table>
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<th>Part I.K.12a,b</th>
<th>Selecting and applying varied and precise vocabulary and other language resources</th>
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<tr>
<td><strong>EMERGING</strong></td>
<td><strong>EXPANDING</strong></td>
</tr>
<tr>
<td>a) Retell texts and recount experiences using a select set of keywords.</td>
<td>a) Retell texts and recount experiences using complete sentences and keywords.</td>
</tr>
<tr>
<td>b) Use a select number of general academic and domain-specific words to add detail (e.g., adding the word <em>spicy</em> to describe a favorite food, using the word <em>larva</em> when explaining insect metamorphosis) while speaking and composing.</td>
<td>b) Use a growing number of general academic and domain-specific words in order to add detail or to create shades of meaning (e.g., using the word <em>scurry</em> versus run) while speaking and composing.</td>
</tr>
</tbody>
</table>

In addition to the standard above, you may find that you touch on the following standards in this lesson as well:

- **P1.K.1** Exchanging information and ideas via oral communication and conversations
- **P1.K.2** Interacting with written English (print and multimedia)
- **P1.K.5** Listening actively and asking or answering questions about what was heard

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When Two Objects Collide

Anchoring Phenomenon
Objects do not move on their own.

Lesson Concept
Analyze and interpret data about the cause and effect of objects colliding.

Investigative Phenomenon
A ball thrown against a wall changes direction.

Standards
Refer to Appendix K.5 for NGSS, CCSS (ELA and Math), and California ELD Standards.
Driving Question
What happens when a moving ball hits a wall?

Storyline Link
In the previous lessons, investigative phenomena using explorations with pushes and pulls established that pushes and pulls can stop objects or move them in different directions. Wind can push objects, too. The force of the push or pull will impact the distance traveled during the movement. (DCI)

In this lesson, the investigative phenomenon is “A ball thrown against a wall changes direction” which explores the question of how to get a ball around defenders in soccer. The activity for the investigation begins by observing how a ball moves in a wall ball game. This deepens understanding of the concept that when objects collide, the direction of the movement changes in predictable patterns. (DCI)

In this mini-wall ball exploration, a ball is rolled down a ramp to collect data about the effect of a ball colliding with a wall. (SEP) The ramp is used to keep the force of the ball consistent during the investigation. Data will be collected and recorded to show how changing the ramp’s angle affects the collision of the ball with the wall. This data will be used to collaboratively discuss the cause and effect phenomena of how the changes with the ramp cause predictable patterns of collisions with the wall. (CCC)

Wall ball helps build an understanding of how players on a soccer field are used as collision points that can change the direction and strength of a push on a soccer ball. This investigation adds to the knowledge of how motionless objects can be made to move. (Anchoring Phenomenon)

The final lesson: Lesson 6: Collision Goal! uses an investigative problem of designing a predictable strategy/solution to play a tabletop game of soccer.

Throughout the lesson, a flag (►) denotes formative assessment opportunities where you may change instruction in response to students’ level of understanding and making sense of phenomena.

Time
80 minutes

Part I 35 minutes
10 minutes Engage I
15 minutes Explore I
10 minutes Explain I

Part II 45 minutes
10 minutes Explore II
20 minutes Explain II
10 minutes Explore III
5 minutes Elaborate/Evaluate
K.5 When Two Objects Collide

Materials

Whole Class
- William’s Wall Ball Tournament video (https://www.youtube.com/watch?v=rhsAKRn10G4)
- K.5.C1: Class Notebook (continuation of K.1.C1: Class Notebook started in Lesson 1: Exploration Box)
- Wall-ball ball

Per Group (Groups of 4)
- 1-inch cube block (to elevate the ruler)
- Ruler (used for ramp)
- Ping pong or tiny bouncy ball
- Plastic cup cut in half (a basket for the ball to enter)
- Sheet of 12” by 18” construction paper
- Heavy wooden block (approximately 3” by 6”)

Individual
- Sticky notes
- K.5.H1: Recording Sheet
- Pencils
- Crayons

Teacher Use
- K.5.R1: Wall Ball Directions
- K.5.R2: Mini-Wall Ball Set-up

Advance Preparation

1. Find a place outside where students can play wall ball.
2. Prepare the Mini-Wall Ball Game Boards. Use the first drawing on the K.5.R2: Mini-Wall Ball Set-up as a model. Draw a line on the opposite end of the paper to show where students will place the opening of their ramp. Then draw a line about 2 inches wide to show position 1, which will be parallel to the wall, a line of the same size to show position 2 and 3 that will be a diagonal line to the left of position 1. Draw a line where the wooden block should go, about 7 inches away from the ramp line.
3. Assemble materials in a baggie for each group: the ball, the heavy wooden block, the basket (cup), the ruler, and two 1-inch cubes.

6. Prepare the continuation **K.5.C1: Class Notebook** as described in the Toolbox for this lesson. Make sure you create a page in the notebook with a drawing similar to the second drawing in **K.5.R2: Mini-Wall Ball Set-up** and, on a separate page, a drawing similar to the third drawing in the **K.5.R2: Mini-Wall Ball Set-up**.

**Teacher Note**

Every time the ball hits an object, it offers an opportunity to ask about cause and effect. By this point students should be familiar with the idea of cause and effect, so be explicit in using this language.
Procedure

Part I
Engage I (10 minutes)

Ask questions based on observations about the cause and effect of objects colliding in different games.

1. Display the list of questions generated on the Class Notebook in Lesson 3: Cruising Discs for things we need to know to score goals in soccer. Focus the class on the questions “When do players pass to other players or kick the ball somewhere besides the goal?” and “How does a player get around a blocker?” Today we are going to figure out the answer to one of the student questions about where players aim the ball to get around a blocker.

2. Ask students what they know about playing wall ball. Share ideas and show the William’s Wall Ball Tournament video. Ask, “What do you think the players are trying to do? If you could ask the players questions, what would the questions be?” Chart questions in the K.5.C1: Class Notebook and watch the video again to look for answers in the video.

3. Lead a discussion of how the students think wall ball is played, the goal of the game, the rules of the game, and how colliding with the wall is essential to the game. Write “Wall Ball Rules” on a page in the K.5.C1: Class Notebook.

Explore I (15 minutes)

Make observations about the cause and effect of objects colliding.

4. Answer any questions about how the game is played before going outside.
   a. Students form two lines in the wall ball area. Have a student from each line come forward. Give one student the ball and ask him/her to bounce it off the wall so it comes back to the other student.
   b. The rest of the students observe where others aim the ball to get it to come back to the opposite line of students.
   c. After several partners play, facilitate a discussion of strategies to get the ball to come back to the first person in the other line by asking, “What works? What doesn’t work?”
   d. Continue the game until all students have had a turn.
K.5 When Two Objects Collide

Explain I (10 minutes)

Record observations about patterns of cause and effect of objects colliding.

5. Bring students back inside to the carpet. Ask students to share with a partner knee-to-knee (student-to-student discourse) about what they observed about the movement of the ball. Encourage them to use a combination of body language and words such as collide and direction.

6. Ask partners to share ideas with the class and use the K.5.C1: Class Notebook to record ideas about how to draw a diagram of the path of the ball as it moved, collided with the wall, and came to the student in the other line. Ask a variety of students to explain how to draw the diagram and add ideas as they are suggested.

TEACHER NOTE

This is a good time to introduce to students a symbol for collision and to reinforce the use of arrows to show direction in their own diagrams and in class diagrams. This will help familiarize them with these symbols for the following day’s activity.

7. During this time, encourage students to develop a class symbol for movement and collisions. (Possible student ideas might be lines or arrows for movement and stars or asterisks for collisions.)

8. Read a selection from the Literacy Links to develop concepts of print using the terms pushes and pulls. A good choice would be Give it a Push! Give it a Pull! but any of the literature on the list will work.
Part II
Engage II (10 minutes)

Use and share observations of the effect that a collision has on the motion of an object.

9. Display the "Wall Ball Diagram" page in the K.5.C1: Class Notebook and ask, "How did the ball move when we played wall ball? Ask students to come up and trace the pathway of the ball as it moved from player to wall to another player."

10. Play William's Wall Ball Tournament video again, and ask students to observe how the people in the video move around as they play the game. Debrief with the following questions:
   a. What questions do you have about how the players know where to move while playing wall ball?
   b. Why do players move side to side? Do they always hit the ball in the same direction? Why?
   c. How is their movement and aiming the same or different from what is done in soccer?

Explore II (20 minutes)

Record observations to collect data about the cause and effect of objects changing direction after a collision.

11. Introduce the mini-wall ball game to the students. Display the materials they will be using: the ruler, the 2 cubes, the ball, the half of a cup, the heavy wooden block, and a blank sheet of construction paper. Ask students to suggest how they might set up the materials to be a mini-wall ball court using the construction paper as the court.

12. Display the second drawing from the K.5.R2: Mini-Wall Ball Set-up which you already drew in the K.5.C1: Class Notebook. Ask the students how this diagram looks similar to the wall ball court where they played yesterday. Lead a discussion that games like wall-ball have rules so everyone starts at the same place. The starting point needs to be 7 inches from the heavy wooden blocks (the wall). Tell them instead of throwing the ball they will use a ramp. In order to make the ball move faster, they can adjust the ruler with 2 cubes. The half of cup is a basket, or goal, which they place where they predict the ball will go after it hits the heavy wooden block (the wall).

Teacher Note

Many kindergarten students do not consider rules as a constant in a game. Therefore, you may want to add a list of game rules using pictures for students to refer to.
13. Distribute bags of materials and the Mini-Wall Ball Game Board you prepared for each group of 4. Ask groups to find a place at a table or the floor to practice. Have the students set up the wall 7 inches from the starting point as shown on the Mini-Wall Ball Game Board and practice playing their mini-wall ball game. Encourage different angles for setting up the ramps (starting points) in order to change the pathway of the ball after it collides with the wall. After they set up their ramp, they should place the basket to predict where the ball will go. Once they have agreed on the position of the ramp and the basket, they should roll the ball down the ramp and see what happens. They can try moving the basket and moving the ramp to see what happens. At this point, they should just explore rather than focus on the 3 positions for the ramp drawn on the Mini-Wall Ball Game Board.

14. Return to the carpet and ask students to describe the different ways in which they set up the materials to get the ball to go in the basket. Record what students figured out about their set-up in the K.5.C1: Class Notebook.

15. Display the third drawing from the K.5.R2: Mini-Wall Ball Set-up which you had drawn in the K.5.C1: Class Notebook. Have a basket and a ruler available to use for the demonstration. Tell students they might have noticed these 3 positions on their game field. Tell them you are going to place the ramp (the ruler) at position 3. Ask the students where the basket should be placed so the ball after it goes down the ramp and collides with the wall will go into the basket. Call on some students to share their thinking. Place a sticky note with a student’s name on it where that student thinks the basket should be placed.
16. Distribute sticky notes to each student. Tell students they are going to go back to their work stations and have one person place the ramp in one of the three positions and then have each student in the group predict where the basket should go. In their own groups, have them share some of the reasons why one student’s basket position will work with that ramp over another and choose a location for the basket that they agree to try. They must prioritize one basket position to try first.

17. Distribute *K.5.H1: Recording Sheet* to each student. Ask each group to once again release the ball from each ramp position and to record the path of the ball. They should practice multiple times for each ramp position so they can figure out where to place the basket. Each student records what happens on the *K.5.H1: Recording Sheet*.

**Explain II (10 minutes)**

*Use and share observations of the effect that a collision has on the motion of an object.*

18. Ask students to return to the carpet with *K.5.H1: Recording Sheet* and sit with a new partner that was not a member of their group. Ask student pairs to share ideas about how the placement of the ramp caused the ball to move differently after colliding with the wall.

19. Partners share ideas with the group while you start a new page labeled “Things That Happen When Objects Collide” in the *K.5.C1: Class Notebook*.

20. As a whole group, create a record of how the ball moves after collisions from different angles.
Elaborate/Evaluate (5 minutes)

*Collisions affect the observed motion of an object in games.*

21. Wrap up today's investigation asking students to choral read the notebook page labeled "Things That Happen When Objects Collide." Discuss what patterns are recorded about how objects change direction after a collision. Ask individual students to draw a picture of what happens when objects collide. Use arrows, asterisks, and pathways to show where the object starts, collides, changes direction, and ends up.

**TEACHER NOTE**

- Collect the individual K.5.H1: Recording Sheets to evaluate for patterns that show that students understand that changing the starting point changes the collision and the resulting path of the ball to the basket. Use this rubric to score the work.

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<tbody>
<tr>
<td>All three diagrams include a complete pathway with arrows and the collision point.</td>
<td>Two diagrams include a complete pathway and may or may not include the collision point.</td>
<td>One diagram with partial pathways, may or may not include arrows or the collision point.</td>
<td>Off topic or does not include all parts as a minimum.</td>
<td></td>
</tr>
</tbody>
</table>

Note: If students are not understanding using a collision to change direction include the mini-wall ball game in the choice center or ask students to set up different tracks with ramps and cars that will collide and change direction.

22. Review entries in the Class Notebook related to how motionless objects are put into motion through pushes and pulls and move with greater or less force. Pushes and pulls can be used as tools to make things move. Objects can change direction through the use of angles and collisions.

23. Display the question page of the Class Notebook started in Lesson 3: Cruising Discs. Ask students to review the list and think about what else we need to know to plan to make goals in soccer. Tell students in the next lesson they will develop a plan for scoring in soccer.
Literacy Links

It would be appropriate to have students interact with text to extend their understanding of movement. These selections can be read aloud at any time after this lesson where students have experienced pushes and pulls and change of direction. Suggested books include the following:

Nonfiction:
- *Motion: Push and Pull, Fast and Slow* by Darlene R. Stille and Sheree Boyd
- *Push and Pull* by Robin Nelson
- *Forces Make Things Move* by Kimberley Brubaker Bradley and Paul Meisel
- *Push and Pull* by Patricia J. Murphy
- *Push and Pull* by Hollie J. Endres
- *Give it a Push! Give it a Pull!* by Jennifer Boothroyd
- *Push and Pull* by Lola M. Schaefer
- *Push and Pull* by Charlotte Guillain
- *How Things Move* by Don L. Curry

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<td>K.5.R1</td>
<td>Wall Ball Directions</td>
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<td>K.5.R2</td>
<td>Mini-Wall Ball Set</td>
<td>K.5.18</td>
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</table>
Class Notebook (continued from Lesson 1)

- Wall Ball video
- Wall Ball Rules
- Wall Ball Diagram
- Mini-Wall Ball Set-up
Class Notebook (continued)

Mini-Wall Ball Set-up

Things That Happen When Objects Collide

What We Have Learned About Mini-Wall Ball
Recording Sheet

Name: __________________________

1

2

3

Name: __________________________

1

2

3
Wall Ball Directions

How To Play Wall Ball

This isn’t the wall ball you may remember. This fun, fast-paced game is similar to racquetball. All you need is two players, a wall, a bouncy ball, and your hands. A great game for playgrounds, the game of the week is Wall Ball!

Images via Emerson/Bandini Elementary, San Diego Unified School District
[Used with Permission]

Group Size: Any size

Age Group: Grades 1+ (use variation at end of the lesson for younger groups)

Length of Activity: 10 minutes or more

Developmental Goal: To develop basic ball-handling skills and hand-eye coordination.

Equipment: Bouncy Balls
Wall Ball Directions (continued)

Before You Start:
Skills Practiced: Underhand and overhand ball hitting and agility.
Equipment Needed: Enough standard rubber playground balls for each group.
  • Demonstrate how to hit the ball against the wall.
  • Choose players to help demonstrate the game.
  • As they play, point out various rules and directions.
  • Ask the players to explain the boundaries and how to hit the ball.

Set-Up:
Using a play area with a smooth, wide wall and marked boundaries is helpful.

How To Play:
  • The game begins when one player serves the ball by hitting the ball towards the wall.
  • The ball must bounce one time on the ground before it reaches the wall.
  • The receiving player must let the ball hit the wall and bounce once before returning it.
  • The player can then return the ball by hitting it and reaching the wall in one bounce off the ground.
  • Play continues until the ball:
    • Bounces on a line or outside the boundaries.
    • Hits the wall without bouncing off the ground.
    • Bounces twice before it is returned.
    • Is not allowed to bounce.
  • When a player stops the play, s/he goes to the end of the line, and a new player comes into the game.
  • The remaining player is the server and begins the next game.

Variations:
  • For lower-skilled players, allow them to catch and return the ball.

After play has advanced past this basic game, players can add special rules. For example, instead of requiring one bounce before returning the ball, a player could allow returns before the ball bounces as well as on a single bounce.
Mini-Wall Ball Set-up

Mini-Wall Board Game Set-up

Drawing for Class Notebook

A Model Drawing

3 Inches
Next Generation Science Standards (NGSS)

This lesson is building toward:

**PERFORMANCE EXPECTATIONS (PE)**

**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. [Clarification Statement: Examples of pushes or pulls could include a string attached to an object being pulled, a person pushing an object, a person stopping a rolling ball, and two objects colliding and pushing on each other.] [Assessment Boundary: Assessment is limited to different relative strengths or different directions, but not both at the same time. Assessment does not include non-contact pushes or pulls such as those produced by magnets.]

**K-PS2-2** Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.* [Clarification Statement: Examples of problems requiring a solution could include having a marble or other object move a certain distance, follow a particular path, and knock down other objects. Examples of solutions could include tools such as a ramp to increase the speed of the object and a structure that would cause an object such as a marble or ball to turn.] [Assessment Boundary: Assessment does not include friction as a mechanism for change in speed.]


**SCIENCE AND ENGINEERING PRACTICES (SEP)**

**Asking Questions**
- Ask questions based on observations to find more information about the natural and/or designed world.

**Planning and Carrying Out an Investigation**
- With guidance, plan and conduct an investigation in collaboration with peers.
- Make observations (first hand or from media) and/or measurements to collect data that can be used to make comparisons.
- Evaluate different ways of observing and/or measuring a phenomenon to determine which way can answer a question.

**Analyzing and Interpreting Data**
- Record information (observations, thoughts, and ideas).
- Use and share pictures, drawings, and/or other writings of observations.

**Obtaining, Evaluating, and Communicating Information**
- 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.
- Obtain information using various texts, text features (e.g., heading, 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.
### DISCIPLINARY CORE IDEAS (DCI)

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

**PS3.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 speed up or slow down more quickly.

### CROSSCUTTING CONCEPTS (CCC)

**Cause and Effect**
- Events have causes that generate observable patterns.

**Patterns**
- Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

"Disciplinary Core Ideas, Science and Engineering Practices, and Crosscutting Concepts" are reproduced verbatim from A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas. DOI: https://doi.org/10.17226/13165. National Research Council; Division of Behavioral and Social Sciences and Education; Committee on a Conceptual Framework for New K–12 Science Education Standards. National Academies Press, Washington, DC. This material may be reproduced for noncommercial purposes and used by other parties with this attribution. If the original material is altered in any way, the attribution must state that the material is adapted from the original. All other rights reserved.

### Common Core State Standards (CCSS)

**CCSS ELA READING**

**CCSS.ELA-LITERACY.R1.K.1**
- With prompting and support, ask and answer questions about key details in a text.

**CCSS SPEAKING AND LISTENING**

**CCSS.ELA-LITERACY.SL.K.3**
- Ask and answer questions in order to seek help, get information, or clarify something that is not understood.

**MATH PRACTICES**

**CCSS.Math.MP2**
- Reason abstractly and quantitatively.

**MATH MEASUREMENT AND DATA**

**CCSS.Math.K.MD.A.1**
- Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object.

**CCSS.Math.K.MD.A.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.
Appendix K.5

California English Language Development (ELD) Standards

<table>
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<tr>
<th>CA ELD</th>
<th>Part I.K.1 Exchanging information and ideas via oral communication and conversations</th>
</tr>
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<tbody>
<tr>
<td><strong>EMERGING</strong></td>
<td>Contribute to conversations and express ideas by asking and answering yes-no and wh- questions and responding using gestures, words, and simple phrases.</td>
</tr>
<tr>
<td><strong>EXPANDING</strong></td>
<td>Contribute to class, group, and partner discussions by listening attentively, following turn-taking rules, and asking and answering questions.</td>
</tr>
<tr>
<td><strong>BRIDGING</strong></td>
<td>Contribute to class, group, and partner discussions by listening attentively, following turn-taking rules, and asking and answering questions.</td>
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</tbody>
</table>

In addition to the standard above, you may find that you touch on the following standards in this lesson as well:

- **P1.K.2** Interacting with written English (print and multimedia)
- **P1.K.5** Listening actively and asking or answering questions about what was heard
- **P1.K.12** Selecting and applying varied and precise vocabulary and other language resources

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Collision Goal!

K.6

A project of CA NGSS K–8 Early Implementation Initiative.

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Image via iStock.com/pcess609

Standards
Refer to Appendix K.6 for NGSS, CCSS (ELA and Math), and California ELD Standards.

Anchoring Phenomenon
Objects do not move on their own.

Lesson Concept
Plan and conduct an investigation to observe the cause and effect of objects moving and colliding.

Identified Problem
More goals are made in soccer with a plan.
Driving Question
Which plan will move the ball around players?

Storyline Link
In Lesson 5: When Two Objects Collide, students explored the investigative phenomenon "A ball thrown against a wall changes direction" using the game of wall ball. The pattern of pushes in different directions were recorded looking for patterns to use in soccer collisions. This data will be used to solve the problem of planning a strategy for playing the collision game of soccer. (SEP)

In this lesson, the data collected from observing and recording pushes that change direction in Lesson 5: When Two Objects Collide will be used to collaboratively design a solution or strategy for using collisions to move a ball around an obstruction to plan scoring a goal in soccer. Materials available to design or engineer the plan for scoring are familiar materials used throughout the investigations. Materials include a ramp, collision wall, goal, and ball. (SEP) (CCC) (DCI)

Students collaboratively plan, test, adjust their plan, and retest for scoring. This leads to the selection of the best plan or solution. Students use what they have figured out in Lesson 1: Exploration Box about pushes and pulls, combined with designing solutions in Lesson 2: Pullapalooza and strategic use of strength of the force in Lesson 3: Cruising Discs, with the forces of pushes from wind in Lesson 4: Huff, Puff, Move the Ball, and changes due to collisions in Lesson 5: When Two Objects Collide to plan for collisions in the final explanation in this lesson of planning how to move a motionless ball using strength of force and collisions to score a goal in soccer.

An individual plan for scoring will be evaluated based on the student’s understanding of how to get a motionless object (soccer ball) to move in predictable ways using strength of kick (ramp), placement of players for collisions or stopping motion, and direction of kicks to score goals.

Throughout the lesson, a flag (►) denotes formative assessment opportunities where you may change instruction in response to students’ level of understanding and making sense of phenomena.

Time
130 minutes

Part I 40 minutes
10 minutes Engage I
30 minutes Explore I

Part II 30 minutes
30 minutes Explore II

Part III 30 minutes
30 minutes Explain II

Part IV 30 minutes
30 minutes Elaborate/Evaluate
Materials

Whole Class

- FC Barcelona video (https://www.youtube.com/watch?v=CvbIAaEgKjc)
- Chart paper
- Soccer ball
- 2 cones

Group (Groups of 2)

- Ruler for a ramp
- 2 blocks to elevate the ruler
- 1 golf ball or rubber ball
- Half of a plastic cup
- 3 sheets of 12" by 18" construction paper
- Heavy wooden block (approx. 3" by 6") or a thick textbook
- 3 bear counters (or any figure that looks like a player)
- Masking tape
- Crayons

Individual

- Pencils
- Crayons
- Science notebook or piece of paper
- K.6.H1: Soccer Field

Teacher

- K.6.R1: Soccer Game Board Set-up
- K.6.R2: Evaluation Rubric For the Summative Sticky Note Plans

Advance Preparation

1. Prepare the Soccer Game Board for every two students following the Soccer Field diagram on K.6.R1: Soccer Game Board Set-up.
   - Cut a medium or large plastic cup vertically to make two half cups. Tape the opening down centered at the end of the construction paper to form a cave-like opening to serve as the goal.
**K.6 Collision Goal!**

- Draw a line on the opposite end of the paper to show where students will place the opening of their ramp.
- Instead of the pictures of the bears, tape down three bear counters in a line spaced half an inch apart. The line of bears should be about 5 inches in front of the goal.

2. Place ramp materials in a bin so that students can construct a ramp. Include the ball in the bin.

3. Preview FC Barcelona video (https://www.youtube.com/watch?v=CvblAaEgKjc). Cue the video to a section where you see collisions and then a goal. Showing only 1 to 2 minutes of the video.


5. Prepare the **K.6.C1: Class Notebook** for this lesson as described in the Toolbox for this lesson. Make sure you create 2 notebook pages, one that represents the Soccer Game Board and one called the Soccer Field. Use the **K.6.R1: Soccer Game Board Set-Up** as a model.

**TEACHER NOTE**

When setting up soccer fields, glue or tape bears in position and tape the goal in place. Students can use different items to represent their teammates (baskets, books, blocks, etc.), and the ramp can be set at different heights.
**Procedure**

**Part I**

**Engage I (10 minutes)**

*Make observations about patterns seen when an object is put in motion.*

1. Display the chart of brainstormed questions recorded under “Questions” started during Lesson 1: Exploration Box in the **Class Notebook**. Ask students to choral read with you all the questions about how to score a goal in soccer. After each question, invite students to share answers to the question and build on their ideas if needed.

2. Show the **FC Barcelona** video and ask students to look for how these students moved the ball past the opposing players to make a goal.

3. After viewing the video, ask students to think-pair-share knee-to-knee to answer the question, “How did the players get the ball down the field, past the defenders, and into the goal?”
   a. Share partner ideas with the group.
   b. Discuss with the whole group, “What are some of the patterns you noticed?”

**Explore I (30 minutes)**

*Plan and conduct an investigation observing patterns that occur when objects touch or collide.*

4. Ask students to talk about how to get the ball around other players to players on their team when they play soccer. Ask students if they have planned where to move the ball or if their coach had a plan to help them move the ball.

5. Show students the Soccer Game Board which you drew on the **K.6.C1: Class Notebook**. Discuss how the diagram is like the way a large soccer field might look. Listen to what students think the model of the soccer game represents.

6. Emphasize that the bears are the opposing team in this Soccer Game Board. The wall represents players from your own team. Have students think about how to get the ball to collide with the wall of players from your team to get around the bears and make a goal.

**TEACHER NOTE**

Listen for academic words used to describe the movement when the ball collides with another player, e.g. *push, collide, and push off*. Expand student explanations by making statements such as “Yes, it hit another player’s head, or we could say it collided with the player’s head.” This supports both California ELD and CCSS in ELA.
7. Distribute the prepared Soccer Game Board, the ball, the ramp, the block, the 3 bears, and the wall. Have students put the goal and the opposing players into position. Then each student works with a partner to draw a plan on the Soccer Game Board.
   a. Think about where to start the motionless soccer ball using the same kind of ramp used in mini-wall ball with two blocks under the ramp.
   b. Plans should include the pathway to the goal and the collision with the wall (which represent the students’ teammates) to get the ball around the bears and into the goal.
   c. Ask partners to return to the meeting place with their plans on the construction paper.

8. Display all student plans side-by-side on a ledge and ask partners to explain their plan. Ask students to identify what is the same about the plans and what is different. Have students observe and describe the patterns they see in the plans.

9. If students saw an idea in someone else’s plan that they liked, they can revise their plan.

**Part II**

**Explore II (30 minutes)**

*Design a solution using patterns of push and pull or collisions to move a soccer ball to the goal.*

10. Ask partners to test their plans. After the materials are set up, tell students you must approve the set-up and give the go-ahead to test. Circulate around the room. Remind students to record the path of the ball on the field (the construction paper) using different colored crayons. Partners then discuss what worked and what they would like to try for the next set-up.
11. After the initial trial, have partners adjust their models by changing the position of the wall, or the starting point for the ball. After testing, record the pathway using a different-colored crayon. Continue testing until the pathway to the goal is consistent from the starting point, and the ball does not come in contact with the opposing team (the 3 bears).

12. Ask each person to draw a diagram of their final test solution in their kindergarten science notebook or on a sheet of paper. This solution might be quite different than the original plan.

13. Return to the meeting area to discuss the results. Ask partners to explain what they did to get the ball in the goal. How did they figure it out? Have other students ask clarifying questions using the sentence frame: Why did you change _____ to score?

14. Select one or more books from the Literacy Links for a read aloud. Use *How Things Move* if available. Any of the titles can be used to solidify the language of how things move. Discuss main ideas with the class or have the students act out the movements in the book.

**Part III**

**Explain II (30 minutes)**

*Communicate ideas about the cause and effect of an object in motion colliding with another object.*

15. ▶ Ask partner groups to share their plan and the pathways tried. Each partner group takes turns explaining how they adjusted their set-up multiple times to position the teammates and to determine the start position.
K.6 Collision Goal!

Part IV
Elaborate/Evaluate (30 minutes)

Analyze data and observe patterns of objects colliding to plan a solution to move a soccer ball to make a goal.

**TEACHER NOTE**
Set up the Soccer Game Board in the student choice center for students that need practice seeing the pattern caused by changing the angle of the ramp or the placement of the wall. More proficient students can use word cards placed in the center that label defenders, the wall, arrows to indicate a change in direction. The word cards should be available to every student.

16. Display a diagram of the soccer field in the K.6.C1: Class Notebook and explain that a soccer coach has asked us to do a drill to prepare to make a goal outside on a real soccer field.

17. Notice where the defender bears are on the field. Tell them the coach has already placed one sticky note where he/she wants one teammate to stand. Ask two other students to each place one sticky note where two other teammates should stand to have the best chance of getting the ball from a kicker and directing it into the goal.

18. Take the diagram and the students outside. Set up two cones to make a goal and ask three students to stand in a line just like the bears and three students to stand in the place of the sticky notes on your diagram. Ask three additional students to take turns kicking the ball to one of the teammates to see if it will go in the goal. Keep practicing the drill until all students in the class have a chance to play at least two roles.

19. Return to the room and lead a discussion about how the motionless object (a soccer ball) was put into motion with a push (kick), collided with a player, changed direction, and made a goal. Note that the ball eventually stopped moving.

20. Display the page of the Class Notebook with the brainstormed list of games played by students and their families from Lesson 1: Exploration Box. Use choral reading to review the list. Ask partners to discuss knee-to-knee (student-to-student discourse) to identify which games use pushes, pulls, or collisions. Share and record responses using symbols for push, pull, and collision for each game.

**TEACHER NOTE**
Before this Elaborate/Evaluate, take two of the student plans and make a diagram on chart paper like the one provided on K.6.R1: Soccer Game Board Set-up. Have three sticky notes available on the chart. Sticky notes will stand for players from their team. Students will decide where to place the sticky notes.
21. ▶ Distribute **K.6.H1: Soccer Field**. Distribute three sticky notes to each student and ask them to place the sticky notes in the best place for teammates to be able to get a ball from the kicker and kick it into the goal. Ask students to include the pathway of the ball and the three sticky notes and mark where the ball starts its movement, collides and changes direction, and makes a pathway to the goal and stops in the goal.

**TEACHER NOTE**


**Literacy Links**

It would be appropriate to have students interact with text to extend their understanding of movement. These selections can be read aloud at any time after this lesson where students have experienced pushes and pulls and change of direction. Suggested books include the following:

**Nonfiction:**

- *Motion: Push and Pull, Fast and Slow* by Darlene R. Stille and Sheree Boyd
- *Push and Pull* by Robin Nelson
- *Forces Make Things Move* by Kimberley Brubaker Bradley and Paul Meisel
- *Push and Pull* by Patricia J. Murphy
- *Push and Pull* by Hollie J. Endres
- *Give it a Push! Give it a Pull!* by Jennifer Boothroyd
- *Push and Pull* by Lola M. Schaefer
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- *How Things Move* by Don L. Curry

**References**


K.6 Collision Goal!


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<tr>
<td>K.6.R1</td>
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<td>K.6.R2</td>
<td>Evaluation Rubric for the Summative Sticky Note Plans</td>
<td>K.6.15</td>
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</tbody>
</table>
What are some of the patterns you noticed?

Soccer Game Board

Soccer Field

GOAL

***

***

***
Soccer Field

GOAL
Soccer Game Board Set-up

**Soccer Game Board**

GOAL

**Soccer Field**

GOAL

**A Model Drawing**

GOAL

5 Inches
## Evaluation Rubric for the Summative Sticky Note Plans

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<th>2</th>
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<tbody>
<tr>
<td>4</td>
<td>Includes all major parts of the system (sticky note players appropriately placed, pathway shows beginning of the kick, collision point, goal, and stopping point).</td>
<td>Includes all major parts of the system (sticky note players appropriately placed, pathway shows beginning of the kick, goal, and stopping point).</td>
<td>Includes some of the major parts of the system (sticky note players appropriately placed, pathway shows goal).</td>
<td>Includes parts of the system but not enough to clearly show a planned pathway.</td>
</tr>
<tr>
<td>5</td>
<td>Includes collision points, arrows showing change of direction and stopping point.</td>
<td>Misses one or more of the following: starting point, collision point, ending or stopping point, and the pathway between the points.</td>
<td>Misses two or more of the following: starting point, collision point, ending or stopping point, or pathway.</td>
<td>Off-topic plan with direction arrows that are not showing direction or change in direction correctly.</td>
</tr>
<tr>
<td>6</td>
<td>Clear arrows show pathway direction.</td>
<td>Arrows are included that show direction of the pathway.</td>
<td>Does not include arrows showing direction or shows an inaccurate path.</td>
<td></td>
</tr>
</tbody>
</table>
Next Generation Science Standards (NGSS)

This lesson is building toward:

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<thead>
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<th>PERFORMANCE EXPECTATIONS (PE)</th>
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| **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. [Clarification Statement: Examples of pushes or pulls could include a string attached to an object being pulled, a person pushing an object, a person stopping a rolling ball, and two objects colliding and pushing on each other.] [Assessment Boundary: Assessment is limited to different relative strengths or different directions, but not both at the same time. Assessment does not include non-contact pushes or pulls such as those produced by magnets.]

| **K-PS2-2** Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.* [Clarification Statement: Examples of problems requiring a solution could include having a marble or other object move a certain distance, follow a particular path, and knock down other objects. Examples of solutions could include tools such as a ramp to increase the speed of the object and a structure that would cause an object such as a marble or ball to turn.] [Assessment Boundary: Assessment does not include friction as a mechanism for change in speed.]


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<tr>
<th>SCIENCE AND ENGINEERING PRACTICES (SEP)</th>
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<tr>
<td><strong>Planning and Carrying Out an Investigation</strong></td>
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</table>
| • With guidance, plan and conduct an investigation in collaboration with peers.  
• Make observations (firsthand or from media) and/or measurements of a proposed tool or solution to determine if it solves a problem or meets a goal.  

| **Constructing Explanations and Designing Solutions** |
| • Use tools and/or materials to design and/or build a device that solves a specific problem or a solution to a specific problem.  

| **Analyzing and Interpreting Data** |
| • Use and share pictures, drawings, and/or other writings of observations.  
• Analyze data from tests of an object or tool to determine if it works as intended.  

| **Obtaining, Evaluating, and Communicating Information** |
| • 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.  
• Obtain information using various texts, text features (e.g., heading, 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.  

K.6.A1
**DISCIPLINARY CORE IDEAS (DCI)**

**PS2.A Forces and Motion**
- Pushes and pulls can have different strengths and directions.
- 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.

**ETS1.A: Defining and Delimiting an Engineering Problem**
- 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.

**ETS1.B: Developing Possible Solution**
- Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people.

**CROSSCUTTING CONCEPTS (CCC)**

**Cause and Effect**
- Events have causes that generate observable patterns.

**Patterns**
- Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

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**Common Core State Standards (CCSS)**

**CCSS ELA READING**

**CCSS.ELA-LITERACY.R1.K.1**
With prompting and support, ask and answer questions about key details in a text.

**CCSS SPEAKING AND LISTENING**

**CCSS.ELA-LITERACY.SL.K.3**
Ask and answer questions in order to seek help, get information, or clarify something that is not understood.

**MATH PRACTICES**

**CCSS.Math.MP2**
Reason abstractly and quantitatively.
Appendix K.6

MATH MEASUREMENT AND DATA

CCSS.Math.K.MD.A.1
Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object.

CCSS.Math.K.MD.A.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.

California English Language Development (ELD) Standards

CA ELD

Part I.K.1 Exchanging information and ideas via oral communication and conversations

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<tr>
<th>EMERGING</th>
<th>EXPANDING</th>
<th>BRIDGING</th>
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<tr>
<td>P1.K.1</td>
<td>Contribute to conversations and express ideas by asking and answering yes-no and wh-questions and responding using gestures, words, and simple phrases.</td>
<td>P1.K.1 Contribute to class, group, and partner discussions by listening attentively, following turn-taking rules, and asking and answering questions.</td>
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In addition to the standard above, you may find that you touch on the following standards in this lesson as well:

- P1.K.2 Interacting with written English (print and multimedia)
- P1.K.5 Listening actively and asking or answering questions about what was heard
- P1.K.12 Selecting and applying varied and precise vocabulary and other language resources

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