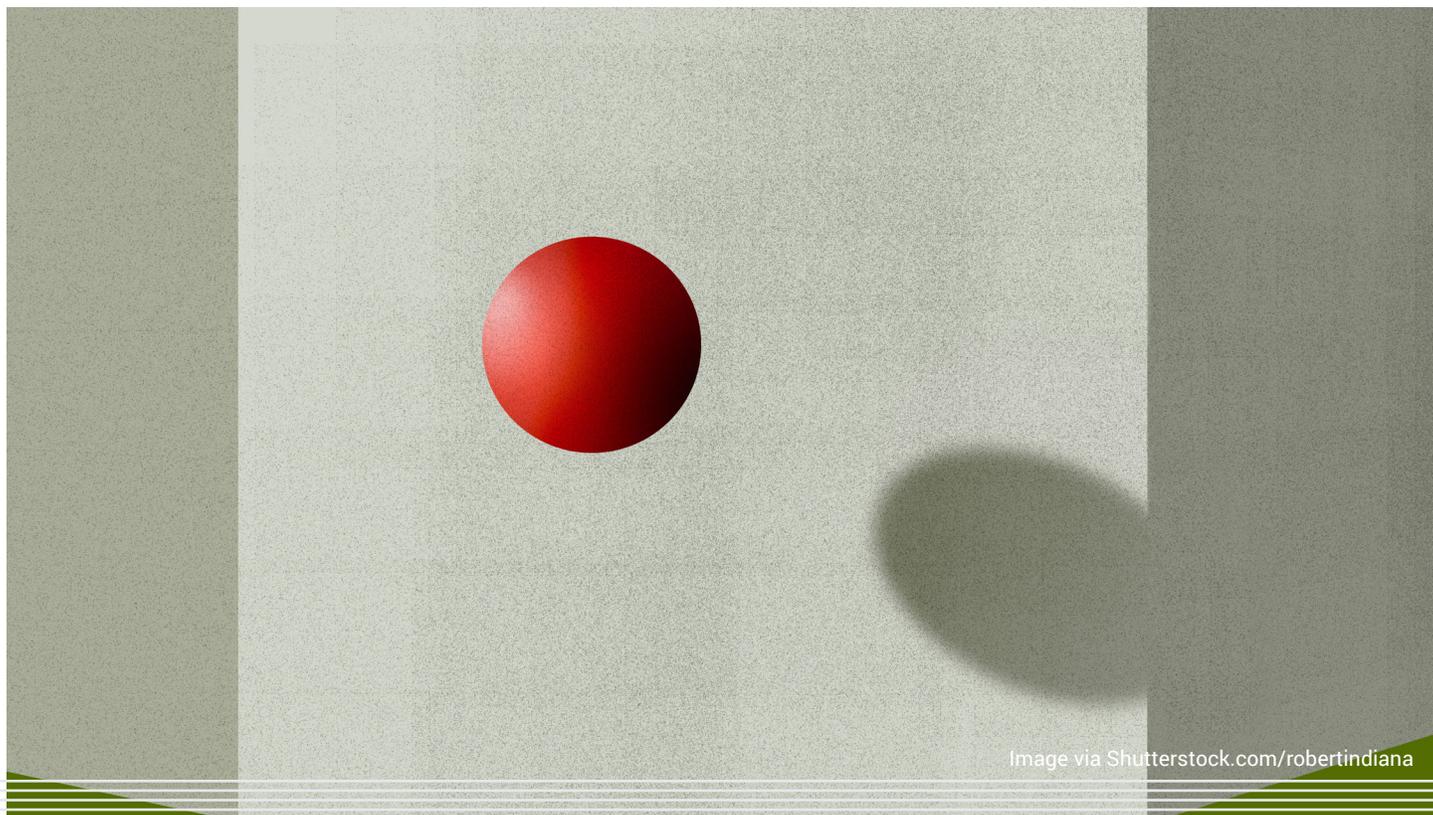


When Two Objects Collide

K.5



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.



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

K.5 When Two Objects Collide



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.
4. Preview **K.5.R1: Wall Ball Directions**.

K.5 When Two Objects Collide

5. Review the [William's Wall Ball Tournament](https://www.youtube.com/watch?v=rhsAKRn1OG4) video (<https://www.youtube.com/watch?v=rhsAKRn1OG4>).
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.

K.5 When Two Objects Collide



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.



Image via Vista Unified School District
[Used with Permission]

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.

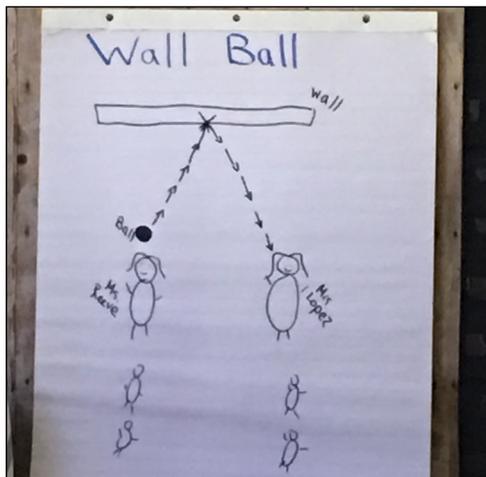


Image via Vista Unified School District
[Used with Permission]

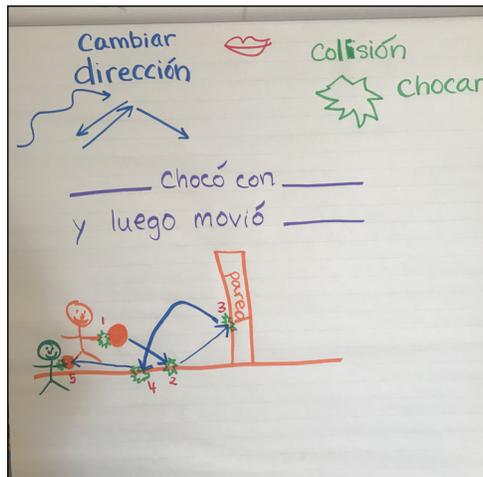


Image via Lakeside USD
[Used with Permission]

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.

K.5 When Two Objects Collide

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.

K.5 When Two Objects Collide

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.

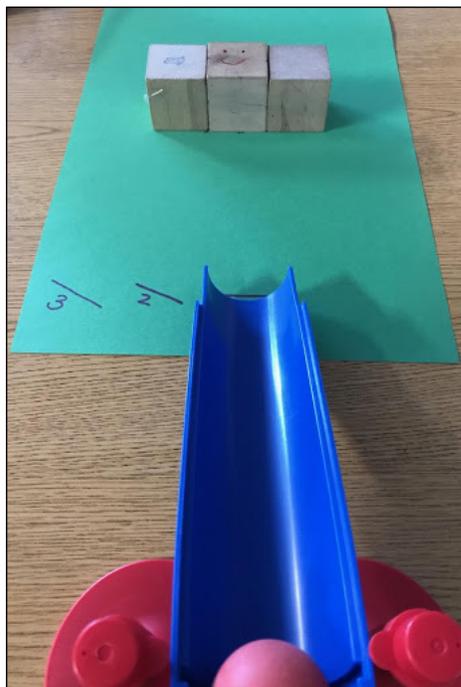


Image by WestEd

Ramp in Position 1

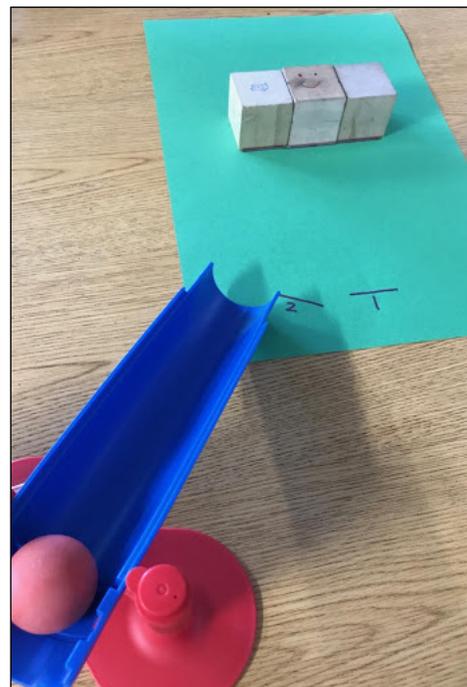


Image by WestEd

Ramp in Position 3

K.5 When Two Objects Collide

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**.

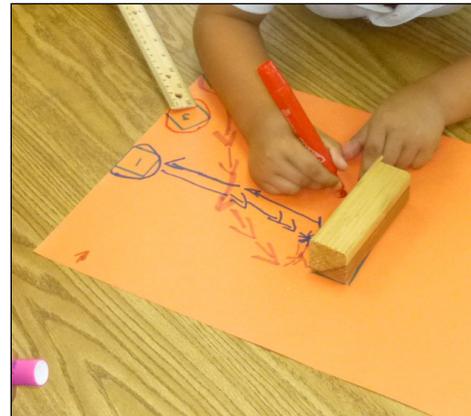


Image via Emerson/Bandini Elementary,
San Diego Unified School District
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Explain II (10 minutes)

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.

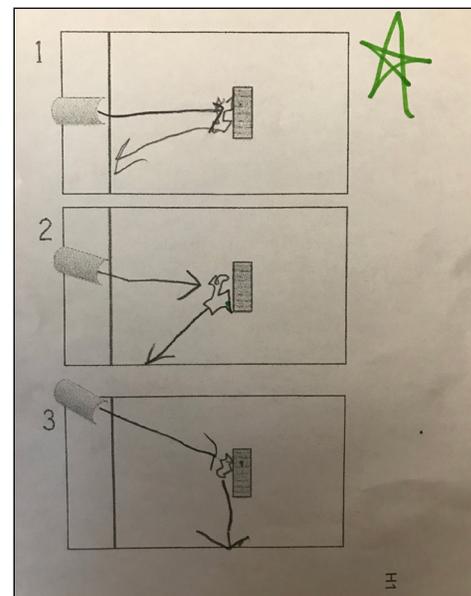


Image via Lakeside USD [Used with Permission]

K.5 When Two Objects Collide

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.

4	3	2	1
All three diagrams include a complete pathway with arrows and the collision point.	Two diagrams include a complete pathway and may or may not include the collision point.	One diagram with partial pathways, may or may not include arrows or the collision point.	Off topic or does not include all parts as a minimum.

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.

K.5 When Two Objects Collide

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

References

- Boothroyd, J. (2010). *Give It a Push! Give It a Pull!* New York, NY: Lerner Digital.
- Bradley, K. B., & Meisel, P. (2010). *Forces Make Things Move*. New York, NY: HarperCollins.
- Curry, D. L. (2001). *How Things Move*. Mankato, MN: Yellow Umbrella Books.
- Endres, H. J. (2004). *Push and Pull*. Bloomington, MN: Yellow Umbrella Books.
- Guillain, C. (2012). *Push and Pull*. London: Raintree.
- Murphy, P. J. (2002). *Push and Pull*. New York, NY: Children's Press.
- Navarro, J. (2011, March 5). William's Wall Ball Tournament-Game 5. Retrieved from <https://www.youtube.com/watch?v=rhsAKRn10G4>
- Nelson, R. (2004). *Push and Pull*. Minneapolis, MN: Lerner Publications.
- Schaefer, L. M. (2000). *Push and Pull*. Mankato, MN: Pebble Books.
- Stille, D. R., & Boyd, S. (2004). *Motion: Push and Pull, Fast and Slow*. Minneapolis, MN: Picture Window Books.

Toolbox Table of Contents

K.5.C1	<u>Class Notebook (continued from Lesson 1)</u>	K.5.13
K.5.H1	<u>Recording Sheet</u>	K.5.15
K.5.R1	<u>Wall Ball Directions</u>	K.5.16
K.5.R2	<u>Mini-Wall Ball Set</u>	K.5.18

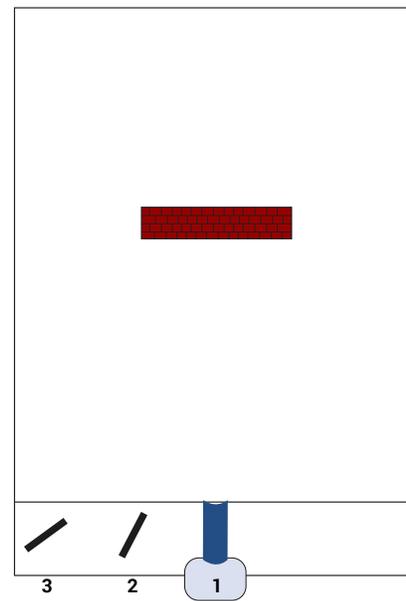
Class Notebook (continued from Lesson 1)

Wall Ball video

Wall Ball Rules

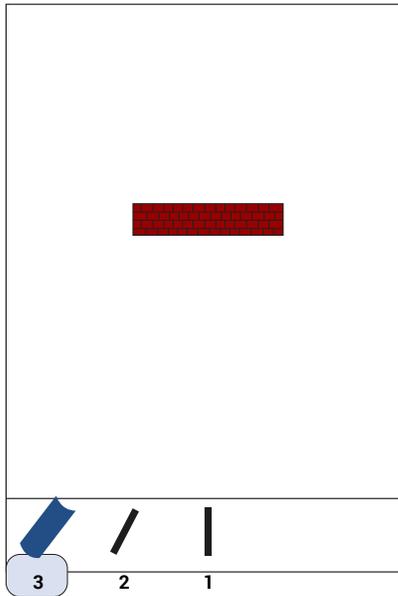
Wall Ball Diagram

Mini-Wall Ball Set-up



Class Notebook (continued)

Mini-Wall Ball Set-up

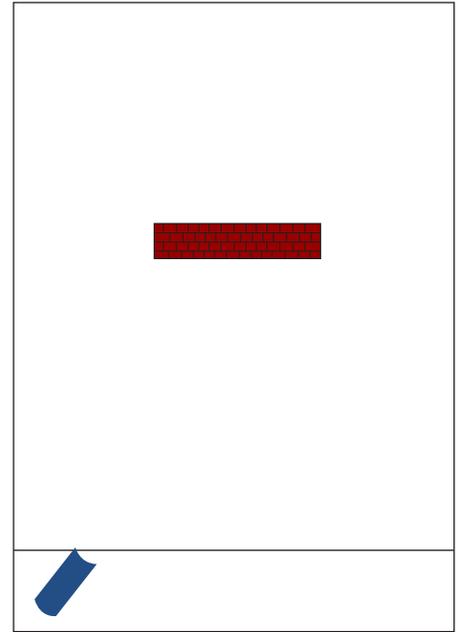
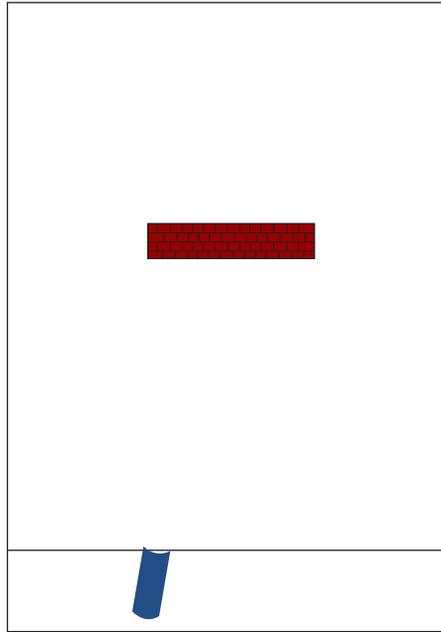
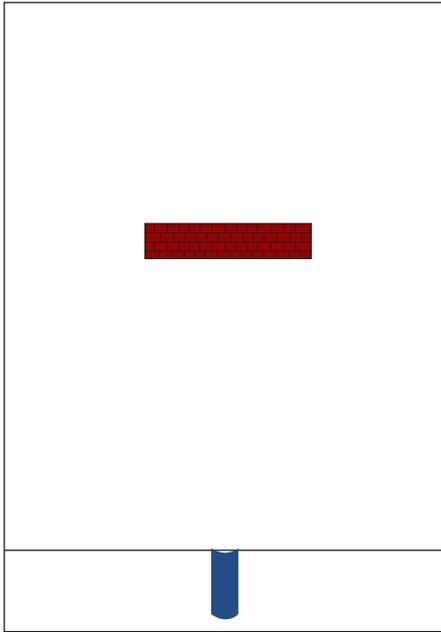


**Things That Happen When
Objects Collide**

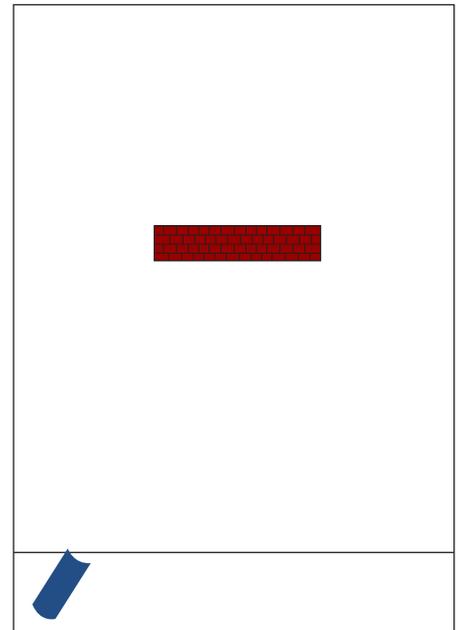
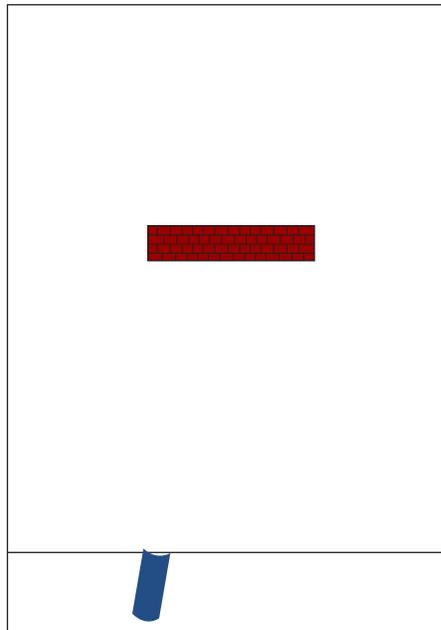
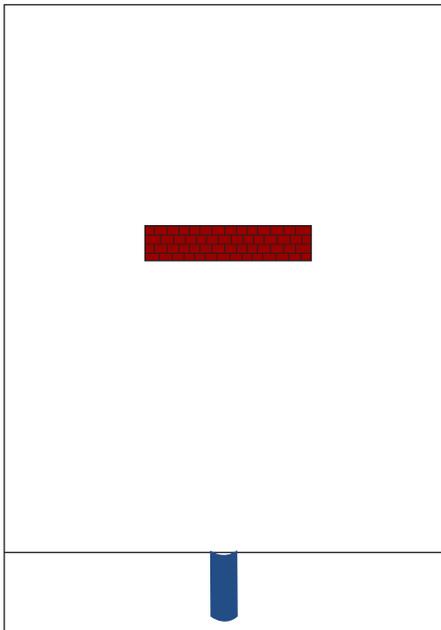
**What We Have Learned
About Mini-Wall Ball**

Recording Sheet

Name: _____



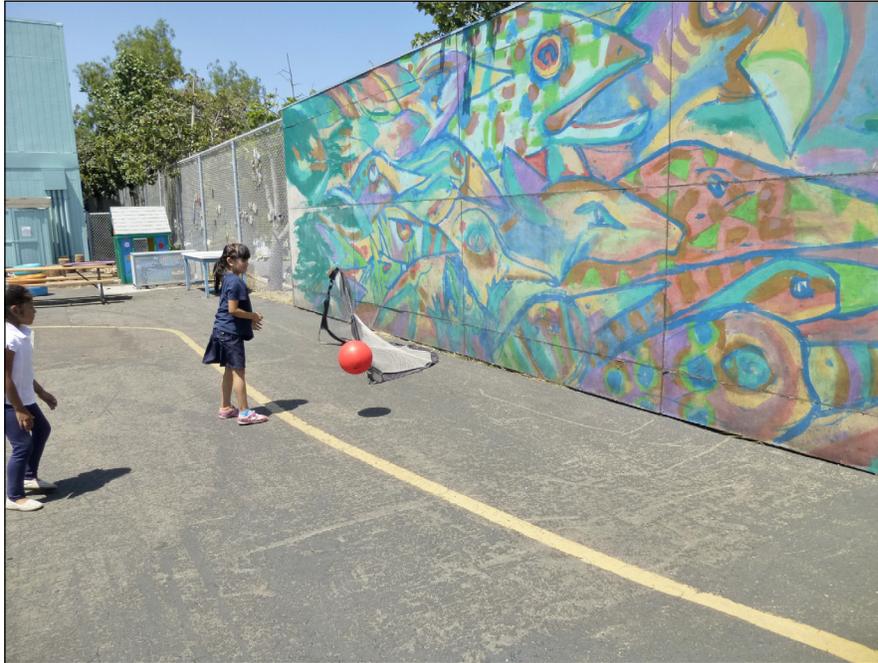
Name: _____



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
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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.

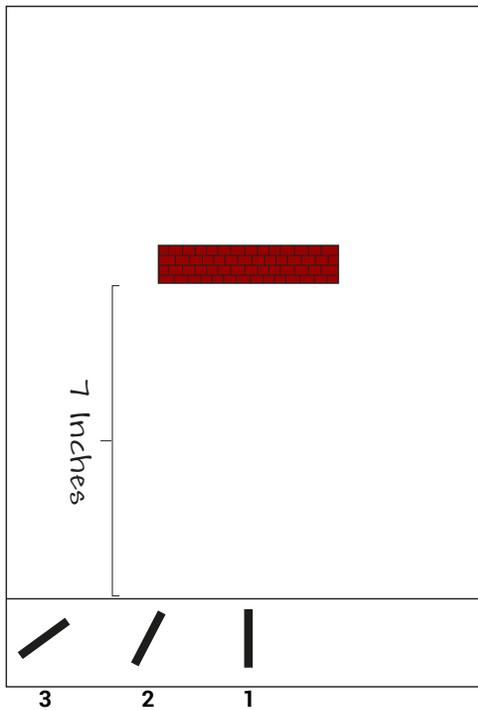
Variations:

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

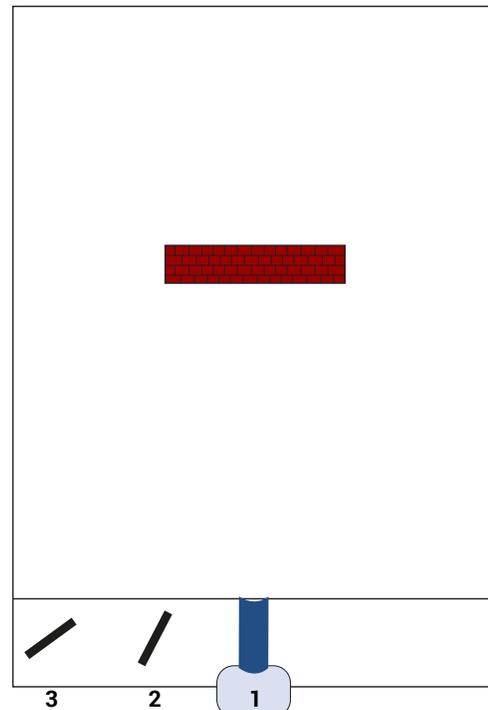
After play has advanced past this basic game, players can add special rules. For example, instead of requiring one bounce before returning the ball, a player could allow returns before the ball bounces as well as on a single bounce.

Mini-Wall Ball Set-up

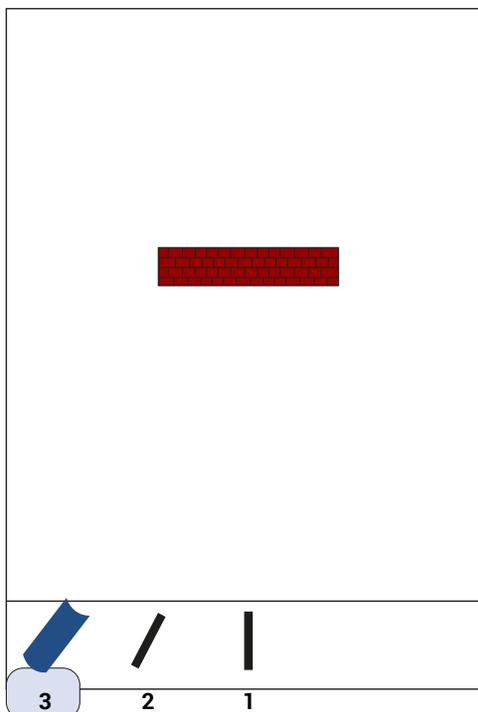
Mini-Wall Board Game Set-up



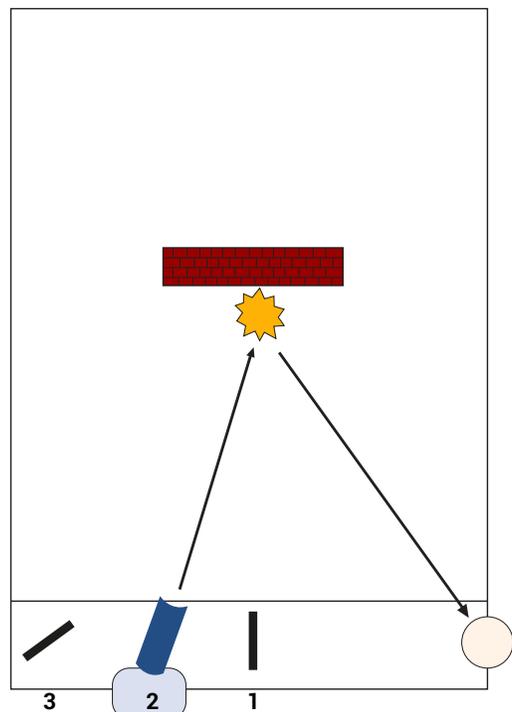
Drawing for Class Notebook



Drawing for Class Notebook



A Model Drawing



Appendix K.5

When Two Objects Collide

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. <i>[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.]</i>
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.* <i>[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.]</i>

NGSS Lead States. 2013. Next Generation Science Standards: For States, By States. Washington, DC: The National Academies Press.

SCIENCE AND ENGINEERING PRACTICES (SEP)
Asking Questions
<ul style="list-style-type: none">Ask questions based on observations to find more information about the natural and/or designed world.
Planning and Carrying Out an Investigation
<ul style="list-style-type: none">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
<ul style="list-style-type: none">Record information (observations, thoughts, and ideas).Use and share pictures, drawings, and/or other writings of observations.
Obtaining, Evaluating, and Communicating Information
<ul style="list-style-type: none">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.

Appendix K.5

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.

CROSCUTTING 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.

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.5

California English Language Development (ELD) Standards

CA ELD

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

Contribute to conversations and express ideas by asking and answering *yes-no* and *wh-* questions and responding using gestures, words, and simple phrases.

EXPANDING

Contribute to class, group, and partner discussions by listening attentively, following turn-taking rules, and asking and answering questions.

BRIDGING

Contribute to class, group, and partner discussions by listening attentively, following turn-taking rules, and asking and answering questions.

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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