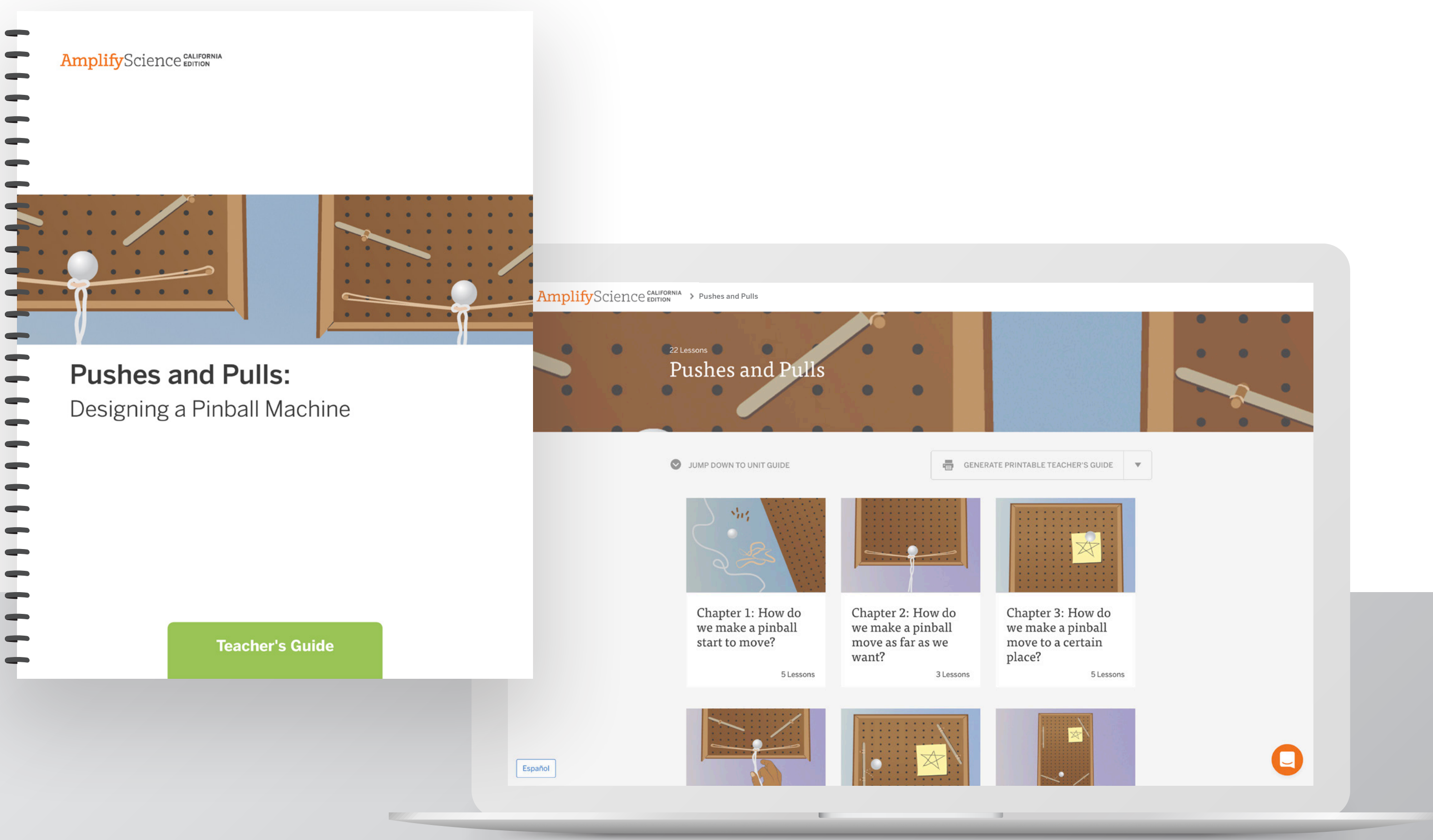
Amplify Science
CALIFORNIA

Kindergarten

UNIT GUIDE

Pushes and Pulls



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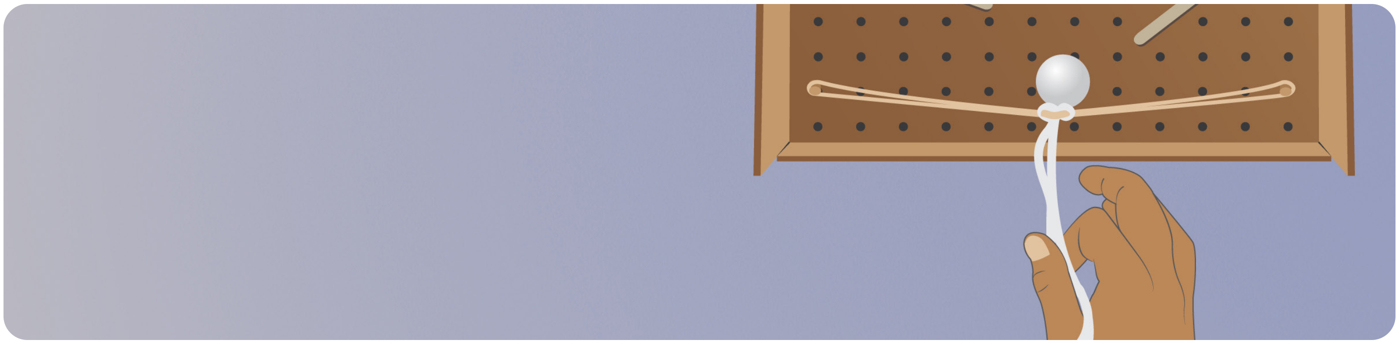


Welcome to Pushes and Pulls

Directional forces (pushes and pulls) are evident everywhere in our world—from pushing a grocery cart to pulling a wagon. From an early age, children use trial and error to learn about the effects of pushing and pulling, and they come into kindergarten with this knowledge. Amplify Science California builds on this inherent knowledge, with the goal of advancing students' understanding so that they can begin to anticipate and articulate how pushes and pulls impact the motion of a ball. Students' increasing experience with and confidence in being able to predict and describe the effect of a specific type of push or pull will give rise to a growing understanding of forces and motion.

> Unlike a typical curriculum, Amplify Science California anchors learning by inviting students to take on the role of scientists and engineers.

In this unit, students take on the role of pinball engineers. Their job is to explore how pinball machines allow people to control the direction and strength of forces on a ball. Working together, students learn about how engineers design and test solutions to problems. By the end of the unit, they use their new understanding of the phenomena of force and motion to identify pushes and pulls more broadly in their lives.

Unit Type: Engineering Design

Student Role: Pinball Engineers

Phenomenon: Pinball machines allow people to control the direction and strength of forces on a ball.

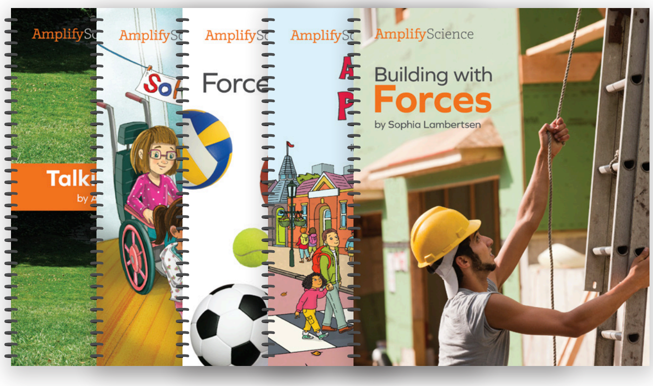
Core Concept: Understanding the effects of forces on the motion of an object

Target Performance Expectations:

- K-PS2-1: Pushes and Pulls
- K-PS2-2: Change Speed and Direction
- K-2-ETS1-1: Defining the Problem
- K-2-ETS1-2: Developing Possible Solutions
- K-2-ETS1-3: Comparing Different Solutions

Students figure out the unit phenomenon through the use of a variety of resources.

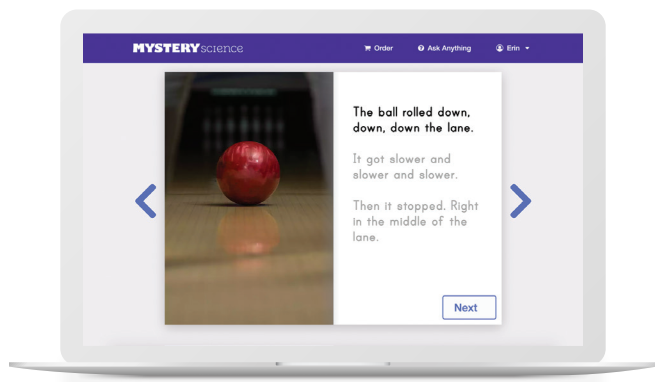
Big Books



Student Books

Hands-On Kit

Videos



About technology in this unit:
Amplify Science California gives you the flexibility to use technology in the way that meets your needs best. In K–2, teachers have the option of using:

- **Student digital licenses** that allow for online completion of work, teacher feedback and grading, and digital class management.
- **Traditional consumable resources** that allow for a more familiar paper and pencil experience.

Whether students use the student digital experience or print workbooks, there are some technology-based activities all students will experience from time to time. In grade K, these activities are limited to digital readers and other media (i.e., videos, images).

About reading in this unit:
In grade K, students are never asked to read alone. Rather, books are read *to, with,* and *by* students with ample scaffolding and support provided by the teacher. Big books are used to introduce ideas through read-aloud and shared reading experiences. Matching student books allow for small-group reading and reading in pairs.

Chapter 1:
The storyline begins

What students investigate:

How do we make a pinball start to move?

What they figure out:

To make a pinball start to move, force must first be exerted on the pinball. A rubber band launcher can be used to exert a force on a pinball.

How they figure it out:

- Investigating how to make objects in the classroom start to move
- Talking about cause and effect
- Learning key scientific language and practicing talking about forces and observed motion during a read aloud of the big book *Talking About Forces*
- Creating models for testing their ideas about making the pinball start to move

KEY

- HANDS-ON
- READING
- STUDENT-TO-STUDENT DISCUSSION
- TEACHER
- TEACHER-LED DISCUSSION
- WRITING

DAY 1 | LESSON 1.1

Pre-Unit Assessment

- Leading a Pre-Unit-Assessment Conversation (15 min)
- Introducing Students' Role as Engineers (10 min)
- Movement Hunt (10 min)
- Discussing Movement (10 min)

Pre-Unit Assessment

DAY 2 | LESSON 1.2

Talking About Forces

- Exploring and Describing Movement (10 min)
- Visualizing Movement (10 min)
- Explaining with Because (10 min)
- Reading *Talking About Forces* (15 min)

On-the-Fly Assessment

DAY 3 | LESSON 1.3

Forces Happen Between Two Objects

- Connecting Force and Movement (15 min)
- Investigating Forces (15 min)
- Explaining Force Between Two Objects (15 min)

On-the-Fly Assessment

DAY 4 | LESSON 1.4

We Are Engineers

- How We Are Like Engineers (10 min)
- Introducing the Box Model (5 min)
- Designing the Launcher in the Box Model (15 min)
- Drawing Diagrams of Our Box Models (15 min)

On-the-Fly Assessment

DAY 5 | LESSON 1.5

Writing About Forces

- Engineers Design Solutions (10 min)
- Adding a Launcher to the Class Pinball Machine (5 min)
- Writing About Forces (15 min)
- Revisiting *Talking About Forces* (15 min)

Critical Juncture Assessment
Self-Assessment

Chapter 2:
The storyline builds

What students investigate:

How do we make a pinball move as far as we want?

What they figure out:

To make a pinball go a longer distance, the rubber band launcher has to exert a strong force. To make it go a short distance, the rubber band launcher has to exert a gentle force. Attaching a shoelace to the rubber band launcher provides a way of adjusting then the force.

How they figure it out:

- Investigating and testing how to make a pinball move short or long distances with the Box Models
- Explaining how the launcher can be used to exert gentle and strong forces to move a pinball different distances
- Learning more about different kinds of forces during a read-aloud of the big book *Forces in Ball Games*

KEY

HANDS-ON

READING

STUDENT-TO-STUDENT DISCUSSION

TEACHER

TEACHER-LED DISCUSSION

WRITING

DAY 6 | LESSON 2.1

Exploring Shorter and Longer Distances

- Identifying New Design Goals (10 min)
- Introducing Distance (5 min)
- Exploring Distance (15 min)
- Talking About Force and Distance (15 min)

On-the-Fly Assessment

DAY 7 | LESSON 2.2

Strong and Gentle Forces

- Reading *Forces in Ball Games* (15 min)
- Talking About Strong and Gentle Forces (10 min)
- Sorting Strong and Gentle Forces (10 min)
- Explaining Strong and Gentle Forces (10 min)

On-the-Fly Assessment

DAY 8 | LESSON 2.3

Designing a New Launcher

- Trying Different Forces in the Box Model (15 min)
- Drawing Diagrams of Our Box Models (10 min)
- Modifying the Class Pinball Machine (5 min)
- Writing About the Class Pinball Machine (15 min)

Critical Juncture Assessment
Self-Assessment

Chapter 3:
The storyline goes deeper

What students investigate:

How do we make a pinball move to a certain place?

What they figure out:

To get the pinball moving in the direction we want (left or right), we must exert a force on the pinball in the direction that we want it to move.

How they figure it out:

- Investigating how to control a pinball's direction of movement by controlling the direction of applied force
- Learning about building with forces
- Talking about forces moving in a particular direction during a shared reading of the big book *Building with Forces*

KEY

HANDS-ON

READING

STUDENT-TO-STUDENT DISCUSSION

TEACHER

TEACHER-LED DISCUSSION

WRITING

DAY 9 | LESSON 3.1

Movement in Different Directions

- Setting the Context with the Pinball Video (5 min)
- Exploring Direction (15 min.)
- Talking About Direction (10 min)
- Visualizing Direction in *Building with Forces* (15 min)

On-the-Fly Assessment

DAY 10 | LESSON 3.2

Building with Forces

- Reading *Building with Forces* (15 min)
- Explaining Forces (15 min)
- Applying Directional Force in the Box Model (15 min)

On-the-Fly Assessment

DAY 11 | LESSON 3.3

Direction and Strength

- Exploring Movement to a Target (15 min)
- Discussing Movement to a Certain Place (15 min)
- Predicting Forces (15 min)

Critical Juncture Assessment

DAY 12 | LESSON 3.4

Targets in the Box Model

- Explaining Both Forces (10 min)
- Moving the Ball to Targets in the Box Model (15 min)
- Drawing Diagrams of the Ball's Direction and Distance (10 min)
- Reflecting on our Work as Engineers (10 min)

On-the-Fly Assessment
Self-Assessment

DAY 13 | LESSON 3.5

Applying Strength and Direction

- Modifying the Class Pinball Machine (10 min)
- Writing About Forces to a Certain Place (15 min)
- Visualizing Movement and Forces (15 min)

On-the-Fly Assessment

Chapter 4:
The storyline gets more complex

What students investigate:

How do we make a moving pinball change direction?

What they figure out:

To make a moving pinball change direction, we have to exert another force on it, either from a moving object or from a still object in its path.

How they figure it out:

- Investigating how to change the direction of a moving pinball
- Working collaboratively with classmates to decide whether and how to add flippers, targets, and a bumper to the Class Pinball Machine
- Exploring the concept of changing directions during a read aloud of the big book *Forces in Ball Games* plus an opportunity to re-read the book with a partner
- Using Explanation Language Frames to help them discuss and write about how forces cause a moving object to change direction

KEY

- HANDS-ON
- READING
- STUDENT-TO-STUDENT DISCUSSION
- TEACHER
- TEACHER-LED DISCUSSION
- WRITING

DAY 14 | LESSON 4.1

Changing Direction

- Framing the Chapter (10 min)
- Exploring Changing Direction (15 min)
- Discussing Changing Direction (10 min)
- Visualizing Changing Direction (10 min)

On-the-Fly Assessment

DAY 15 | LESSON 4.2

Forces Change an Object's Direction

- Reading About Changing Direction (15 min)
- Changing Directions with Rugball (10 min)
- Explaining Changing Directions (10 min)
- Reflecting on Changing an Object's Direction (10 min)

On-the-Fly Assessment

DAY 16 | LESSON 4.3

Flippers and Bumpers

- Changing Direction in the Box Model (15 min)
- Drawing a Diagram of Changing Direction (10 min)
- Applying Ideas to the Class Pinball Machine (5 min)
- Writing About Changing Direction (10 min)

Critical Juncture Assessment
Self-Assessment

Chapter 5:
The storyline expands

What students investigate:

How can we make the pinball machine do all the things we want it to do?

What they figure out:

Pinball engineers plan, make, test, and modify their designs based on what they learn. In our pinball machine, forces from the rubber band launcher make the ball start moving in the direction and over the distance we want, and forces from blocks and flippers cause the pinball to change direction.

How they figure it out:

- Learning about others who have tried to design a solution to a problem during a read aloud of the big book *Room 4 Solves a Problem*
- Creating and improving their pinball machine, first on their own in their Box Models and then in the Class Pinball Machine
- Drawing their plans
- Writing a mini-book to explain what they have learned

KEY

- HANDS-ON
- READING
- STUDENT-TO-STUDENT DISCUSSION
- TEACHER
- TEACHER-LED DISCUSSION
- WRITING

DAY 17 | LESSON 5.1

Room 4 Solves a Problem

- Reading *Room 4 Solves a Problem* (15 min)
- Introducing Planning in the Design Cycle (5 min)
- Planning Changes to the Box Model (10 min)
- Making a Solution in the Box Model (15 min)

On-the-Fly Assessment

DAY 18 | LESSON 5.2

Testing and Improving Our Box Model

- Reading *Room 4 Solves a Problem* (15 min)
- Reflecting on Testing in the Design Cycle (5 min)
- Testing in the Box Model (15 min)
- Introducing the Mini-Book (10 min)

On-the-Fly Assessment

DAY 19 | LESSON 5.3

Showcasing Our Box Models

- Showcasing the Box Model (20 min)
- Completing the Mini-Book (15 min)
- Finishing the Class Pinball Machine (10 min)

On-the-Fly Assessment
Self-Assessment

Chapter 6:
Application to a new context

What students investigate:

Where are forces around us?

What they figure out:

There are strong and gentle forces in different directions all around us. We know a force has been exerted on an object whenever that object starts moving, changes direction, or stops moving.

How they figure it out:

- Touring their school to identify evidence of forces
- Learning about forces at work in the world during a shared reading of the big book *A Busy Day in Pushville*

KEY

- HANDS-ON
- READING
- STUDENT-TO-STUDENT DISCUSSION
- TEACHER
- TEACHER-LED DISCUSSION
- WRITING

DAY 20 | LESSON 6.1

Searching for Forces

- Brainstorming Forces in the World (10 min)
- Exploring *A Busy Day in Pushville* (15 min)
- Going on a School Forces Tour (20 min)

On-the-Fly Assessment

DAY 21 | LESSON 6.2

A Busy Day in Pushville

- Discussing the School Forces Tour (15 min)
- Reading *A Busy Day in Pushville* (15 min)
- Reflecting on the Unit (15 min)

Self-Assessment

DAY 22 | LESSON 6.3

End-of-Unit Assessment

- Talking with Students About the Pinball's Movement

End-of-Unit Assessment

All students. All standards.

Rather than treating the standards simply as a list of topics to cover, we designed Amplify Science California to allow for truly in-depth and integrated coverage of the disciplinary core ideas (DCIs), science and engineering practices (SEPs), and crosscutting concepts (CCCs). Unlike other programs, however, ours makes the NGSS' vision of "all students, all standards" a reality by creating a unit-specific learning progression for every unit called a Progress Build.

Each Progress Build defines several levels of understanding of the unit's anchoring phenomenon, with each level integrating and building upon the knowledge and skills from lower levels. In this way, each Progress Build provides a clear roadmap for how students' understanding of the phenomenon is expected to deepen and develop with each successive chapter and lesson.

What's more, the program's system of assessments is also tied to these Progress Builds. This carefully crafted integration provides teachers with credible, actionable, and timely diagnostic information about student progress toward the unit's learning goals and grade-level performance expectations. Armed with this powerful data, teachers have the ultimate flexibility to decide when to move on and when to slow down and dive deeper.

Pushes and Pulls Progress Build

The Progress Build in this unit consists of four levels of understanding. At each level, students add new ideas and integrate them into a progressively deeper understanding of the effects of different forces on the motion of an object.

Progress Build Level 1:
An object starts moving when a force is exerted on it.

Progress Build Level 2:
Stronger force causes an object to move a longer distance.

Progress Build Level 3:
An object starts to move in the direction of the force exerted on it.

Progress Build Level 4:
Moving objects can change direction because of a force from a moving or still object.

Examples of differentiation in this unit

In addition to providing unit-specific Progress Builds that break learning goals into smaller, more achievable levels of understanding, Amplify Science California makes learning accessible for all students through a variety of scaffolds, supports, and differentiation strategies for every lesson. **For a complete list of strategies, see the Differentiation section of every Lesson Brief**.

Below are a few examples of strategies embedded in this unit.

For English learners:

Kinesthetic response (Example from Lesson 2.1)
In the Embodied Forces Routine students use their whole bodies to enact the differences between short and far distances. Using their whole bodies to reinforce concepts and vocabulary can be very helpful for English language learners.

For students needing more support:

Participation with the What We Know chart (Example from Lesson 4.2)
For students who are having a difficult time grasping the concept of redirection, it may help if they are involved in the creation of the visuals for the chart. When you add the movement arrows to the chart in Activity 4, you can provide students with copies of the visuals of the ball/wall and the ball/child kicking the ball. First, model thinking aloud about where the ball would move and then change direction. Then, have students draw the arrows along with you.

For students ready for a challenge:

Rereading with a new focus (Example from Lesson 3.2)
You could challenge students to revisit *Building with Forces* with a focus on the direction of forces being exerted. Ask students to revisit the images in the book with a partner and discuss in which direction forces are being exerted with more independence. Suggest that students continue to use the Explanation Language Frame (It moved _____ because the force was _____.) as they share their ideas.

3-D Statements

In order to help teachers recognize the three-dimensional structure of every unit, chapter, and lesson, each unit contains a 3-D Statement document that makes the integration clear.

Making the 3-D statement document all the more effective, the three dimensions are color-coded for easy recognition.

Pushes and Pulls 3-D Coverage

SEPs	DCIs	CCCs
Science and Engineering Practices	Disciplinary Core Ideas	Cross-Cutting Concepts

Unit Level

Students plan and carry out investigations to determine how force affects the movement of an object, its direction, and its distance (cause and effect; scale, proportion, and quantity; structure and function). They assume the role of engineer as they engage in the design process to develop models that test ideas and construct solutions with the goal of designing a Class Pinball Machine.

Chapter Level

Chapter 1: How do we make a pinball start to move?

Acting as pinball engineers, students create Box Models to test ideas in order to begin designing a Class Pinball Machine. They carry out investigations, draw diagrams, then share solutions of possible launchers to make the pinball start to move (cause and effect; structure and function).

Chapter 2: How do we make a pinball move as far as we want?

Students carry out investigations in their Box Models to test how to make a pinball move short or long distances. They draw diagrams of modified launchers and provide evidence-based explanations to claim how gentle forces and strong forces can move a pinball different distances (cause and effect; scale, proportion, and quantity; structure and function).

Chapter 3: How do we make a pinball move to a certain place?

Students explore, observe, and investigate how force can move objects to the left and to the right. Students use data from these investigations to apply changes to the Class Pinball Machine so force may be exerted on a ball to hit a target (cause and effect; scale, proportion, and quantity; structure and function).

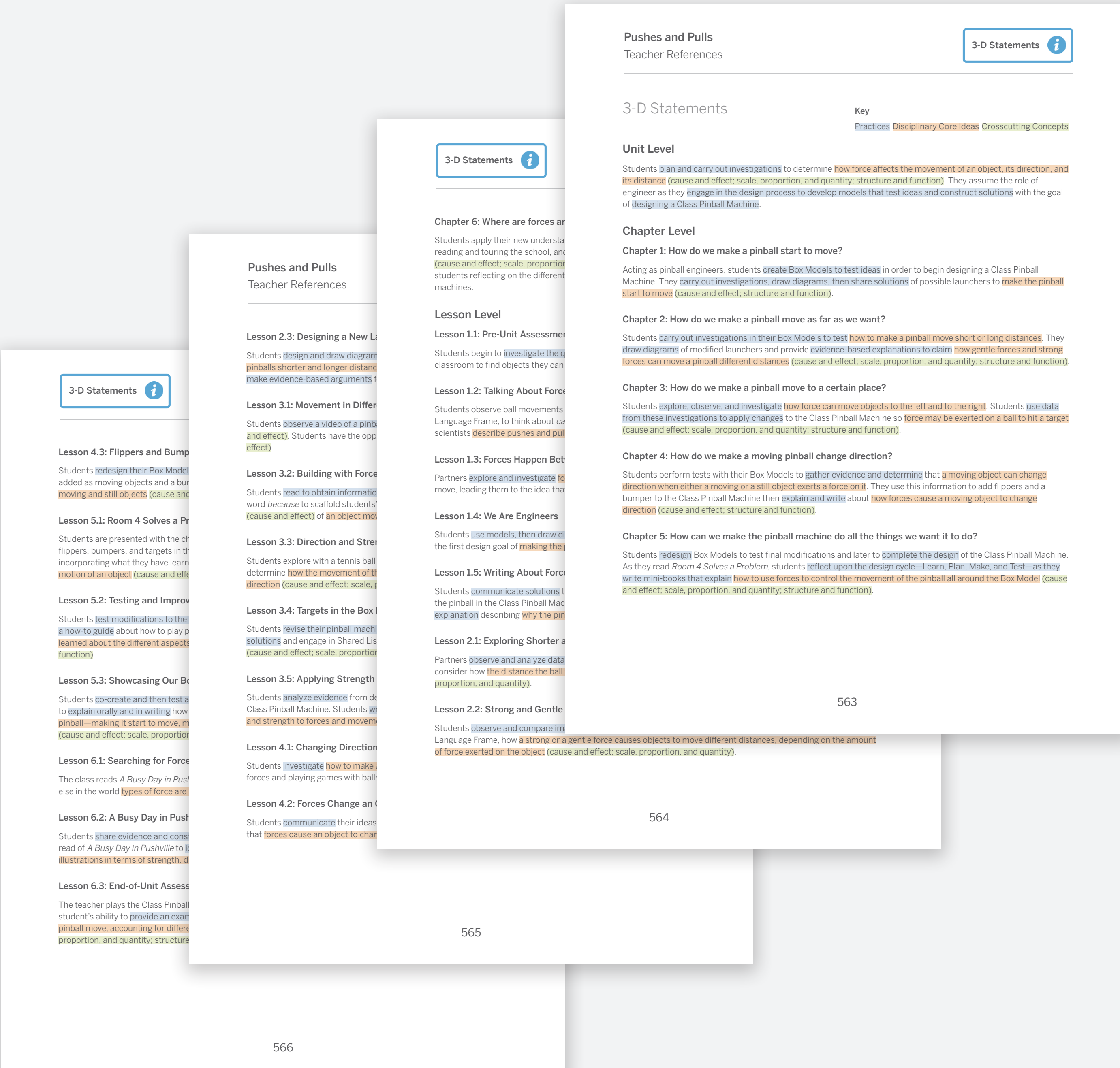
Chapter 4: How do we make a moving pinball change direction?

Students perform tests with their Box Models to gather evidence and determine that a moving object can change direction when either a moving or a still object exerts a force on it. They use this information to add flippers and a bumper to the Class Pinball Machine then explain and write about how forces cause a moving object to change direction (cause and effect; structure and function).

Chapter 5: How can we make the pinball machine do all the things we want it to do?

Students redesign Box Models to test final modifications and later to complete the design of the Class Pinball Machine. As they read *Room 4 Solves a Problem*, students reflect upon the design cycle—Learn, Plan, Make, and Test—as they write mini-books that explain how to use forces to control the movement of the pinball all around the Box Model (cause and effect; scale, proportion, and quantity; structure and function).

To review the 3-D Statements at the lesson level, see the Lesson Brief section of every lesson.



Pushes and Pulls
Teacher References

3-D Statements

3-D Statements

Key
Practices Disciplinary Core Ideas Crosscutting Concepts

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Notes

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For more information on Amplify Science, visit **amplify.com/science/california**.

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