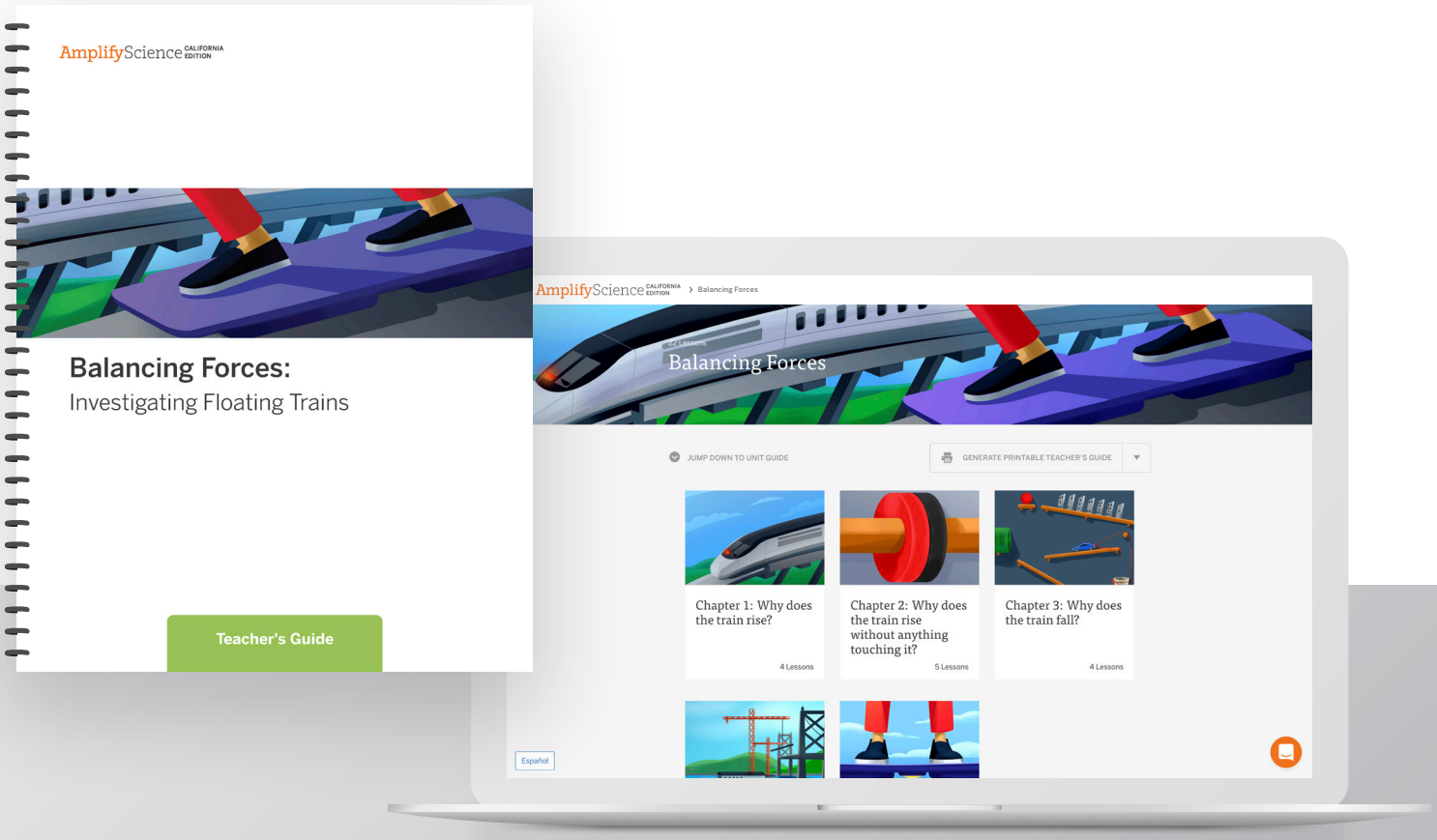
Amplify Science
CALIFORNIA

Grade 3

UNIT GUIDE

Balancing Forces



Amplify.

THE LAWRENCE HALL OF SCIENCE
UNIVERSITY OF CALIFORNIA, BERKELEY

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Welcome to Balancing Forces

The forces that are acting on and around us every day are often unseen and misunderstood. Even adults can find themselves perplexed or struggling with long-held misconceptions if asked to explain unseen forces, such as gravity and magnetic force. Since these concepts are abstract and global in nature, it requires a great deal of firsthand exploration and sense-making to help students ground their understanding and integrate their new knowledge. By organizing this unit around the context of a floating train, Amplify Science California provides students with the necessary experiences, processing time, and extra supports to truly understand a phenomenon that requires a grasp of an array of foundational concepts in the area of force 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 help the citizens of the fictional town Faraday. While excited to hear that a new train service will be built for their city, Faraday's citizens are concerned when they hear that the train floats. In their role as engineers, students are challenged to figure out how a train can float in order to address the concerns of the locals and calm their fears.

Unit Type: Modeling

Student Role: Engineers

Phenomenon: The town of Faraday is getting a new train that floats above its tracks.

Core Concept: Understanding forces and how they can cause stability or change in an object's motion

Target Performance Expectations:

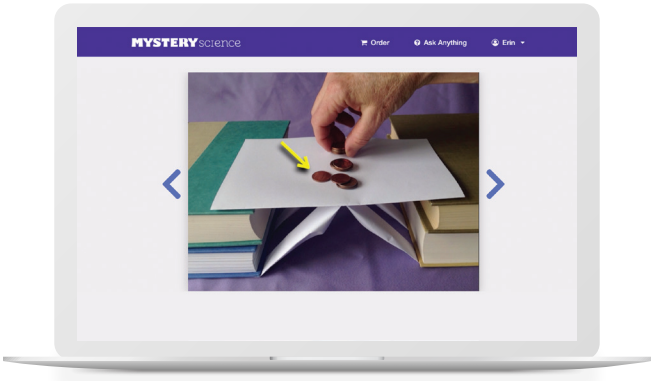
- 3-PS2-1: Balanced and Unbalanced Forces
- 3-PS2-2: Predicting Motion
- 3-PS2-3: Non-Touching Forces
- 3-PS2-4: Solve Problem with Magnets

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

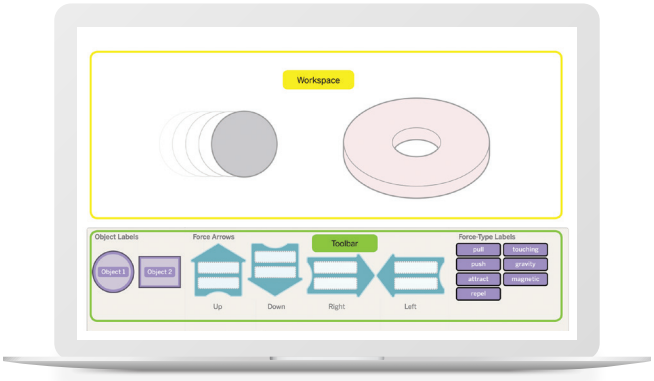
Student Books

Hands-On Kit

Videos



Practice Tools



About technology in this unit:
Amplify Science California gives you the flexibility to use technology in the way that meets your needs best. In 3–5, 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 3, technology-based activities include Practice Tools and some digital Simulations. In this particular unit, only 5 of the 22 lessons incorporate the use of devices with only 4% of the unit's activities involving the use of a digital tool.

When the use of a digital tool is called for in a lesson, teachers have several implementation options:

- **If limited student devices are available,** students can do activities in pairs or small groups.
- **If no student devices are available,** teachers can project the digital tool to the class and create a whole class experience.

Chapter 1: The storyline begins

What students investigate:

Why does the train rise?

What they figure out:

A train is a big object. Objects can start moving when they are pushed or pulled on by a second object. There must be some force acting between the train and another object to make the train rise.

How they figure it out:

- Conducting hands-on investigations
- Considering the forces in the world all around us in the student book *Forces All Around*
- Discovering patterns in what can make an object change motion by starting to move or stopping
- Writing scientific explanations

KEY


HANDS-ON


MODELING


READING


STUDENT-TO-STUDENT DISCUSSION


TEACHER-LED DISCUSSION


WRITING

DAY 1 | LESSON 1.1

Pre-Unit Assessment

- The Floating Train Video (10 min)
- Writing Initial Explanations (20 min)
- Introducing Investigation Notebooks (10 min)

Pre-Unit Assessment

DAY 2 | LESSON 1.2

Making an Object Move

- Introducing the Problem (10 min)
- Discussing Initial Ideas (10 min)
- Making Blocks Move (20 min)
- Sharing Observations (20 min)

DAY 3 | LESSON 1.3

Forces All Around

- Setting a Purpose for Reading (5 min)
- *Forces All Around* (25 min)
- Sharing Observations and Drawing Conclusions (25 min)
- Introducing the Science Idea of Change (5 min)

On-the-Fly Assessment

DAY 4 | LESSON 1.4

Explaining Forces and the Train

- Observing Forces in Chain Reactions (10 min)
- Creating Forces in Chain Reactions (15 min)
- Modeling How to Write a Scientific Explanation (10 min)
- Asking Questions About What Makes the Train Rise (10 min)
- Writing a Scientific Explanation (15 min)

On-the-Fly Assessment
Critical Juncture Assessment
Self-Assessment

Chapter 2:
The storyline builds

What students investigate:

Why does the train rise without anything touching it?

What they figure out:

When the train starts moving as it rises off the track, it does so because of a non-touching force: magnetic force. The train rises because a repelling force acts between magnets on the tracks and magnets on the train.

How they figure it out:

- Gathering evidence to explain how the train could rise without anything touching it
- Conducting investigations that help them discover that magnets can exert forces at a distance
- Discovering various kinds of forces and scenarios: touching forces, gravity, magnetic force, electromagnetic force, multiple forces, and balanced and unbalanced forces in the student book *Forces All Around*
- Exploring the similarities and differences between magnets of different shapes, sizes, and strengths, as well as magnetic poles and what magnets attract in the student book *What My Sister Taught Me About Magnets*
- Exploring how magnetic forces can make objects move by analyzing data to find patterns
- Creating both physical models and diagram models that represent magnetic forces at work
- Writing scientific explanations

KEY


HANDS-ON


MODELING


READING


STUDENT-TO-STUDENT DISCUSSION


TEACHER-LED DISCUSSION


WRITING

DAY 5 | LESSON 2.1

Discovering Non-Touching Forces

- Investigating Non-Touching Forces (20 min)
- Making Sense of Magnet Observations (20 min)
- Diagramming Magnetic Forces (10 min)
- Activating Prior Knowledge about Magnets (10 min)

On-the-Fly Assessment

DAY 6 | LESSON 2.2

What Objects Do Magnetic Forces Act On?

- Investigating What Objects Magnetic Forces Act On (25 min)
- Discussing What Objects Magnetic Forces Act On (20 min)
- Reading *Handbook of Forces* (15 min)

On-the-Fly Assessment

DAY 7 | LESSON 2.3

Investigating Ways Magnetic Force Moves Objects

- Exploring Forces with Magnet Tricks (15 min)
- Sharing and Discussing Magnet Tricks (15 min)
- Reading About Magnets in *Handbook of Forces* (20 min)
- Think-Pair-Share: Magnet Tricks (10 min)

On-the-Fly Assessment

DAY 8 | LESSON 2.4

What My Sister Taught Me About Magnets

- Setting A Purpose for Reading (5 min)
- Partner Reading *What My Sister Taught Me About Magnets* (30 min)
- Sharing Evidence and Reading Data Tables (20 min)

On-the-Fly Assessment

DAY 9 | LESSON 2.5

Explaining Magnetic Force and the Train

- Return to the Problem of the Floating Train (20 min)
- Word Relationships (15 min)
- Reviewing How to Write a Scientific Explanation (10 min)
- Writing a Scientific Explanation (15 min)

On-the-Fly Assessment
Self-Assessment

Chapter 3:
The storyline goes deeper

What students investigate:

Why does the train fall?

What they figure out:

When the train falls, it does so because a force is acting on it. Since a second object is not pushing or pulling the train, there must be a non-touching force at work. The train falls because of the force of gravity. We know that forces always act between two objects. The force of gravity is acting between the train and Earth. Earth attracts the train, and the train moves toward it.

How they figure it out:

- Making observations and posing questions about gravity
- Gathering evidence from a reference book
- Designing chain reactions involving touching forces and non-touching forces: magnetic force and gravity
- Analyzing patterns in data from the chain reaction and making diagrams modeling the forces involved
- Writing scientific explanations

KEY


HANDS-ON


MODELING


READING


STUDENT-TO-STUDENT DISCUSSION


TEACHER-LED DISCUSSION


WRITING

DAY 10 | LESSON 3.1

Observing Evidence of Gravity

- Revisiting the Floating Train (5 min)
- Investigating Gravity (15 min)
- Asking Questions About Gravity (10 min)
- Revisiting *Forces All Around* (20 min)
- Diagramming an Example of Gravity (10 min)

On-the-Fly Assessment

DAY 11 | LESSON 3.2

Reading About Gravity

- Revisiting *Handbook of Forces* (20 min)
- Discussing Gravity Acting Between Two Objects (20 min)
- Reading with a New Purpose (20 min)

On-the-Fly Assessment

DAY 12 | LESSON 3.3

Observing Forces in Chain Reactions

- Discussing Forces in a Video (15 min)
- Exploring Forces in a Chain Reaction (25 min)
- Word Relationships (20 min)

DAY 13 | LESSON 3.4

Modeling and Explaining the Falling Train

- Diagramming Forces (25 min)
- Discussing the Falling Train (20 min)
- Writing an Explanation of the Falling Train (15 min)

On-the-Fly Assessment
Critical Juncture Assessment
Self-Assessment

Chapter 4:
The storyline gets more complex

What students investigate:

Why does the train float, even though gravity is acting on it?

What they figure out:

More than one force can be exerted on the train at a time. The force of gravity is pulling the train toward Earth, and magnetic force is pushing the train up away from the tracks. Those forces work in opposite directions so when the forces are balanced, the train floats and stays in the air.

How they figure it out:

- Investigating why an object might not move even when a force is acting on it
- Gathering evidence to support the claim that two forces can act on an object at once
- Learning about balanced forces by planning and conducting investigations with a floating paper clip
- Learning about one of the lead engineers involved in the design of the new San Francisco Bay Bridge in the student book *Explaining a Bridge*
- Creating physical models and diagrams
- Writing scientific explanations

KEY


HANDS-ON


MODELING


READING


STUDENT-TO-STUDENT DISCUSSION


TEACHER-LED DISCUSSION


WRITING

DAY 14 | LESSON 4.1

One Object, Two Forces

- Revisiting the Floating Train (15 min)
- Investigating Touching Force and Gravity (15 min)
- Investigating Magnetic Force and Other Forces (15 min)
- Discussing and Writing About Two Forces Acting at Once (15 min)

On-the-Fly Assessment

DAY 15 | LESSON 4.2

Investigating Balanced Forces

- Floating Paper Clip Challenge (20 min)
- Learning More from *Handbook of Forces* (20 min)
- Word Relationships (20 min)

On-the-Fly Assessment

DAY 16 | LESSON 4.3

Explaining a Bridge

- Reading *Explaining a Bridge* (45 min)
- Concluding Discussion (15 min)

On-the-Fly Assessment

DAY 17 | LESSON 4.4

Modeling and Explaining Balanced Forces

- Diagramming and Exploring the Floating Paper Clip (30 min)
- Discussing and Modeling the Floating Train (15 min)
- Writing an Explanation of the Floating Train (15 min)

On-the-Fly Assessment
Self-Assessment

Chapter 5: Application to a new context

What students investigate:

How does the train change from floating to falling?

What they figure out:

When the track's electromagnet is turned off, magnetic force is no longer exerted and the forces are no longer balanced. When gravity is the only acting force, the forces on the train become unbalanced, and the train falls.

How they figure it out:

- Conducting investigations and using mathematical thinking to discover what can make forces unbalanced
- Applying their developing understanding of balanced and unbalanced forces, and stability and change, a new invention: a hoverboard
- Reading about how hoverboards work in the student book *Hoverboard*
- Gathering evidence about electromagnets from a demonstration
- Creating physical models as evidence of how the train could work and creating diagram models to show the role that forces play
- Writing scientific explanations

KEY


HANDS-ON


MODELING


READING


STUDENT-TO-STUDENT DISCUSSION


TEACHER-LED DISCUSSION


WRITING

DAY 18 | LESSON 5.1

Investigating Unbalanced Forces

- Unbalanced Forces on the Paper Clip (20 min)
- Analyzing Data About Forces (15 min)
- Planning and Conducting Investigations (25 min)

DAY 19 | LESSON 5.2

Hoverboard

- Reading *Hoverboard* (25 min)
- Discussing Evidence from *Hoverboard* (15 min)
- Word Relationships (20 min)

On-the-Fly Assessment

DAY 20 | LESSON 5.3

Electromagnets and Predicting Patterns

- Introducing Electromagnets (20 min)
- Reading About Electromagnets (20 min)
- Investigating Repeating Patterns of Motion (20 min)

DAY 21 | LESSON 5.4

Modeling the Train

- Discussing and Modeling the Floating Train (20 min)
- Diagramming the Floating Train (30 min)

DAY 22 | LESSON 5.5

End-of-Unit Assessment

- Writing a Scientific Explanation About the Floating Train (25 min)
- Revisiting Anticipatory Charts (20 min)
- Inventing with Magnets (15 min)

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.

Balancing Forces Progress Build

The Progress Build in this unit consists of three levels of understanding. At each level, students add new ideas and integrate them into a progressively deeper understanding of how forces can cause stability or change in an object's motion, and how magnetic force can be used to counterbalance the force of gravity.

Progress Build Level 1:

A force is a push or pull that acts between two objects.

Progress Build Level 2:

Forces can be touching or non-touching.

Progress Build Level 3:

More than one force can act on an object at the same time. When those forces are balanced, a still object will remain still; when those forces are unbalanced, the object will start to move.

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:

Students summarize (Example from Lesson 3.1)
Extended whole-class discussions may be challenging for some English learners to understand. In order to summarize, students need to develop facility with distinguishing relevant and irrelevant content, and then make use of the relevant material. Students benefit from explicit and intentional instruction on summarizing. "Collaborative Summarizing" is one approach for supporting English learners with this process. To engage students in collaborative summarizing, invite a small group of students to work with the "Gravity" section of *Handbook of Forces* to do the following:

- Determine the key idea or content of the text.
- Determine what is most important about the key idea or content identified.
- Use key words from the text to help summarize the most important points in 15 words or fewer.

For students needing more support:

Writing support (Example from Lesson 4.4)
Included with this lesson is an additional version of page 52, Scientific Explanation of Why the Train Floats, in the Investigation Notebook. The additional version is provided as a copymaster (PDF file in Digital Resources). The question included in both versions is identical, and all students are expected to write about the same science ideas. However, the copymaster includes a topic sentence, and sentence frames are provided for each main idea in the explanation. If you would like to give some students the more scaffolded version, print out the copymaster and make enough copies to have on hand during the lesson. You might also want to meet with a small group of students to help support them during the writing activity while the rest of the class works more independently.

For students ready for a challenge:

Students conduct their own investigation (Example from Lesson 2.4)
Have pairs or small groups come up with their own questions about magnets to investigate. Have them write notes about their results, using a data table if appropriate. Don't be surprised if students' investigations are not as clearly focused on an answerable question as the investigations in the book, unless you have time to help these students refine their questions and methods.

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.

Balancing Forces 3-D Coverage

SEPs
Science and Engineering Practices

DCIs
Disciplinary Core Ideas

CCCs
Cross-Cutting Concepts

Unit Level

Students are challenged to explain how a floating train works in order to reassure nervous citizens. To solve the mystery, students plan and conduct investigations, analyze patterns in data (patterns), and obtain information about magnetic force, gravity, and balanced and unbalanced forces. Students write explanations and create physical models and diagram models to show why the train's vertical motion is stable at times and changes at times (stability and change).

Chapter Level

Chapter 1: Why does the train rise?

Students ask questions about the floating train and discover, by analyzing patterns in data(patterns), that a force can cause an object's motion to change as it starts or stops moving (stability and change).

Chapter 2: Why does the train rise without anything touching it?

Students plan and conduct investigations and obtain information from books and from patterns in data to gather evidence (patterns) that magnetic force can cause some objects to move without the magnet touching the object (cause and effect).

Chapter 3: Why does the train fall?

Students ask questions about what causes objects to fall, and they write explanations and make models to show how the force of gravity causes the train to fall back to the track (cause and effect).

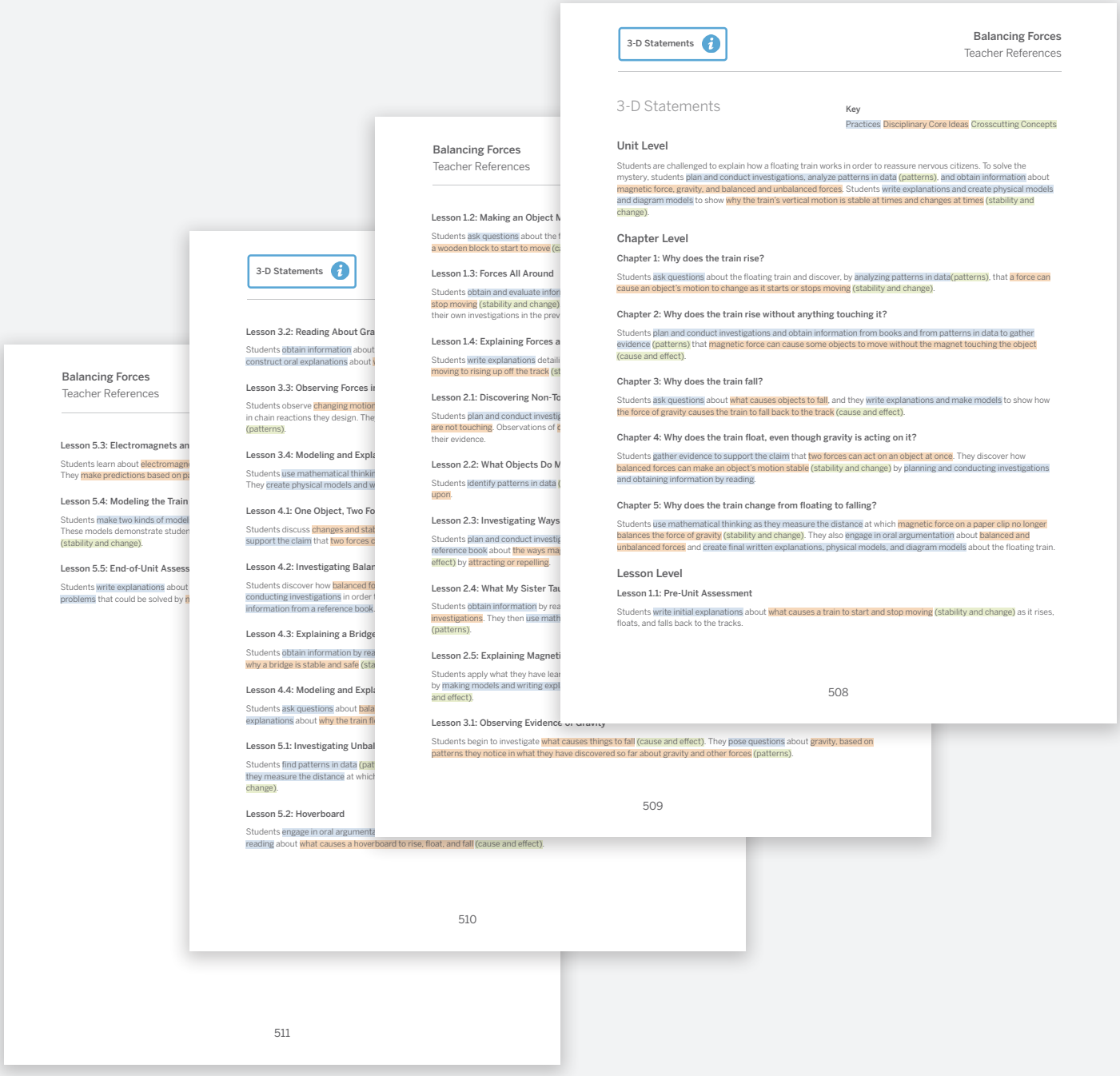
Chapter 4: Why does the train float, even though gravity is acting on it?

Students gather evidence to support the claim that two forces can act on an object at once. They discover how balanced forces can make an object's motion stable (stability and change) by planning and conducting investigations and obtaining information by reading.

Chapter 5: Why does the train change from floating to falling?

Students use mathematical thinking as they measure the distance at which magnetic force on a paper clip no longer balances the force of gravity (stability and change). They also engage in oral argumentation about balanced and unbalanced forces and create final written explanations, physical models, and diagram models about the floating train.

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



Balancing Forces
Teacher References

Lesson 5.3: Electromagnets an

Students learn about electromagn
They make predictions based on pa

Lesson 5.4: Modeling the Train

Students make two kinds of model
These models demonstrate studen
(stability and change).

Lesson 5.5: End-of-Unit Assess

Students write explanations about
problems that could be solved by

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3-D Statements

Lesson 3.2: Reading About Gra

Students obtain information about
construct oral explanations about

Lesson 3.3: Observing Forces i

Students observe changing motion
in chain reactions they design. The
(patterns).

Lesson 3.4: Modeling and Expla

Students use mathematical thinkin
They create physical models and w

Lesson 4.1: One Object, Two Fo

Students discuss changes and stat
support the claim that two forces c

Lesson 4.2: Investigating Balan

Students discover how balanced fo
conducting investigations in order
information from a reference book.

Lesson 4.3: Explaining a Bridge

Students obtain information by rea
why a bridge is stable and safe (sta

Lesson 4.4: Modeling and Expla

Students ask questions about bala
explanations about why the train fl

Lesson 5.1: Investigating Unbal

Students find patterns in data (pat
they measure the distance at which
change).

Lesson 5.2: Hoverboard

Students engage in oral argumenta
reading about what causes a hoverboard to rise, float, and fall (cause and effect).

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Balancing Forces
Teacher References

Lesson 1.2: Making an Object M

Students ask questions about the f
a wooden block to start to move (ca

Lesson 1.3: Forces All Around

Students obtain and evaluate infor
stop moving (stability and change)
their own investigations in the prev

Lesson 1.4: Explaining Forces a

Students write explanations detaili
moving to rising up off the track (st

Lesson 2.1: Discovering Non-To

Students plan and conduct investig
are not touching. Observations of c
their evidence.

Lesson 2.2: What Objects Do M

Students identify patterns in data (
upon.

Lesson 2.3: Investigating Ways

Students plan and conduct investig
reference book about the ways ma
effect) by attracting or repelling.

Lesson 2.4: What My Sister Tau

Students obtain information by rea
investigations. They then use math
(patterns).

Lesson 2.5: Explaining Magneti

Students apply what they have lear
by making models and writing expl
and effect).

Lesson 3.1: Observing Evidence of Gravity

Students begin to investigate what causes things to fall (cause and effect). They pose questions about gravity, based on patterns they notice in what they have discovered so far about gravity and other forces (patterns).

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3-D Statements

Balancing Forces
Teacher References

3-D Statements

Key
Practices Disciplinary Core Ideas Crosscutting Concepts

Unit Level

Students are challenged to explain how a floating train works in order to reassure nervous citizens. To solve the mystery, students plan and conduct investigations, analyze patterns in data (patterns), and obtain information about magnetic force, gravity, and balanced and unbalanced forces. Students write explanations and create physical models and diagram models to show why the train's vertical motion is stable at times and changes at times (stability and change).

Chapter Level

Chapter 1: Why does the train rise?

Students ask questions about the floating train and discover, by analyzing patterns in data(patterns), that a force can cause an object's motion to change as it starts or stops moving (stability and change).

Chapter 2: Why does the train rise without anything touching it?

Students plan and conduct investigations and obtain information from books and from patterns in data to gather evidence (patterns) that magnetic force can cause some objects to move without the magnet touching the object (cause and effect).

Chapter 3: Why does the train fall?

Students ask questions about what causes objects to fall, and they write explanations and make models to show how the force of gravity causes the train to fall back to the track (cause and effect).

Chapter 4: Why does the train float, even though gravity is acting on it?

Students gather evidence to support the claim that two forces can act on an object at once. They discover how balanced forces can make an object's motion stable (stability and change) by planning and conducting investigations and obtaining information by reading.

Chapter 5: Why does the train change from floating to falling?

Students use mathematical thinking as they measure the distance at which magnetic force on a paper clip no longer balances the force of gravity (stability and change). They also engage in oral argumentation about balanced and unbalanced forces and create final written explanations, physical models, and diagram models about the floating train.

Lesson Level

Lesson 1.1: Pre-Unit Assessment

Students write initial explanations about what causes a train to start and stop moving (stability and change) as it rises, floats, and falls back to the tracks.

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