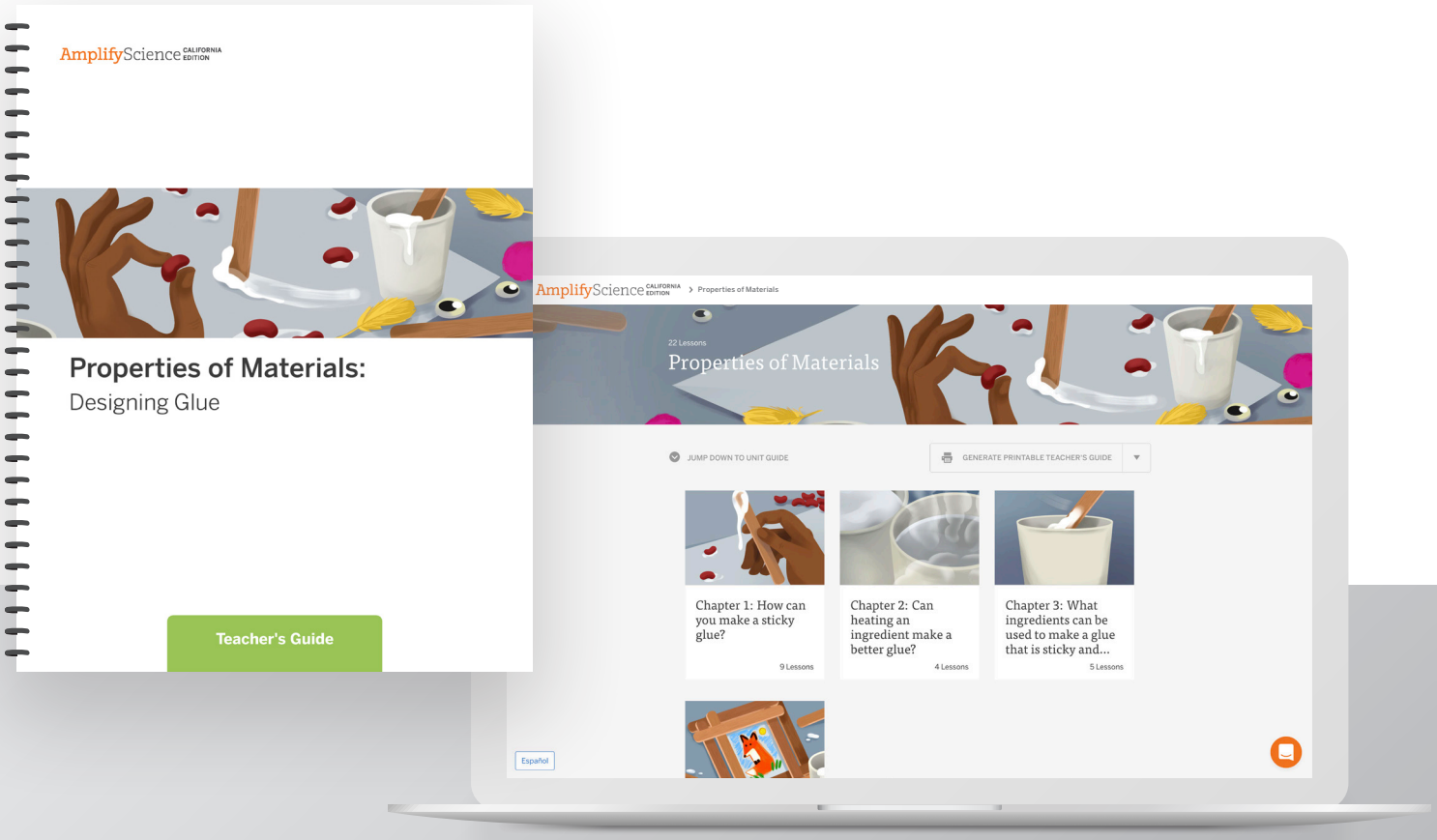
Amplify Science
CALIFORNIA

Grade 2

UNIT GUIDE

Properties of Materials



Amplify.

THE LAWRENCE HALL OF SCIENCE
UNIVERSITY OF CALIFORNIA, BERKELEY

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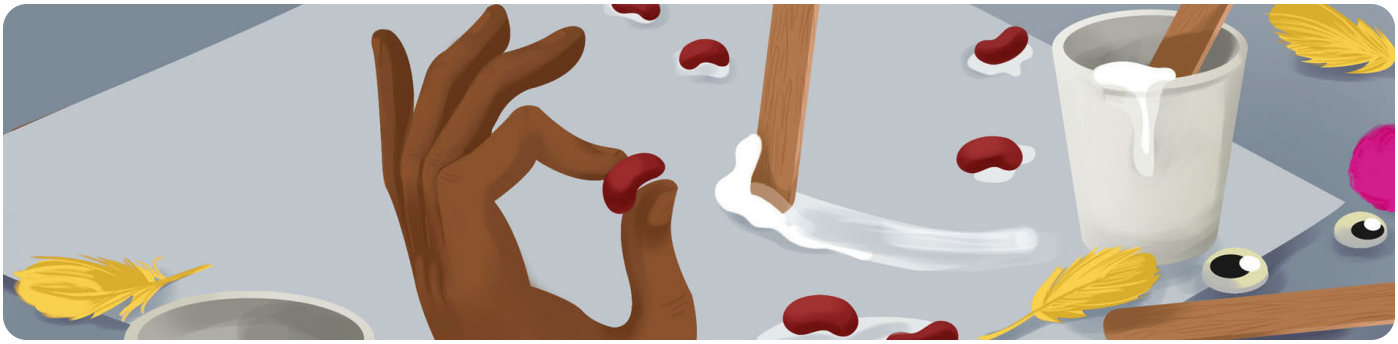


Welcome to Properties of Materials

How can you design a mixture for a certain purpose? For centuries, humans have undertaken this challenge. From the creation of medicines, paints, and building materials, to the development of cleaning products, adhesives, and foods, mixtures have proven to be essential to life as we know it. Yet many mixtures wouldn't exist if it weren't for scientists and engineers applying scientific knowledge, engineering practices, and a spirit of persistence to solve problems. Amplify Science California helps students develop the engineering expertise they need to be successful problem solvers through authentic opportunities to learn, plan, make, test, and modify their own designs. This includes opportunities to feel frustrated when a design fails to meet expectations and elated when design goals are met at last.

> 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 glue engineers. Their job is to create a glue for use at their school that best meets a set of design goals. Working together, they learn how the properties of ingredients affect the properties of mixtures. They then use this knowledge to iteratively design a series of glue mixtures, each one better than the one before. By the end of the unit, students present their glue mixture along with a case for why their mixture best meets the design goals.

Unit Type: Engineering Design

Student Role: Glue Engineers

Phenomenon: Different glue recipes result in glues that have different properties.

Core Concept: Understanding the structure and properties of matter

Target Performance Expectations:

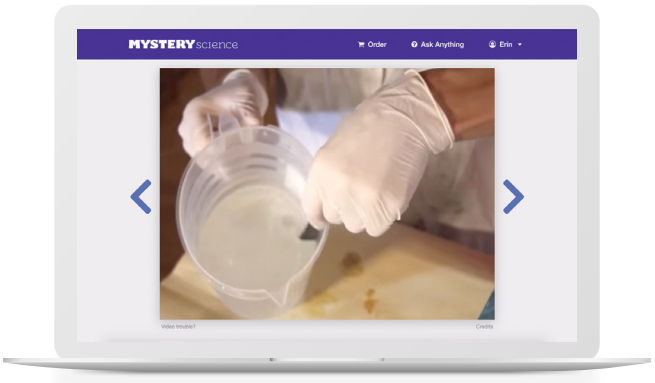
- 2-PS1-1: Properties of Materials
- 2-PS1-2: Materials for Specific Purposes
- 2-PS1-3: Pieces Can be Made Into New Objects
- 2-PS1-4: Changes Caused by Heating and Cooling
- K-2-ETS1-1: Defining Problems
- K-2-ETS1-3: Developing Possible Solutions

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

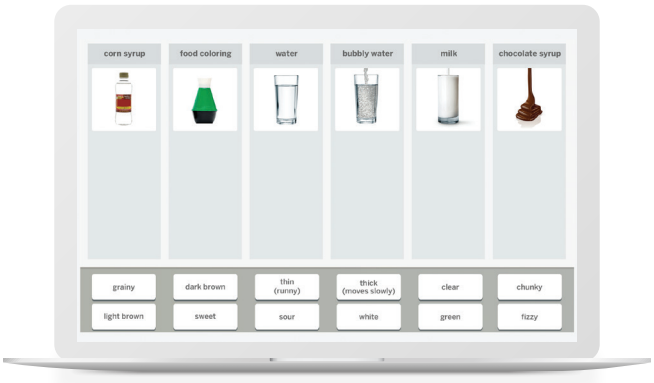
Student Books

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 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 2, technology-based activities are limited to Practice Tools. In this particular unit, only 5 of the 22 lessons incorporate the use of devices with only 6% 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:

How can you make a sticky glue?

What they figure out:

Glue is a mixture of several ingredients such as flour, water, and cornstarch, and depending on the properties of those ingredients and how they are combined, you can create different glues. Some glues might be stickier or stronger than others. By understanding materials and observing and testing different recipes, you can choose the ingredients that provide the properties you are seeking.

How they figure it out:

- Considering the relationship between objects, the materials used to make them, and the properties of those materials as they read the student book *What If Rain Boots Were Made of Paper?*
- Investigating the properties of two mystery glues and making scientific arguments about whether they are the same or different glues
- Researching possible glue ingredients as they read the student book *Handbook of Interesting Ingredients*
- Exploring how food engineers use design practices to create new kinds of food as they read the student book *Jelly Bean Engineer*
- Learning about five inventors and their work to solve problems by thinking of new ideas and designing inventions as they read the student book *Ideas and Inventors*
- Observing and testing possible glue ingredients for their sticky properties

KEY


HANDS-ON


MODELING


READING


STUDENT-TO-STUDENT DISCUSSION


TEACHER-LED DISCUSSION


WRITING

DAY 1 | LESSON 1.1

Pre-Unit Assessment

- Observing Substances (40 min)
- Observing a Mystery Mixture (20 min)

Pre-Unit Assessment

DAY 2 | LESSON 1.2

What If Rain Boots Were Made of Paper?

- Introducing the Design Challenge (10 min)
- Predicting as a Reading Strategy (15 min)
- Reading *What If Rain Boots Were Made of Paper?* (25 min)
- Reflecting on Materials and Properties (5 min)
- Keeping Track of New Ideas (5 min)

On-the-Fly Assessment

DAY 3 | LESSON 1.3

Observing Properties of Glue

- Materials Riddles (15 min)
- Uses and Properties of Glue (10 min)
- Observing Mystery Glues (20 min)
- Setting Up Glue Tests (15 min)

DAY 4 | LESSON 1.4

Supporting Claims with Evidence

- Introducing Word Relationships (15 min)
- Observing Mystery Glue Tests (15 min)
- Providing Evidence (10 min)
- Writing About Mystery Glue (20 min)

On-the-Fly Assessment

DAY 5 | LESSON 1.5

Observing and Testing Ingredients

- Introduction to Design Goals (5 min)
- Observing Dry Glue Ingredients (15 min)
- Making and Observing Mixtures (15 min)
- Discussing Properties of Ingredients and Mixtures (10 min)
- Setting Up Sticky Tests (15 min)

On-the-Fly Assessment

DAY 6 | LESSON 1.6

Evaluating Sticky Test Evidence

- Gathering Test Results (10 min)
- Graphing Results and Evaluating Evidence (25 min)
- Evaluating Evidence and Summarizing Results (10 min)
- Exploring The *Handbook of Interesting Ingredients* (15 min)

On-the-Fly Assessment

DAY 7 | LESSON 1.7

Jelly Bean Engineer

- Different Amounts, Same Properties (10 min)
- Making Predictions (10 min)
- Reading *Jelly Bean Engineer* (20 min)
- Reflecting on Vocabulary in the Book (5 min)
- Learning About the Design Cycle (15 min)
- Reading *Ideas and Inventors* (20 min)

On-the-Fly Assessment

DAY 8 | LESSON 1.8

Using Evidence to Plan Glues

- Setting the Context (10 min)
- Ingredient Thought Swap (20 min)
- Preparing to Write (10 min)
- Writing About the Glue Ingredients (20 min)

On-the-Fly Assessment

DAY 9 | LESSON 1.9

Making Our First Glue

- Preparing to Make Glue (10 min)
- Making Our First Glue (20 min)
- Applying Vocabulary with the Word Relationship (10 min)
- Writing About Glues (20 min)

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

Chapter 2: The storyline builds

What students investigate:

Can heating a substance (and returning it to its original temperature) make a better glue?

What they figure out:

When water is heated and returned to room temperature, the properties of the water go back to the way the were. When some other materials are heated and then returned to room temperature, their properties change permanently. For example, when a mixture of cornstarch and water is heated and then returned to room temperature, it has different properties than it had before.

How they figure it out:

- Learning about how heating and cooling can cause materials to change, and how some of these changes are reversible and others are irreversible as they read the student book *Can You Change It Back?*
- Conducting tests to determine whether heating improves their own glue

KEY


HANDS-ON


MODELING


READING


STUDENT-TO-STUDENT DISCUSSION


TEACHER-LED DISCUSSION


WRITING

DAY 10 | LESSON 2.1

Can You Change It Back?

- Testing Our First Glue (15 min)
- Introducing *Can You Change It Back?* (15 min)
- Reading *Can You Change It Back?* (25 min)
- Discussing Key Concept and Questions (5 min)

On-the-Fly Assessment

DAY 11 | LESSON 2.2

Exploring Heating and Cooling

- Framing the Lesson (10 min)
- Comparing an Unheated and a Heated Mixture (20 min)
- Heating and Cooling Card Sort (15 min)
- Writing About Heating or Cooling (15 min)

Critical Juncture Assessment

DAY 12 | LESSON 2.3

Cause and Effect

- Sticky Test Results (10 min)
- Navigating a Reference Book (10 min)
- Introducing Cause and Effect (10 min)
- Cause and Effect in the Reference Book (20 min)
- Discussing the Evidence (10 min)

On-the-Fly Assessment

DAY 13 | LESSON 2.4

Writing About Heating Ingredients

- Reviewing Key Concepts (10 min)
- Evidence Thought Swap (20 min)
- Modeling How to Write a Design Argument (10 min)
- Writing an Argument (20 min)

On-the-Fly Assessment
Self-Assessment

Chapter 3:
The storyline goes deeper

What students investigate:

What ingredients can be used to make a glue that is sticky and strong?

What they figure out:

Ingredients can be combined to create different glues that have different properties. Sometimes, the properties of glue are a combination of the properties of the substances that make up that glue, such as a flour-water combination. For example, baking soda, which is smooth, and flour, which is sticky, can be combined to make smooth and sticky glue.

How they figure it out:

- Observing the design process in action as they read the student book *Jess Makes Hair Gel*
- Modifying their glue design based on a newly added design criteria—the property of strength

KEY


HANDS-ON


MODELING


READING


STUDENT-TO-STUDENT DISCUSSION


TEACHER-LED DISCUSSION


WRITING

DAY 14 | LESSON 3.1

Jess Makes Hair Gel

- Introducing *Jess Makes Hair Gel* (10 min)
- Reading *Jess Makes Hair Gel* (30 min)
- Connecting to the Design Cycle (10 min)
- Reflecting on Cause and Effect (10 min)

On-the-Fly Assessment

DAY 15 | LESSON 3.2

Adding Strength as a Design Goal

- Adding Strength as a Design Goal (10 min)
- Introducing Strength Tests (10 min)
- Observing Ingredients and Setting Up Tests (30 min)
- Discussing How Ingredients Affect Mixtures (10 min)

On-the-Fly Assessment

DAY 16 | LESSON 3.3

Evaluating Strength Test Evidence

- Making Observations and Gathering Test Results (20 min)
- Graphing Test Results and Making Claims (15 min)
- Searching for Evidence in a Reference Book (15 min)
- Reporting Multiple Sources of Evidence (10 min)

On-the-Fly Assessment

DAY 17 | LESSON 3.4

Writing Design Arguments

- Adding a Third Design Goal (15 min)
- Evaluating Evidence (20 min)
- Writing Design Arguments (25 min)

On-the-Fly Assessment

DAY 18 | LESSON 3.5

Making Our Second Glue

- Writing a Glue Recipe (15 min)
- Making Glue and Setting Up Tests (25 min)
- Making and Discussing Predictions (5 min)
- Reflecting on Designing Mixtures (15 min)

Critical Juncture Assessment
Self-Assessment

Chapter 4: Application to a new context

What students investigate:

What is the glue recipe that best meets our design goals?

What they figure out:

It will typically take multiple design cycles to find the exact glue recipe (mixture) that meets the design goals. By designing and testing mixtures that include ingredients with the desired properties, glue engineers can identify the best result and successfully meet their design goals.

How they figure it out:

- Evaluating and testing their second glue recipe
- Modifying the design based on their test results
- Presenting their own glue mixture and making the case for how it meets the design goals, as well as evaluating the mixtures created by their peers

KEY


HANDS-ON


MODELING


READING


STUDENT-TO-STUDENT DISCUSSION


TEACHER-LED DISCUSSION


WRITING

DAY 19 | LESSON 4.1

Evaluating Second Glues and Revising Recipes

- Conducting Strength Tests and Evaluating Results (20 min)
- Discussing Results and Preparing to Modify Recipes (15 min)
- Writing Recipes for Third Glues (10 min)
- Making Third Glues and Setting Up Tests (15 min)

On-the-Fly Assessment

DAY 20 | LESSON 4.2

Making Final Glues

- Completing Tests and Recording the Results (15 min)
- Engaging in a Thought Swap (20 min)
- Revising Designs and Making Picture Frames (25 min)

On-the-Fly Assessment

DAY 21 | LESSON 4.3

Mystery Mixtures

- Word Relationships Routine (20 min)
- Engaging in the Ingredient Properties Sorts (15 min)
- Engaging in the Mystery Mixtures Sorts (15 min)
- Reviewing Cause and Effect with Mystery Mixtures (10 min)

On-the-Fly Assessment

DAY 22 | LESSON 4.4

End-of-Unit Assessment

- Observing Final Glues (15 min)
- Writing a Letter to the Principal (35 min)
- Final Reflection (10 min)

End-of-Unit Assessment
Self-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.

Properties of Materials 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 to design a mixture with desired properties for a specific purpose.

Progress Build Level 1:
Different materials have different properties.

Progress Build Level 2:
Mixtures have different properties, depending on their ingredients.

Progress Build Level 3:
Heating or cooling a substance can change it to a new substance.

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:

Strategic partnering (Example from Lesson 4.1)
This lesson includes extended partner work for the glue strength investigation and the subsequent partner discussion. Each student will continue to work with the same partner through Lesson 4.3. Extended academic discourse that is equitable (that is, all students have an opportunity to engage) is critical for developing both language and content knowledge. Strategic partnering is essential for English learners as they develop understanding of new content. Therefore, consider carefully which partner to assign for each English learner in your class and assign a partner who has slightly higher English language skills than the student in question. Opportunities for English learners to engage in conversations that are slightly above their language-proficiency level can accelerate second-language learning and increase students' confidence with engaging in science discourse. We suggest you assign different partners over the course of the unit so an English learner who serves as a language mentor for another English learner in one lesson gets a partner with more advanced English in another lesson. When assigning partners, consider which partnering structure will be most supportive for your students.

For students needing more support:

Record one observation in a small group (Example from Lesson 2.2)
You may wish to meet with a small group of students who need more support and work together to record an observation of the mixture before and after heating. Together, you could generate a sentence describing evidence to support whether the properties of the mixtures are the same or different. Work together to formulate the observation and have all students record it.

For students ready for a challenge:

Devising tests (Example from Lesson 3.3)
For students who need more challenge, encourage them to devise their own way to assess the strength of a glue ingredient. They may devise tests that can be conducted in the class. Or, they may brainstorm ideas for how to test the strength of a glue with no restrictions on equipment or materials. In this case, students should include a detailed description of how to conduct the devised test, along with a materials list. It may be helpful as well for students to include diagrams to illustrate 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.

Properties of Materials 3-D Coverage

SEPs
Science and Engineering Practices

DCIs
Disciplinary Core Ideas

CCCs
Cross-Cutting Concepts

Unit Level

Students investigate and then analyze and interpret data to determine different properties of materials (patterns, cause and effect). This informs the design of a glue mixture with a combination of desired properties that make it best suited for classroom use.

Chapter Level

Chapter 1: How can you make a sticky glue?

Students work to define the problem of designing a sticky glue (cause and effect). They plan and carry out investigations to compare the property of stickiness of each possible glue ingredient (patterns). This provides the evidence they need to design their first glue mixture.

Chapter 2: Can heating an ingredient make a better glue?

Students obtain, evaluate, and communicate evidence about the effects that heating and cooling an ingredient has on its properties (patterns, cause and effect).

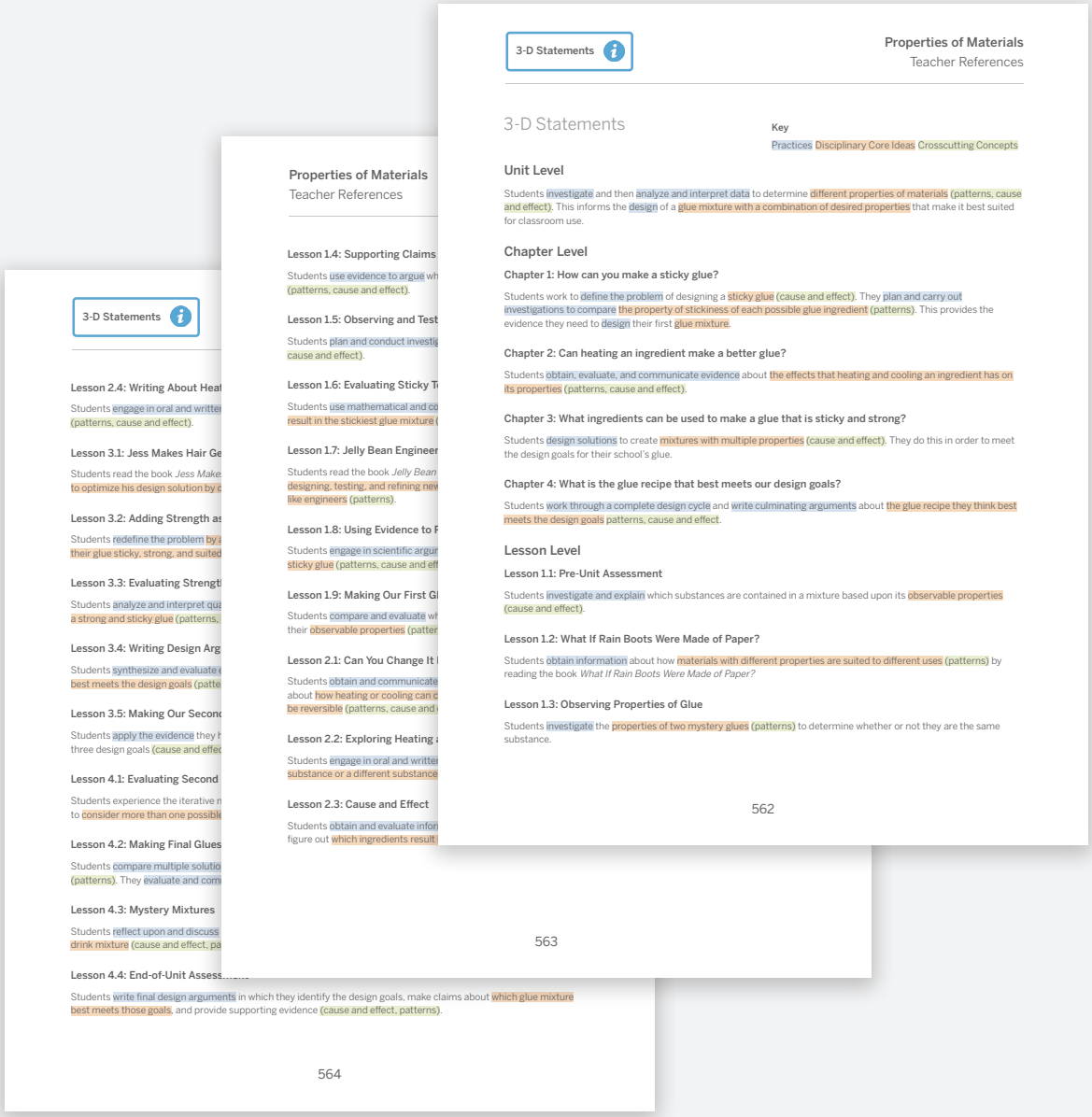
Chapter 3: What ingredients can be used to make a glue that is sticky and strong?

Students design solutions to create mixtures with multiple properties (cause and effect). They do this in order to meet the design goals for their school's glue.

Chapter 4: What is the glue recipe that best meets our design goals?

Students work through a complete design cycle and write culminating arguments about the glue recipe they think best meets the design goals patterns, cause and effect.

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



3-D Statements

Properties of Materials
Teacher References

3-D Statements

Key
Practices Disciplinary Core Ideas Crosscutting Concepts

Unit Level

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Students work through a complete design cycle and write culminating arguments about the glue recipe they think best meets the design goals patterns, cause and effect.

Lesson Level

Lesson 1.1: Pre-Unit Assessment

Students investigate and explain which substances are contained in a mixture based upon its observable properties (cause and effect).

Lesson 1.2: What If Rain Boots Were Made of Paper?

Students obtain information about how materials with different properties are suited to different uses (patterns) by reading the book *What If Rain Boots Were Made of Paper?*

Lesson 1.3: Observing Properties of Glue

Students investigate the properties of two mystery glues (patterns) to determine whether or not they are the same substance.

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Properties of Materials
Teacher References

Lesson 1.4: Supporting Claims

Students use evidence to argue wh
(patterns, cause and effect).

Lesson 1.5: Observing and Test

Students plan and conduct investig
cause and effect).

Lesson 1.6: Evaluating Sticky T

Students use mathematical and co
result in the stickiest glue mixture (

Lesson 1.7: Jelly Bean Engineer

Students read the book *Jelly Bean*
designing, testing, and refining new
like engineers (patterns).

Lesson 1.8: Using Evidence to F

Students engage in scientific argur
sticky glue (patterns, cause and eff

Lesson 1.9: Making Our First Gl

Students compare and evaluate wh
their observable properties (patter

Lesson 2.1: Can You Change It

Students obtain and communicate
about how heating or cooling can c
be reversible (patterns, cause and

Lesson 2.2: Exploring Heating

Students engage in oral and writte
substance or a different substance

Lesson 2.3: Cause and Effect

Students obtain and evaluate infor
figure out which ingredients result

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3-D Statements

Lesson 2.4: Writing About Heat

Students engage in oral and writte
(patterns, cause and effect).

Lesson 3.1: Jess Makes Hair Ge

Students read the book *Jess Make*
to optimize his design solution by c

Lesson 3.2: Adding Strength as

Students redefine the problem by
their glue sticky, strong, and suited

Lesson 3.3: Evaluating Strengt

Students analyze and interpret qua
a strong and sticky glue (patterns,

Lesson 3.4: Writing Design Arg

Students synthesize and evaluate
best meets the design goals (patte

Lesson 3.5: Making Our Second

Students apply the evidence they h
three design goals (cause and effec

Lesson 4.1: Evaluating Second

Students experience the iterative n
to consider more than one possible

Lesson 4.2: Making Final Glues

Students compare multiple solutio
(patterns). They evaluate and com

Lesson 4.3: Mystery Mixtures

Students reflect upon and discuss
drink mixture (cause and effect, pa

Lesson 4.4: End-of-Unit Assess...

Students write final design arguments in which they identify the design goals, make claims about which glue mixture best meets those goals, and provide supporting evidence (cause and effect, patterns).

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Notes

Notes

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

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