GRADE 3 STUDENT TEXTBOOK

Engineering Design and Fair Tests

CHAPTER 6 | FIVE DAILY LESSONS

Read | Explore | Practice | Review

Original Ahava chapter edition, 2026

Using your student textbook

The book supplies explanations and examples for one chapter. Read each numbered lesson before attempting its corresponding workbook exercises. The separate teacher guide is for checking answers, not for copying.

- Read the vocabulary and the full lesson first.
- Study the worked example and explain it in your own words.
- Answer the checkpoint questions without a teacher’s key.
- Complete the matching daily PDF workbook and save privately.
- Review errors with your teacher before the next lesson.

Chapter contents

- Day 1: Define a Design Problem
- Day 2: Plan Alternative Models
- Day 3: Conduct a Fair Test
- Day 4: Improve From Evidence
- Day 5: Explain the Results

This is one chapter edition, not a full 36-week textbook.

Lesson 1: Define a Design Problem

Vocabulary

- criterion: a measurable feature a successful design must satisfy
- constraint: a limit such as time, materials, size, or cost
- prototype: a trial model built to learn from tests
- load: the weight or force supported by a structure

Student reading

Engineers solve problems by describing what must happen and the limits they must work within. Suppose a paper bridge must span a 20-centimeter gap and support ten identical washers. The distance and supported load are criteria, because a test can show whether the bridge meets them. Limiting materials to two sheets of paper and a small quantity of tape is a constraint.

A bridge works by transferring a load through its structure to its supports. A flat strip of paper may sag while a folded strip can resist bending differently. The effect depends on paper thickness, fold shape, the spacing between supports, and where the washers are placed. No shape should be called the winner until designs are actually compared.

The question ’Which paper-bridge design carries more identical washers across the same gap?’ is testable. The number of washers supported before failure can be counted, but the washers must be the same type and size for a meaningful comparison. The gap must stay at 20 centimeters for each test.

Use books or sturdy low supports on a clear tabletop with adult supervision. Do not stand on the structure or use sharp cutting tools without a responsible adult. Draw a labeled diagram of the gap, supports, paper bridge, and point where the load is placed.

Worked example

Design requirement: span 20 cm and support 10 equal washers. Criteria: reaches the supports and holds the washers. Constraints: two paper sheets and limited tape. Measurement: count equal washers held for five seconds without collapse.

Check your understanding

- 1. What must the bridge accomplish?
- 2. Name one material constraint.
- 3. What measurement tests success?
- 4. Why use identical washers?

After reading, complete Chapter 6, Day 1 in the corresponding workbook.

Lesson 2: Plan Alternative Models

Vocabulary

- model: a representation or trial structure used to explore an idea
- beam: a structural member that resists bending
- fold: a crease that changes a sheet’s shape and stiffness
- prediction: an expected outcome stated before testing

Student reading

Design work is more useful when it compares alternatives. For example, a student could build a flat paper bridge and a folded accordion-style bridge using the same available paper. A design sketch must identify each shape, the 20-centimeter span, and how the ends rest on supports.

Changing the fold pattern may change how the paper distributes forces. The flat and folded designs differ in a planned way, but if the folded model uses twice as much paper, then paper quantity becomes another difference. We can compare models fairly only when we identify which features are changing.

A prediction is not a measured result. A student might predict that a folded bridge will hold more washers. The prediction can be explained by the idea that folds may increase resistance to bending, but the student still needs a controlled test to know the actual outcome.

Write a simple plan before constructing. Specify paper size, tape amount, distance between supports, where to place the washers, how long to wait before declaring success, and how many times to repeat each test. Number each model so the table can distinguish its results.

Worked example

Model A: flat paper strip. Model B: same-size strip folded into an accordion. Both span 20 cm, use the same tape allowance and carry washers at the center. The independent feature is the shape of the paper.

Check your understanding

- 1. Name two features to label.
- 2. What distinguishes a prediction from a result?
- 3. Why use the same span in both designs?
- 4. Suggest a design besides a flat strip.

After reading, complete Chapter 6, Day 2 in the corresponding workbook.

Lesson 3: Conduct a Fair Test

Vocabulary

- variable: a factor that may change during an investigation
- controlled condition: a factor deliberately kept the same
- trial: one complete run of a test
- data: information observed or measured

Student reading

A fair test changes one factor of interest while keeping other important conditions alike. For the paper bridges, the main changed factor could be the folding pattern. Use the same washer type, support height, support spacing, placement method and wait time for every trial.

A useful data table includes model name, trial number, washers supported, and observations. You might record sagging, tearing, or the point of collapse. Record results exactly as seen, even when a result surprises you. A measurement that differs from a prediction is information, not something to erase.

Repeated trials help reveal variation. One run might be affected by a slightly different fold or washer placement. A student can compare three trials per model and calculate the mean of the washer counts. Add the three counts and divide by three.

Do not report practice numbers as an actual experiment. If a worksheet gives hypothetical results, clearly label them ’sample data.’ For a real test, write the date and actual measurements. Keep the work surface clear and do not place fragile or heavy objects below the bridge.

Worked example

Sample data, not an actual experiment: Model A supports 2, 3, and 4 washers, mean 3. Model B supports 7, 8, and 9, mean 8. Under these sample conditions, Model B supports a larger mean load, but no real result is established.

Check your understanding

- 1. Identify two variables to control.
- 2. What result should be recorded?
- 3. Why repeat a test?
- 4. Give one example of an unfair comparison.

After reading, complete Chapter 6, Day 3 in the corresponding workbook.

Lesson 4: Improve From Evidence

Vocabulary

- revision: a change made after examining results
- evidence: observations or data relevant to a claim
- trade-off: gaining one benefit while giving up another
- retest: repeating a measurement after changing a design

Student reading

Engineers often improve a design after its first test. If a paper bridge bends at the center, a student might try narrower folds or reposition supports while keeping the span fixed. The change should address an observed weakness, not an imagined result.

After revising a design, test it using the same load and measurement method. Keep the revised result separate from the earlier data. A change that helps the bridge hold more washers might take more paper or longer assembly time. That is a trade-off if materials or time matter.

A design should be evaluated against the original criteria. A bridge that holds 12 washers but spans only 15 centimeters does not meet a 20-centimeter requirement. A bridge that meets the span but uses more than the allowed paper violates the material constraint.

Explain improvements with a claim-evidence-reasoning pattern. State which model performed better, name the measured result, and explain why the change may have helped. Do not claim an exact mechanism that was not observed or measured.

Worked example

Original model held 6 washers; revised model held 9 washers in one trial. Evidence shows improvement in that measured trial, but the revised design still misses the 10-washer target. More trials and another revision may be appropriate.

Check your understanding

- 1. Which design meets the criterion?
- 2. How many more washers does B support?
- 3. Suggest one modification of A.
- 4. What would count as evidence of improvement?

After reading, complete Chapter 6, Day 4 in the corresponding workbook.

Lesson 5: Explain the Results

Vocabulary

- claim: a statement supported or challenged by evidence
- reasoning: the explanation connecting evidence to a claim
- limitation: a feature of a test that restricts its conclusions
- reproducible: able to be repeated using a clearly described method

Student reading

A scientific conclusion includes the question, the measured results, and an explanation. It also identifies limits. An engineering conclusion should say whether each model met the design criteria and constraints, not merely which model looked attractive.

The bridge test cannot establish that one folding pattern is the strongest bridge design in the world. It examined specific paper, supports, washers, and building methods. Results from another paper type or a longer span might differ. Good scientists explain what was tested and what was not.

To communicate results clearly, include a labeled sketch, a table with units or counts, repeated trials where possible, and a short description of failure points. If measurements were simulated rather than collected, state that clearly.

For the final chapter task, write four parts: Design problem, Test method, Evidence, and Conclusion with limitations. Then suggest one safe next test. This shows the entire process of defining, building, testing, revising, and explaining.

Worked example

Model B met the 20-cm span and held 10 washers in repeated tests while staying within the paper limit. In our trials, it met the criteria. We cannot conclude it would perform the same way with different paper or much heavier objects.

Check your understanding

- 1. State the main success criterion.
- 2. Why might one test not guarantee all future results?
- 3. Name a useful observation besides washer count.
- 4. Use the sample data in a qualified claim.

After reading, complete Chapter 6, Day 5 in the corresponding workbook.

Chapter review

Revisit any missed questions using the reading and the vocabulary. State the evidence for each claim and distinguish observations from interpretations.

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Sample data, not an actual experiment: Model A supports 2, 3, and 4 washers, mean 3. Model B supports 7, 8, and 9, mean 8. Under these sample conditions, Model B supports a larger mean load, but no real result is established.

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Day 5: Explain the Results

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Teacher and parent note

Use the separate answer key and teacher guide for review, reteaching and independent assessment. This edition is not yet a complete school-year text, nor has it been fully aligned and verified against all grade-level state standards.