**Lesson 9** Testing and Evaluating Solutions

“Shipping Day”

**Problem statement:** How do engineers test if their packages can survive the shipping process?

**Learning objectives:** I can test multiple solutions to a design problem by using a rubric to identify if our package could survive the shipping process and how it could be improved.

**Lesson standards (NGSS, CCSS, CTE):**

NGSS: Engineering

3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

**Soft skills:**

Students will use creativity and collaboration to determine with their group how best to meet design rubric expectations.

**Locally and/or personally relevant for students:**

Students are using community locations (such as a playground) to simulate a real-world workplace and are using imaginative play to connect their learning to the STEM field.

**Connections to career and educational pathways:**

Students are following the Design process, much like engineers, to test a product that will then be presented to “consumers”

**Materials:**

* At least one-dozen boiled eggs per testing day
* Rubric modified in lesson 1
* Technical Drawing from lesson 2
* Prototype created from lesson 3
* Optional: video from Lesson 1 to show shipping facility/shipping process (Inside one of UPS’ busiest days<https://www.youtube.com/watch?v=l0-ukGIwcH8>)
* Shipping Facility Rubric (one per group or student) *(Appendix A)*
* Shipping Facility Rubric (sample) (*Appendix B)*

**Lesson preparation:**

Copy rubric modified in lesson 1 (one per group or per student)

**Time required:** Two 45 minutes sessions

**Grouping of students for instruction:**

Students will continue to stay in groups assigned in lesson 1

**What is the instruction? Consider the PBL Procedure that is being addressed here:**

* Students will meet in design teams with prototype, technical drawings, and actual package
* Teacher will model how to use the rubric for each test; each design group will receive a copy of the rubric and discuss the testing process (simulating whether the package could survive a “shipping facility” experience
* Students and teacher will proceed to a playground space to test packages, conduct the test data, determine where their package is and is not meeting the standards of the tests, and have time to manipulate package and come up with design solutions to meet more of the tests on the rubric

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| **Teacher** | **Student** |
| **Intro lesson: 10 minutes**  Remind students that today is Shipping Day! Share with students that they will be using the rubric they made at the beginning of the unit to test if their package can survive being shipped around the world. Ask students to share aloud what are some things that a package would endure when being shipped. | Students gathered in groups; students share aloud what are some things a package would endure if it were being shipped around the world. |
| **Test and Evaluate Solution (design process): 5 minutes**  Reintroduce rubric that groups designed at the beginning of the unit to simulate the Shipping Facility; show students how to identify whether a test was successful or not on rubric (✓ or X) | A few students will model on teacher’s sample Shopping Facility rubric on board/projector |
| **Explanation of shipping test:**10 minutes  Ask students what they should do if the package is *not* successful on a given test; teacher guides students towards strategies to generate multiple solutions (such as looking at technical drawings, technical writing, prototype, materials, etc).  Teacher shows students their boiled eggs. Remind them that their eggs should still be in-tact at the end of the shipping test.  Distribute one boiled egg per group. Groups will place the boiled egg into their package.  Remind students that it is expected that they may not pass every test, and that part of the design process is working with a group to determine possible solutions and that they should put an X on the rubric if the package fails a test and take notes on why they think it failed. | Discuss briefly in groups (1-2 minutes) about what to do if the package is not successful in a test and share out with the class.  Students will determine how the egg will sit inside the package. |
| Shipping Facility: 20-30 minutes  **Depart to “Shipping Facility”** (school playground, if possible) with class; teacher guides groups through the shipping facility by sharing each part of the shipping process scenario:  “Welcome to the *Kirkland* *Regional Shipping Center.* Be careful where you are walking as there are many robotic machines here helping to move packages to the correct locations, and be sure to raise your hand if you have questions as many of the machines here are quite loud. As you can see, the packages that move through this facility are crossing a rather large space and move rather quickly…”  Teacher, with the support of each design group, models the tests as shown on the rubric  Example:“Here your packages will move up a ramp to arrive on the conveyor belt..”  → Have 1 student model pushing a package up the ramp  → Have each group test their packages for the rest of the class  Remind students that it is necessary for the design process to not only record if the package was successful, but also what they noticed about how the packaged look, felt, sounded, etc. | Students will follow teacher on “tour of the Shipping Facility”.  Each design group will model their test for the rest of the class. |
| Teacher will observe students completing tests and support students in following rubric | Students will conduct each of the tests and record on their rubric; they must record at least 1 observation for each test |
| Teacher will collect students and return to classroom | Students will record their rubric data on a class rubric on the board/projector and **remove their eggs from their packages and throw them away.** |
| **Communicate the solution (design process):** 10-15 minutes  Teacher guides students to discuss in their groups about the tests and why they believe their package design was unsuccessful for certain tests.  Share with students that engineers and designers use information from failed tests to redesign. They will have an opportunity to modify their package design and have another opportunity to visit the Shipping Facility to determine if their package design passes all the tests  *POSSIBLE BREAK POINT FOR LESSON----------*  **Improve: Redesign as needed (design process):** 15 minutes  Once students have drawn or written their reason for altering their design and shown it to the teacher, students may continue to use supplies to alter their packages. | Students will talk in their group about their tests and why they believe their package design was unsuccessful for certain tests.  If their package failed any of the tests, they must come up with at least two possible solutions for alterations.  ------------------------------------------------  Students must demonstrate these solutions in either a drawing or writing (students may choose to modify their technical drawings at this time or use a copy). |
| **Test again:** 15 minutes  Provide students another opportunity to visit the outdoor “Shipping Facility” and complete the failed tests and rubric again. | Students will complete all failed tests again and complete the rubric |
| **Reflection**: 15-30 minutes  Guide students to discuss as a group and then share out with the class about the following questions:   1. What part of your design helped/hindered your package from “surviving” the shipping facility? 2. What part of your group work helped/hindered your package from being successful? 3. What would you change about your package now that you have completed the design, build, and testing process? 4. What questions/ wonderings do you have about designing packages? | Reflection/ Present  Students complete the reflection on their own, and then may share out as a class. |

**Accommodations:**

**\*”**Shipping Facility” can be designed as tests within a classroom/school building instead of on a playground, as needed

**Extensions:**

-Provide students multiple opportunities to modify their designs based on feedback from failed tests and then visit the outdoor “Shipping Facility” and complete the failed tests and rubric again.

-Have students come up with their own prototype using only recycled or recyclable materials and share back with the class whether or not this impacted the sturdiness of the package or its ability to survive the Shipping process.

**Assessment:**

Formative Assessment in the Lessons

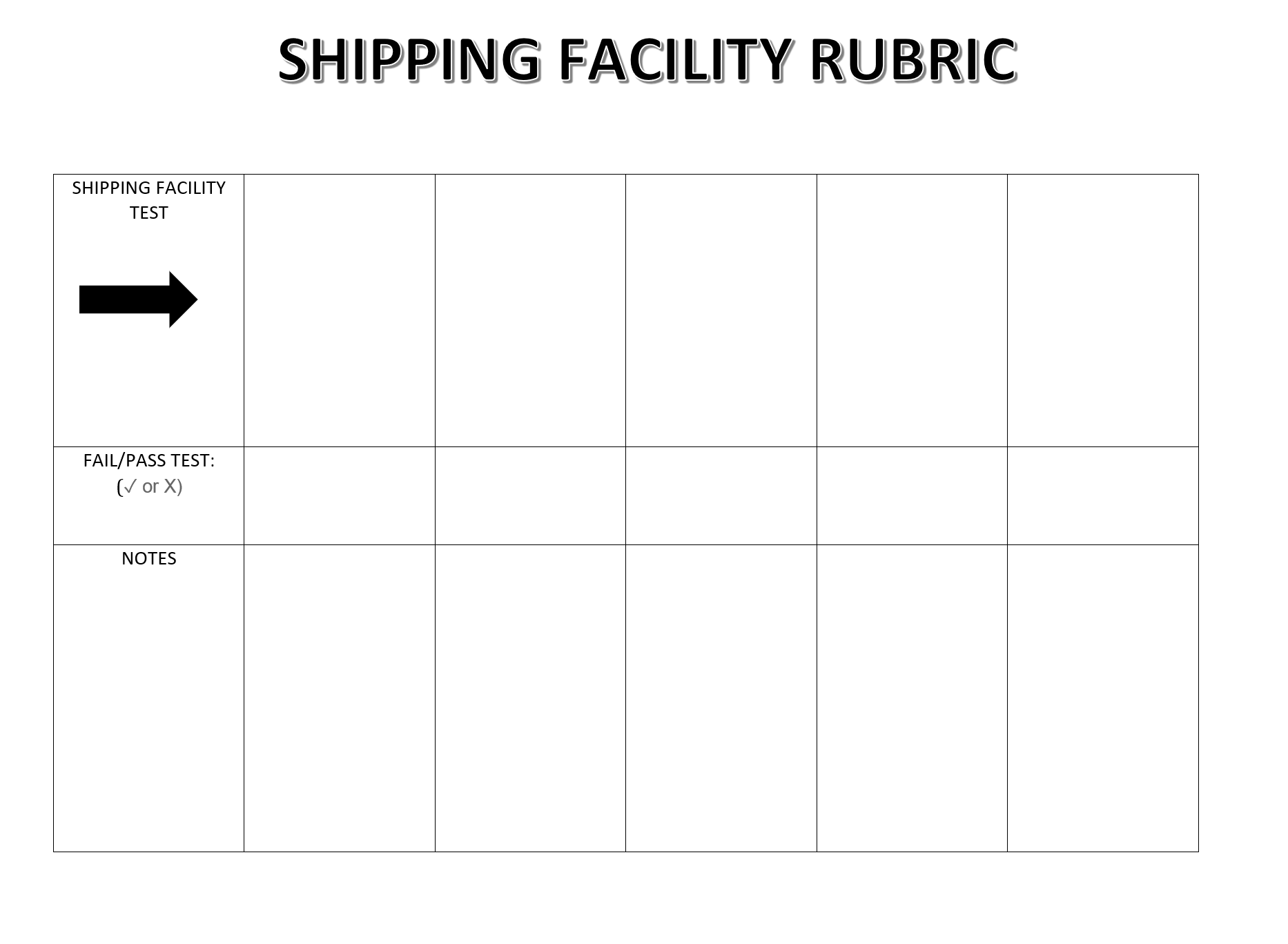
1. Observe conversations taking place in groups, giving attention to students’ recognition of the design process to identify problems with the design and to come up with multiple solutions.

Summative Assessment for the Unit

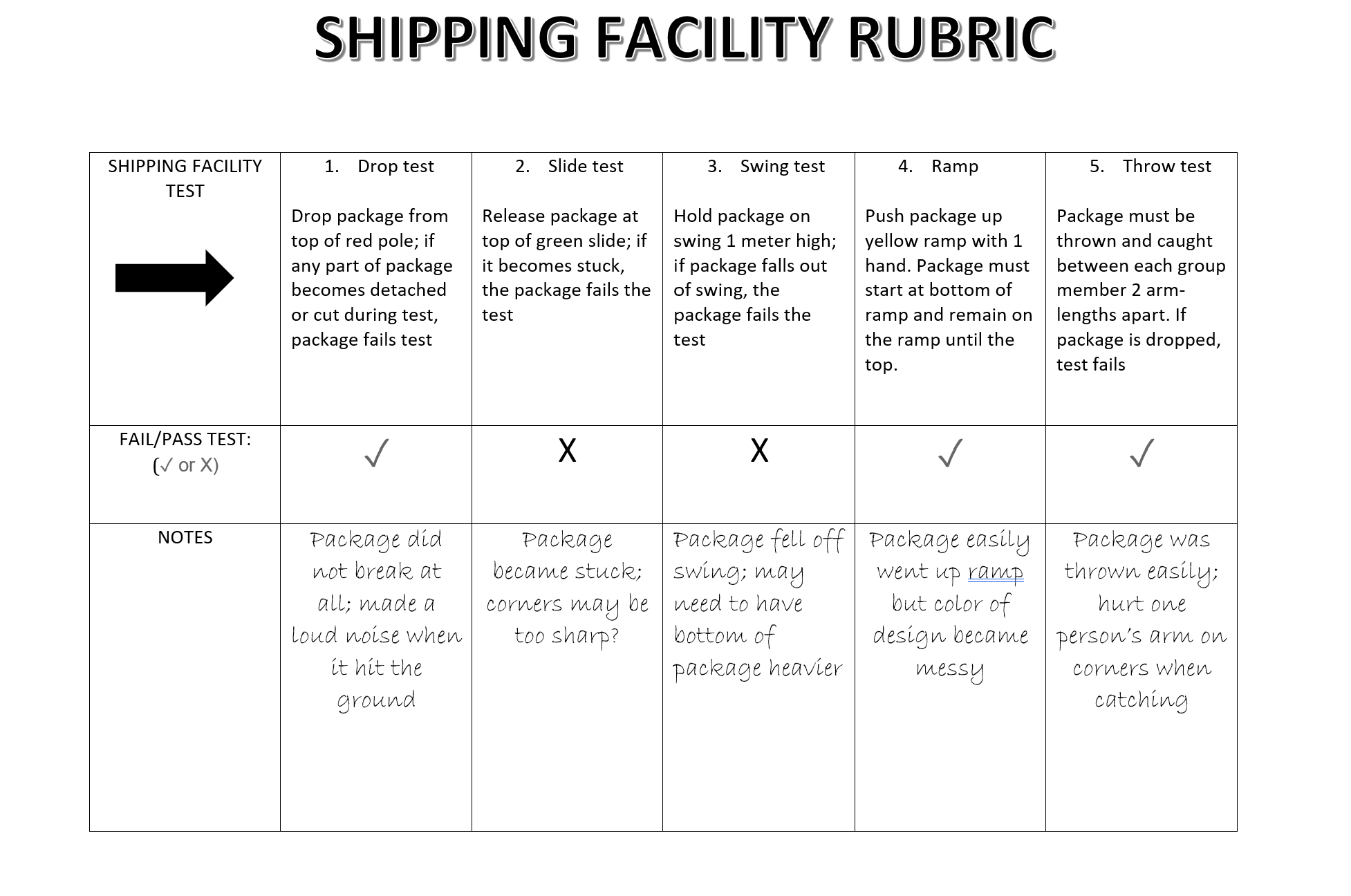
1. Students complete the Shipping Facility Rubric with notes and they can articulate through drawings or oral explanation why the believe their package was successful on certain tests and failed on others.

*Appendix A:*

*Blank Rubric:*

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*Appendix B:*

Sample Rubric to model for students

*Appendix C: Reflection*

1. What part of your design helped/hindered your from “surviving” the shipping facility?
2. What part of your group work helped/hindered your package from being successful?
3. What would you change about your package now that you have completed the design, build, and testing process?
4. What questions/ wonderings do you have about designing packages?