

**MIDDLE SCHOOL**

**Green Chemistry**

**Lesson Five: Testing the Cell Phone Cases**

**Background:** For a technology to be truly sustainable according to green chemistry standards, it has to (along with other traits) work just as well or better than available alternatives. To test the performance of a product, engineers and materials scientists will determine the criteria that are important to the functionality of their product, then design their tests to evaluate that criteria. The results of each test will guide the engineers and scientists to make decisions about their product and to determine how they should proceed in their work.

In Lesson 2, students designed procedures to test the properties of their prototypes. In this lesson, students will revise those procedures and use them to evaluate their mycelium cell phone cases. They will then use the information from their experiments to draw conclusions about their final product and choose one case to recommend. Their recommended case will be the focus of their presentation in Lesson 6.

It is important to note that the cell phone cases made in class will likely not perform as well as commercially available plastic cases. The main goal is for students to end up with a final product that can support the *possibility* that this type of cell phone case could one day work.

**Goal:** Test different variables to see if they impact the effectiveness of the product

**Objectives:** Students will…

* Analyze the data collected during their cell phone case’s growth stage
* Test their cell phone case for characteristics based on their ideal cell phone case
* Evaluate the cost, safety, and performance of their cell phone cases to determine which of their models best meets the criteria for success

**Key Terms:** prototype, redesign

**Materials:**

* Student sheets from Lessons 2/4
* Testing procedures from student notebooks
* Copies of Lesson 5 Student Sheet
* Miscellaneous materials for product testing

**Time Required:** 45–60 minute class period

**Standards Met:**

**MS-ETS1-1.** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

**MS-ETS1-2.** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

**MS-ETS1-3.** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

**MS-ETS1-4.** Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

**Keys to Success:**

* The reflection on the cell phone case growth and student observations can be extended or shortened, depending on available time.
* The resulting cell phone cases will not perform as well as commercially available cell phone cases. If necessary, remind students that all inventions must start somewhere!

**Teacher Preparation:**

* Gather any materials needed to perform the tests from Lesson 2.

**Procedure:**

*Engage:* Students reflect on the growth of their cell phone cases and make predictions about the tests they will use to evaluate the cases.

* Invite class to share how the growth of their cell phone cases compared to their predictions.
  + What did you see throughout the growth process?
  + What aligned with your predictions?
  + What was surprising to you?
  + What conclusions have you been able to draw about your cases so far?
* Ask students to pull out their engineering design process sheets from Lessons 2/4.
* Review the tests that the class performed on the prototype without the mycelium material.
* Invite students to share any reflections or lessons learned from their first round of testing.
* Ask students to predict how testing their mycelium cell phone case may differ from testing the original prototype.

*Explore:*Student groups continue to work through the engineering design process as it relates to the tests they will perform on each case.

* Encourage students to explain any changes or adjustments they plan on making to their testing procedure.
* Have groups refer to their prototype testing procedures in their notebooks and note any changes.

*Explain:*Students reflect on the green chemistry criteria as a way to measure the sustainability of a product.

* As a class, reflect back on the three criteria for green chemistry technology (cost, safety, and performance) as a way of measuring the sustainability of a product.
* Remind the class that they have already considered environmental impact (safety) and have thought about the efficiency of the procedure to minimize costs and waste.
  + NOTE: Grow.bio mycelium products, used as an alternative for Styrofoam shipping materials, is cost comparable per unit volume. More information can be found through <https://ecovativedesign.com/home>.
* Remind the class that, as they discussed when they tested their prototypes, the best way to test the performance of a product is to run different experiments and evaluate how well their product works. The information they gain from their materials tests will give them a full picture of the cost, safety, *and* performance of their sustainable technology.

*Extend/Elaborate:*Student groups perform tests and collect data related to each cell phone case.

* Have the students break into their groups.
* Instruct student groups to build data tables in their notebooks to capture any important information they will gather from their tests.
* Allow student groups to run their experiments on both cases, A and B. If time is limited, each group can divide into two sub-groups, who will each run tests on one case.

*Evaluate:*Students draw conclusions about their final product using the information they gather during their experiments.

* Distribute the Lesson 5 Student Sheet to each group. Have groups complete the provided questions to guide them in drawing conclusions about their cell phone cases.

**Lesson Five: Testing the Phone Cases Student Sheet**

Answer the questions below with sufficient detail to support your conclusions.

1. How well did cell phone case A perform?
2. How well did cell phone case B perform?
3. What are the biggest strengths and weaknesses of cell phone case A?
4. What are the biggest strengths and weaknesses of cell phone case B?
5. What other tests would you want to perform on your cases, if given more time?
6. Which of your two cell phone cases would you recommend, and why?