# Classroom Teacher Preparation

## Engineering 1: What's the best vehicle?

***Please use the following to prepare for the next SfS lesson.***

## Description:

In this lesson, students are presented with a problem and identify the criteria and constraints presented in the problem. Afterwards, students will test four types of vehicles on their ability to solve that problem. Based on the results of the testing, students will identify the vehicle that is the best solution to the problem and explain why, using evidence from their tests.

## Lesson Objectives – SWBAT ("Students Will Be Able To…"):

**3rd-8th**

- Identify the best possible solution to a problem by identifying criteria and constraints and testing the possible solutions.
- Review information about and make observations of a vehicle design to identify what problem the vehicle was created to solve.

**6th-8th**

- (Optional) Develop a tradeoff matrix that weighs competing criteria and constraints for one or more vehicle designs

## Disciplinary Core Idea (DCI)

*ETS1 Engineering Design*

- (3rd-5th) ETS1.A: *Defining and Delimiting an Engineering Problem* - The success of a designed solution is determined by considering the desired features of a solution (criteria).
- (6th-8th) The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful.

## Science & Engineering Practice (SEP)

*Asking Questions and Defining Problems*

- (3rd-5th) Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.
- (6th-8th) Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions.

## Crosscutting Concept (CCC)

*Structure and Function*

- (3rd-5th) Substructures have shapes and parts that serve functions.
- (6th-8th) Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.

## Preparation:

This lesson can be used as an introduction to or as practice with the first step of the engineering design process: The identification of a problem to solve and the specification of clear goals, or criteria, that the final product must meet (NGSS Framework, p 204). No specific preparation is needed, but it would be helpful to discuss with your SfS instructor the amount of familiarity your students have with design problem criteria and constraints, and with the engineering design process as a whole.

## Room Set Up for Activities:

Students will work in groups of 2-4. They will need a clear working surface at least the size of one desk.

## Safety:

There are no safety concerns with this lesson, but the materials should be handled gently to avoid damaging them.

## Related Modules:

This lesson may be taught as part of a sequence or group of related modules on Engineering Design. Modules include:

*Engineering 2: Rover Restraint* – This module gives students a hands-on, team-oriented introduction to engineering within the context of space exploration. They learn about NASA's Mars rovers as examples of the challenges engineers face in balancing competing goals, while creating a lander for a mock rover to be tested in an egg drop.

*Engineering 3: (Re)-Building a Bridge* – Students design, build, and test prototype bridges that can transport a defined number of people, modeled by weights. During testing, they identify the failure points of their models and use these data to improve their designs, rebuild, and retest.

*Engineering 4: Engineering Redesign with Legos* – Focuses on the redesign step of the Engineering and Design process. Students must redesign a flawed prototype based on certain constraints (i.e., redesign and rebuild a Lego bookcase in order to easily transport it from classroom to classroom).

For other module sequences and groups, look here: www.sciencefromscientists.org/sequences

## Standards Covered:

Please click the following link to our website to review the standards covered by this lesson, listed by state: www.sciencefromscientists.org/standards/

Lessons are matched to both national NGSS and local state standards.

## After Our Visit:

*Extend this lesson by challenging students to design bridges that meet specific criteria.*

Access this Extension activity by visiting the Classroom Post found on our website at sciencefromscientists.org/cohorts. Use the name of your school/cohort and password to log in.

To help Evaluate, check out our Open Response questions online at sciencefromscientists.org/open-response-questions. They are freely available for all of our lessons for current teachers. Use the password supplied by your instructor to log in.

## Additional Resources:

- The Systems Engineering Toolbox – Pugh Matrix: https://ngss.nsta.org/Resource.aspx?ResourceID=218
- Extreme Biosuits: A multi-day engineering project: https://www.teachingchannel.org/biosuit-engineering-unit-boeing

- The Engineering Process: Crash Course Kids #12.2 (5:16) https://www.youtube.com/watch?v=fxJWin195kU&list=PLhz12vamHOnZ4ZDC0dS6C9HRN5Qrm0jHO&index=3&t=0s
- Defining a Problem: Crash Course Kids #18.1 (3:39): https://www.youtube.com/watch?v=OyTEfLaRn98&list=PLhz12vamHOnZ4ZDC0dS6C9HRN5Qrm0jHO&index=3
- Defining Success: Crash Course Kids #18.2 (3:58): https://www.youtube.com/watch?v=XyFUqFQfl30&list=PLhz12vamHOnZ4ZDC0dS6C9HRN5Qrm0jHO&index=4