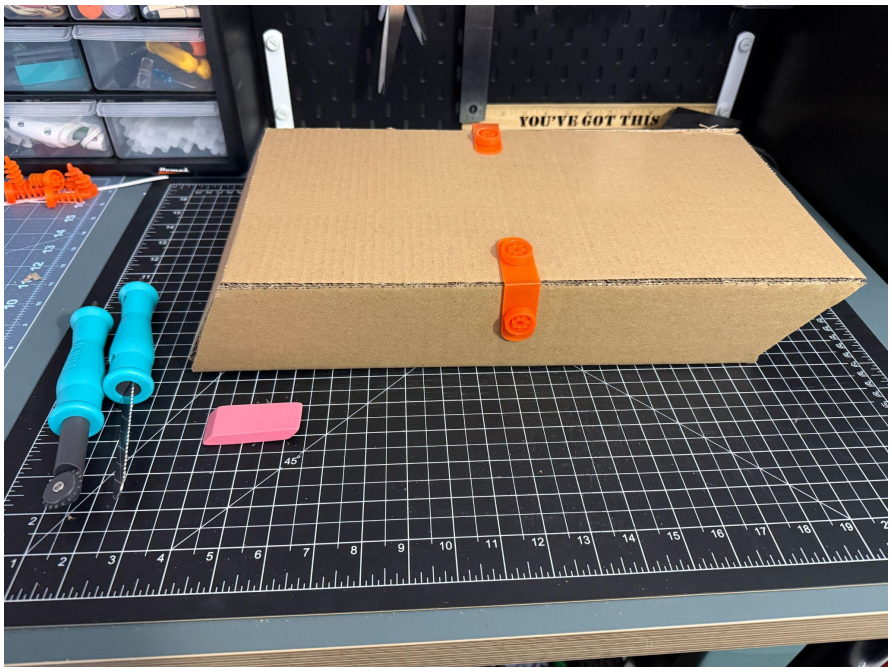
Cardboard Scale Model

Math ➡ 4th-7th Grade

Required Learning Modules

All Tool-torials



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- Overview and Learning Goals
- Teacher Preparation
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- Classroom Tips and Modifications

SWIFT KID-SAFE CARDBOARD CREATIONS

CreXo™

Cardboard Scale Model Overview

Project Overview

Students will create a cardboard scale model of an object, demonstrating their understanding of concepts such as measurement, ratios, proportional relationships and three-dimensional figures. This project is designed to be completed after your core content has been presented and can serve as a summative assessment or unit final project.

Student Learning Goal

Students will be able to design and build a three-dimensional cardboard scale model of an object of their choice, using a scale factor of their choice or one assigned to them.

Estimated Timeline

- 3-4 class periods (45-60 minutes each), depending on experience level.

Materials Needed

- Swift Student Kit (1 kit : 2-3 students)
- Cardboard of various sizes
- Craft supplies such as construction paper, popsicle sticks, tape, pipe cleaners, pom poms, markers, etc.

Supplemental Resources

- Swift Engineering Design Notebook

Teacher Preparation

Below are some suggestions for teachers to complete prior to the start of the lesson.

Become familiar with the Swift Student Kit

- View the video Tool-torials and relevant How-To videos based on your Swift classroom materials available on CreXo Classroom and have them available for student viewing.
- Swift projects can be as simple or complex as students want! Encourage your students to experiment with ideas and problem solve as they build. The Engineering Design Process is a cycle, not a linear path!
- Review the Builder's Guides for basic build ideas and more advanced mechanisms. Students can use these resources as examples or thought starters.

Before the first day of the project:

Complete the following before students enter the room to prepare for each team of students (we suggest 2-3 students to each kit):

- Print or share electronically the Swift Engineering Design Notebook.
- Determine how students will access project materials.
    - Will materials be available at their tables or in a specific location in the room?
    - What additional craft supplies will they need access to for their builds?
- Set aside space in the classroom for student projects to be stored between sessions.

Project Pacing Guide

Session 1
Time: 45-60 min

Description:
- Students will watch a video to gain an understanding of scale, scale factor, and proportions.
- Students will be introduced to the Swift tools available to construct their projects.
- Students will work individually or in teams to select an object for their scale model and begin planning their build using the Swift Engineering Design Notebook.

Session 2
Time: 45-60 min

Description:
- Students will continue planning their build using their Swift Engineering Design Notebook.
- Students will develop prototypes to test their plan and refer to the Swift Tool-torials for guidance as needed.
- By the end of this session, students should have a finalized plan for their build.

Session 3
Time: 45-60 min

Description:
- Students will construct their scale model builds independently or in teams.

Session 4
Time: 45-60 min

Description:
- Students will complete the construction of their scale model builds and the reflection page in their Swift Engineering Design Notebook.
- Teachers may choose to provide additional build time as needed and supplement the reflection or add other assessments if appropriate.

STANDARDS ALIGNMENT

Common Core Math Standards

4.MD.A
Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit.

5MD.A
Convert like measurement units within a given measurement system

6.G.A
Solve real-world and mathematical problems involving area, surface area, and volume.

6.RP.A
Understand ratio concepts and use ratio reasoning to solve problems.

7.G.A
Draw, construct, and describe geometrical figures and describe the relationship between them.

7.RP.A
Analyze proportional relationships and use them to solve real-world and mathematical problems.

NGSS Engineering Design Standards

K-2-ETS1-2
Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

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.

SESSION 1 Outline

MATERIALS NEEDED: Swift Student Kit, craft supplies	**TIME:** 45-60 min
LEARNING GOAL: Students will learn about creating scale models, scale, and scale factor and how to use the Swift tools to build their projects. Students will begin to plan their designs.	**RESOURCES:** Swift Engineering Design Notebook

1. **Project Introduction** (15 min)
   Introduce the Scale Model Project to your students. It may be helpful to show students example visuals or images of objects that are or are not to scale, or have a project pre-built to help students make the connection. Below are some optional Youtube videos you could use as an intro:
   - What is Scale and How to Find Scale Factor
   - Relating Scale Drawings to Ratios and Rates
   - Understanding Scale: How to use Proportions to Shrink or Enlarge

   You can either assign a object and scale factor to your students or allow them choose to their own. Present any requirements and constraints for the project. Share criteria for success, and the grading rubric/process. Share examples of projects, either one you have created or via the images on the next page.

   Consider the sample requirements below, and create your own to suit your needs:
   - Students must choose or be assigned an object and scale factor to build. They will be responsible for knowledge of mathematical process involved with creating this object to scale.
   - The scale model must represent a real-world object. For example, an enlarged model of a pink eraser or a reduced model of the classroom or school.
   - Students must present their work to the class (or to an audience of your choice), justify their design choices and, explain how their project represents scale factor.

2. **Learn about the Swift Student Kit** (5 min)
   Introduce the tools available in the Swift Student kit. You might choose to review the tutorial videos with students or allow them to review them independently to learn how each of the tools work. If time allows, let students practice using the tools and make simple builds not related to the project so they can gain confidence in their building skills and knowledge.
   - Recommended tutorials are available on Page 3 of this project map.

SESSION 1 Outline (continued)

3. Scale Factor and Object Selection (10 min)

Have students select the object their group will build and the scale factor they will use, or assign each group an object and scale factor. Let students know they should be ready to start planning in the next section.

Consider the following questions to ask students as they plan:

- Do you want to create your model to be larger than (enlarged) or smaller than (reduced) the original object?
- What limitations might you run into when you implement your plan? Are those limitations enough of a concern to make you rethink the build you want to create?
- How will you ensure you will be able to use the Swift tools effectively in your build?

4. Planning Time (15-20 min)

- Have students complete their Swift Engineering Design Notebooks, creating a 2D or 3D drawing of their planned design. Ensure students are **labeling** their drawings to reflect accurate scale.
- Students should label where the Swift screws, bolts, or connectors will go on their design.
- If they would like more space to create a detailed plan, students may plan on a separate piece of paper or on the back.
- If they want to incorporate color into their design, they should include the color on their plan.
- During this step, you may also find it helpful to have students list the materials they will need for their projects. Students should refer to their sketches and create a materials list based on their designs. If you have limited supplies, be sure to tell students what materials are available.

SESSION 2 Outline

MATERIALS NEEDED: Swift Student Kit, craft supplies	**TIME:** 45-60 min
LEARNING GOAL: Students will continue to plan their designs, while creating prototypes and reviewing Tool-torials, with the goal of selecting their final build.	**RESOURCES:** Swift Engineering Design Notebook

Session Introduction (5-10 min)
Remind students of the project goals and timeline for the day. Encourage students to share their tips and tricks for measuring, building, and troubleshooting!

Planning Time (30-40 min)
Allow students time to continue working on their Swift Engineering Design Notebook.

- Students should be creating prototypes of their scale models to evaluate their plan.
- Students should be using a ruler for measurements with the goal of making their models as accurate as possible.

Pack Up Time (10 min)
Allow students time to pack up their project materials and worksheets.

- Consider where students will store their projects. Will they keep their prototypes built or disassemble them to make their final builds?
- How will they turn their worksheets in?

Suggestions for build days:

1. **Have Swift Build tutorials on standby.**
   Students may need reminders and assistance troubleshooting, especially as they learn how to use the Swift tools.
2. **Normalize iteration, troubleshooting, and frustration.**
   These critical components of the Engineering Design Process can sometimes be new and frustrating for students. Proactively introduce each concept to set students up for success.
3. **Empower students to work as a team, independent from the teacher.**
   Students should push themselves out of their comfort zones with collaboration, problem solving, and giving and receiving feedback. This project is designed to be student-centered and teachers should be ready to give assistance only when asked.

SESSION 3 Outline

MATERIALS NEEDED: Swift Student Kit, craft supplies	**TIME:** 45-60 min
LEARNING GOAL: Students will construct their final scale model builds, following the plan that they have laid out in their Swift Engineering Design Notebook.	**RESOURCES:** Swift Engineering Design Notebook

Session Introduction (5-10 min)
Remind students of the project goals and timeline for the day. Encourage students to share their tips and tricks for measuring, building, and troubleshooting!

Building Time (30-40 min)
Allow students time to begin constructing their models using cardboard, the Swift Student Kit, and any craft supplies they may need. Students should be using a ruler for measurements with the goal of making their models as accurate as possible.

Pack Up Time (10 min)
Allow students time to pack up their projects and worksheets.

- Consider where students will store their projects. Will they keep their prototypes built or disassemble them to make their final builds?
- How will they turn their worksheets in?

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1. **Have Swift Build tutorials on standby.**
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3. **Empower students to work as a team, independent from the teacher.**
   Students should push themselves out of their comfort zones with collaboration, problem solving, and giving and receiving feedback. This project is designed to be student-centered and teachers should be ready to give assistance only when asked.

SESSION 4 Outline

MATERIALS NEEDED: Swift Student Kit, craft supplies	**TIME:** 45-60 min
LEARNING GOAL: Students will finish constructing their final scale model builds, following the plan that they have laid out in their Swift Engineering Design Notebook.	**RESOURCES:** Swift Engineering Design Notebook

Session Introduction (5 min)
Remind students of the project goals and timeline for the day. Encourage students to share their tips and tricks for measuring, building, and troubleshooting!

Building Time (20-30 min)
Allow students time to complete construction of their models using the Swift Engineering Design Notebook.

- NOTE: You may choose to allow more or less build time for your students. Work within the constraints of your own classroom and timeframe!

Pack Up Time (5 min)
Allow students time to pack up their project materials and worksheets.

- Consider where students will store their projects.
- How will they turn their worksheets in?

Optional: Reflection
The teacher may choose to provide more build time as needed and supplement any reflection or additional assessment if they choose in addition to the reflection page in the Swift Engineering Design Notebook.

CLASSROOM TIPS

Quick Problem Solving

- **Swift Saw**
  - **Power Supply**: If the saw powers off unexpectedly, check that the power cable has not been disconnected
  - **Waste Drawer**: Always turn the Swift Saw off before emptying the waste drawer. Empty any cardboard waste into a trashcan after each use.
  - **Auto-Stop Feature**: If your Swift Saw jams at any time, your saw will automatically pause for safety purposes. If this happens:
    - Try turning the saw off and back on.
    - If still jammed, turn off for an additional 30 seconds before turning back on.
    - If your saw does not restart after the above, reference our online FAQ section to clear the jam: www.crexo.com/brands/swift/faqs/
- **Swift Tools**
  - Tutorial videos are available to demonstrate proper use of the tools included in the kit and can be used as a reference for any project.
- Visit www.classroom.crexo.com for more resources.

Critical Thinking Approach to Questions

If your students are stuck and asking for help, try open-ended responses that guide and empower students to solve problems and seek solutions themselves. These are two of our favorites:

- What problem are you trying to solve right now?
- What solutions have you tried so far?

CONTACTS

CreXo

- crexo.com/support

SHARE WITH US!

How did it go? Do you have photos or videos to share? We love hearing from you!

- Reach out to us on:
  - Twitter, Instagram, Facebook

COMMON MODIFICATIONS

SHORT ON TIME?

- Consider breaking up the full project into segments, or mini-projects. This option chunks the project into smaller parts, making it easier to complete in shorter timeframes.
- If your teaching schedule allows, collaborate with teachers across subject areas to create meaningful, interdisciplinary projects and dedicate more time to the project.
- Swift Projects make perfect after-school programs. If it works for you and your school community, consider starting a makerspace or inviting students to stay after school to work.

SHORT ON EQUIPMENT?

- If you need to work with groups larger than the intended 2-3 students, consider assigning roles to each group. For example: students can research, document the process, explain build design, etc.
- If necessary, make the Swift project a station as part of a rotation of multiple activities so smaller groups can work with the kits available. Once the allotted station time has ended, students deconstruct their projects so the next group can use the tools.

NEED MORE DIFFERENTIATION?

- If you have some students that need a challenge, consider adding extra criteria to their assignment such as use a specific mechanism included in the builder's guides from our build page.
- For students who need more support or scaffolding, resources like our Hardware Guide, Tool-torials, and Step-By-Step builds may be helpful.