

Engineering Unit Plan

Building a Rube Goldberg Machine

Overview: In this unit the students will first design a paper structure to support the weight of a book. Student groups will compete to see which team's structure will support more weight. This is the lead-in activity to the unit which reviews the 6 simple machines, teaches the engineering process, and encourages collaboration among students.

Goal: Students will refine collaboration and communication skills. Students will be able to identify the parts of the engineering process.

Unit Duration: 4-5 weeks

By the end of the unit, students will be able to:

- List the general steps of the engineering process
- Identify the 6 simple machines contained in a complex machine
- Use their knowledge of simple and complex machines to design and build a small Rube Goldberg machine
- Think critically to evaluate the importance of machines they encounter in life
- Use given formulas to calculate work and mechanical advantage

Materials

- Newspaper
- Duct tape
- Rulers
- Scissors
- 4-5 heavy books (dictionaries or books all of the same weight and size)
- 1 piece of cardboard per group (8.5" x 11")
- Note paper
- Pencils
- Rube Goldberg Worksheet
- Recyclable materials (toilet paper and paper towel tubes, tissue boxes, plastic bottles, egg cartons, cardboard boxes, etc.)
- Suggested materials: hot glue and gun, marbles, dominos, small paper cups (Dixie cups), string, paper clips, rubber bands, hot wheels cars, plastic spoons, books

Resources

- The Paper House Walk Through https://www.youtube.com/watch?v=5XIsDnz_xml
- Rocket Boom Who was Rube Goldberg? <https://www.youtube.com/watch?v=94eSJfv4uic>
- Ok Go-This Too Shall Pass-Rube Goldberg music video <https://www.youtube.com/watch?v=qybUFnY7Y8w>
- Pass the Salt Joesph's Longest Machine Ever <https://www.youtube.com/watch?v=nORRgU8sGdE>

Criteria for projects:

- Strong Paper Structure
- 8 sheets of newspaper
- One roll of duct tape (8 yards)
- Minimum of 8" in height
- Must support the weight of several books



Rube Goldberg Machine

- Design a device to solve simple everyday tasks that uses maximum effort to achieve minimal results
- Machine must have a minimum of 5 processes or steps
- Utilize at least 3 simple machines in the design
- Machine must work in a minimum of 1 of 3 trials

Timeline

2 months: Plan lessons, begin collecting recyclable materials

1 month: Secure room for classes

2 weeks: check links to videos

1 week: review lessons

Activity Overview

Week	Activity	Activity Outline	Guiding Questions
1	Designing strong paper structures	<ul style="list-style-type: none"> • Organize into teams and discuss pros and cons of various shapes to make newspaper into before having a volunteer press on the example of rectangle and triangle structures. • Explain the challenge- using 8 sheets of paper, 8 yards of duct tape, and one 8.5" x 11" piece of cardboard design a structure a min of 8" high that will support the weight of several books. • Encourage planning the design using notepaper and a pencil. Distribute materials and assist students to troubleshoot • Test designs and allow for revising if time • Show the paper house video at the end of session (rolling into cylinders disperses the stress evenly through the entire shape, engineers have to think about load distribution and incorporate triangles, arches, and domes into their structures, the Rockport, MA house was built in the 1920's by a mechanical engineer. The walls are made of layers of newspaper glued and varnished to make them stronger. The builder lived in the house for 6 years before it became a tourist attraction.) 	<p>What can make tubes stronger if they start to twist or tilt? If your structure collapses, what can you do to stabilize the base? If your tubes are wrinkled, loose, or dented, how will they perform in your structure? How do you think newspaper could be used effectively as the main material to build a house for a family?</p>
2	Testing of Strong Paper Structures and Intro to Rube Goldberg Machine	<ul style="list-style-type: none"> • Complete final testing of strong paper structures • Introduce Rube Goldberg and play the Rocket Boom Rube Goldberg video • Discuss how Rube Goldberg's drawings depicted complex contraptions, but were nothing more than a series of simple machines • Define the 6 simple machines and ask for examples of the machines found in everyday life (PowerPoint) • Discuss the 7 steps to engineering design and tie in to how it will be used in future lessons • Play pass the salt video to generate ideas for materials they can use to build their machines. 	<p>What is a Rube Goldberg? Do such machines actually exist? How does Rube Goldberg fit into engineering when he's known for his drawings?</p>

<p style="text-align: center;">3</p>	<p>Engineering a Rube Goldberg Machine</p>	<ul style="list-style-type: none"> • Review the 7 steps to engineering process • Have student groups begin to define the problem, gather their information, brainstorm ideas • Assist students as needed • Once they have selected the most promising idea, have them explain their design 	<p>What specific task do you want the machine to perform?</p> <p>What materials will you need?</p> <p>What tools will you need to create your design?</p>
<p style="text-align: center;">4</p>	<p>Designing and Building Your Rube Goldberg Machine</p>	<ul style="list-style-type: none"> • This time is for the students to design and build their structures • Assist as necessary • Complete this lesson in a place where students can build their designs and leave them undisturbed. 	<p>How can you redesign your machine to improve it?</p>
<p style="text-align: center;">5</p>	<p>Testing and Redesigning Your Rube Goldberg Machine</p>	<ul style="list-style-type: none"> • Students will test their machine • Redesign machine as necessary • Students present redesigned machine to other groups • Discuss how when Rube Goldberg presented his designs to others, they often said they would not work. Using what we now know along with formulas for mechanical advantage and force, perform calculations to see if Rube Goldberg's "self-operating napkin" machine will work (worksheet) 	<p>Can Rube Goldberg's machines actually work?</p> <p>If you could choose to make a new machine, what would you make?</p>