



RUBE GOLDBERG MACHINES

LESSON 3: Designing a Rube Goldberg Machine

LESSON OVERVIEW	GRADE LEVEL	BASE LESSON TIME
In this lesson, students will investigate how simple machines are put together to create a Rube Goldberg Machine. Students will examine how the components work together and look at what happens when sections of the system work and do not work. They will begin to understand how cause and effect relationships and patterns play out within the idea. Students will also explore their YIP RGM Inventor's Journal and understand the value of documentation in the invention design process. They will learn how to record their invention design process and the importance of keeping accurate details.	K-8	40-50 minutes

TEACHER/LEADER TIPS
<p>The second part of this lesson asks students to begin to design and build their own Rube Goldberg machine. It is recommended that students work in pairs or groups for this project, but you may choose for them to work independently as well. (Please note, groups of up to five (5) students may present a Rube Goldberg Machine project together at the Northern New England Invention Convention, if invited based on your school invention showcase or fair.) Allow time for students to make their groups and then time for the groups to brainstorm ideas for a machine that will perform a simple task in a complicated way.</p> <p>Students are encouraged to use the YIP RGM Inventor's Journal to record their invention journey, from ideating the unique way students will solve the annually assigned task, to the design plans, to building and then testing and re-designing the machine. YIP RGM Inventor's Journals may be ordered in the YIP Pack (see YIP website for order forms and details), or may be downloaded and printed from the YIP website: https://www.unh.edu/leitzel-center/young-inventors-program/teach/curricula. Teachers should distribute and introduce the YIP RGM Inventor's Journal in this lesson or ask students to record their activities in a logbook or other notebook. Be sure to let students know of any requirements or expectations for journals. Teachers may choose to let students take home their journals or not. If students work on their Rube Goldberg Machines at home, they may record their notes and activities on separate pages and insert them into the journal later. Younger students (K-2) may need help from adults when writing. Journals should reflect age-appropriate documentation. The Rube Goldberg Machine Design worksheet in this lesson, as well as the Changes to My Rube Goldberg Machine Design worksheet and Rube Goldberg Machine Testing Feedback Grid worksheet in Lesson 4 are also included in the YIP RGM Inventor's Journal. If students are using the journal, these worksheets will not need to be printed separately and students can complete them directly in the journal. Inventor journals or logbooks of some kind are required for participation in the Northern New England Invention Convention.</p>

Specifications for Rube Goldberg Machine projects are as follows:

***Teachers may choose to alter the requirements, but the following standards are required for competition in the Northern New England Invention Convention and National Rube Goldberg Contest**

	Apprentice Level: Grades K - 5	Division I: Grades 6 - 8	Division II: Grades 9 -12
Maximum Physical Size	6ft (W) x 6ft (L) x 6ft (H)	8ft (W) x 8ft (L) x 8ft (H)	10ft (W) x 10ft (L) x 10ft (H)
Minimum Number of Steps (Transfers of Energy)	10 Steps	15 Steps	20 Steps
Number of Different Simple Machines Incorporated	Four (4) Different Simple Machines (lever, incline plane, wheel & axle screw, wedge, and pulley)		
Group Size	Up to 5 students per group (Individual students are allowed)		
Single Run Time	Maximum Three (3) Minutes		
Guaranteed Number of Machine Runs	Two (2) Runs		
Hazardous Materials, Flames, Dangerous Objects	Not Permitted		
Incorporation of Live (or Previously Alive) Animals	Not Permitted - Including Taxidermied Animals		
Political References	Not Permitted		
Objects Flying Beyond Machine Boundaries	Allowed with PRIOR Safety Approval		
Rube Goldberg Machine Steps vs Chain Reaction Device Interactions	Standard domino topples & simple marble run style steps are DISCOURAGED - BE CREATIVE!!!		

****IMPORTANT****

ALL machines will be solving the same simple task. The 2024 Rube Goldberg Machine Contest task is to:

PUT TOOTHPASTE ONTO A TOOTHBRUSH

***Teachers may choose to alter the task or allow students to choose their own task, however doing so negates eligibility for competition in the Northern New England Invention Convention and National Rube Goldberg Machine Contest.**

Teachers are encouraged to review all design plans before allowing students to move on to build. This will help the support for each group, what materials they may need and to anticipate and guide them through any challenges they face as they begin to build in the next classes.

Note: There are no Google Slides to accompany this lesson. Video may be downloaded or is accessible online to share with students.

GETTING YOURSELF READY

Materials:	Your Preparation:	Agenda:
<ul style="list-style-type: none"> • <u>Video Link:</u> Audri's Rube Goldberg Machine Monster Trap, (4:07 minutes), https://www.youtube.com/watch?v=0uDD EEHdf1Y • Simple Machine Scavenger Hunt worksheet • YIP RGM Inventor's Journal • Rube Goldberg Machine Design Plan worksheet (included in YIP RGM Inventor's Journal) 	<ul style="list-style-type: none"> • Set up and test video • Print Simple Machine Scavenger Hunt worksheet • Gather YIP RGM Inventor's Journals to distribute 	<p>Warm-Up: Move it! Simple Machine Scavenger Hunt (10 minutes)</p> <p>Activity: How Does It Work? (15 minutes)</p> <p>Activity: Designing Your Rube Goldberg Machine (25 minutes)</p> <p>Closure (5 minutes)</p>

GETTING YOUR STUDENTS READY

Objective:

Students will be able to demonstrate their understanding of the six types of simple machines. Students will show how simple machines can be combined to produce multiple reactions in the context of accomplishing a larger task. Students will brainstorm ideas for their own Rube Goldberg Machine and begin to design a plan for their machines. Students will understand the importance of documenting ideas and all activities related to their design process. Students will understand how to use the YIP RGM Inventor's Journal.

CONTENT

<p>Warm Up: Simple Machine Scavenger Hunt (10 minutes)</p>	<p>Ask students to complete the Simple Machine Scavenger Hunt worksheet. You may choose to have students stay in the classroom or you may decide to go outside to the playground or to another space in the building.</p>
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<p>Activity: How Does it Work? (15 minutes)</p>	<p>Let's watch this video of a young inventor's example of a Rube Goldberg Machine.</p> <p>Share Video: Play video of Audri's Rube Goldberg Monster Trap from the beginning to 1:38, then stop for a discussion.</p> <p>Link: https://www.youtube.com/watch?v=0uDDEEHdf1Y, (included in Google Slides: Lesson 3).</p> <p>Ask students to turn to a partner and discuss how Audri explained how the machine was going to work. What simple machines did they see? What forces might be used? What are some of the cause and effect relationships in the machine?</p> <p>Now, we're going to watch what happens next.</p> <p>Share Video: Play video from 1:38- 2:23. You will notice several failures in the operation of the machine. Go back and play video from 2:18 - 2:23 again. This is when the machine fails for the second time. Have the students observe carefully. (Replay video section again if needed).</p> <p>Ask students what questions they have after watching this section. You may put students into table groups or small groups. Why did the machine stall? Why didn't the ball push the tube to make the glass fall? How could he have fixed this?</p> <p>Note to Teacher: <i>You may choose to go into a deeper discussion about forces and the force needed to make the glass fall, or you may just look at the relationships between the simple machines and how they are connected to operate successfully.</i></p> <p>Share Video: Play video from 2:37-3:15, where the machine is successful.</p> <p>Ask students to discuss their observations in small groups again. How might they compare what they saw when the Rube Goldberg Machine worked versus when it did not. Then bring the class together to discuss why looking at the entire system might help them understand why the machine worked in some parts but not as a whole.</p>
<p>Activity: Creating a Design Plan (25 minutes)</p>	<p>Tell students that soon they are going to make their own Rube Goldberg Machines. But before they can build anything, they must have three essential components:</p> <ol style="list-style-type: none"> 1) A unique idea on how to solve the assigned Final Task* 2) Design Plan 3) An invention journal or logbook to document their design process <p>*2024 Final Task: PUT TOOTHPASTE ONTO A TOOTHBRUSH.</p> <p>Distribute the YIP RGM Inventor's Journal to students or ask them to begin to record all activities related to their projects from this point forward in a logbook of some sort. See</p>

Teacher/Leader Tips for more details on how to prepare students to use the journal. Remind students to write in their YIP RGM Inventor's Journal or alternative logbook whenever they are working on or even thinking about their inventions. They can also write on notebook paper and staple it to the journal later. Guide students through the YIP RGM Inventor's Journal.

Explain that as inventors, it is essential that they document and record all steps of their invention design process. Even Rube Goldberg who drew his contraptions had to come up with ideas and then draw them out before he put them all together into the final version of the cartoon. This journal will help you keep all of your ideas and notes about your designs, your tests and their results, and the changes you make along the way as you create your Rube Goldberg Machine. Inventors record everything they do to serve as a record to prove that their ideas are original and belong to them. Tell students that this is their journal. And, even if working in a group, each individual must keep their own notes and journal about their project. The invention journal will be used for the rest of the time they work on their Rube Goldberg Machine project. If students do any thinking or working on their project outside of class, they can still take notes and add them to the journal later.

Note to Teacher: *If allowing students to work together, establish the groups and ground rules before brainstorming ideas for a machine.*

Tell students that they will now have time to brainstorm how they will solve the ordinary task to: **PUT TOOTHPASTE ONTO A TOOTHBRUSH**. Lead the students in a small brainstorming session to create ideas that solve that task in the most extraordinary means. Creativity is key!

Ask students if it is alright to brush your teeth with peanut butter? What if your toothbrush is a toilet plunger with a mop head for bristles? Explain that those are perfectly creative ideas students can utilize in their machine designs. Students are allowed to physically pick up the toothbrush and brush your own teeth after the machine completes the task. The emphasis on building a Rube Goldberg Machine is their creativity and humor.

Explain to the students the requirements for their Rube Goldberg Machines (noting your specific Division rules based on grade level)

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Minimum Number of Steps (Transfers of Energy)	10 Steps	15 Steps	20 Steps
Number of Different Simple Machines Incorporated	Four (4) Different Simple Machines (ever, incline plane, wheel & axle screw, wedge, and pulley)		
Group Size	Up to 5 students per group (Individual students are allowed)		

Note to Teacher: You may choose to put a time limit to the brainstorming session to ensure students have time to begin designing their Rube Goldberg Machines. Use suggested ideas in the Teacher/Leader Tips section if needed. You may also wish to hear and approve ideas from each group before allowing them to move on to the design phase.

Once students have their unique way of solving the assigned task, ask them to complete the Rube Goldberg Machine Design Plan worksheet in the YIP RGM Inventor’s Journal as they design their machine. Students may wish to draw out a draft(s) on scrap paper before using the worksheet. Changes can always be made to the design, so this worksheet does not have to be a final one. All drafts should be saved and inserted into the journal, even if the idea is totally scrapped later- it is critical to show the full evolution of the idea and design. Students must have a design plan, with labels and explanations of the simple machines used, how they work together, and the materials they plan to use, before they can begin to build the machine.

As students design, remind the class about some of their observations from Aubri’s Rube Goldberg Machine Monster Trap video. What simple machines do they want to use? How will they fit them together? What forces do they need to create the correct cause and effect relationships? How are they going to start the machine? It is important to mention that it might be easier to work backwards, starting with how the machine will complete the task and then building from there to the start point. There is no “right” way to design.

Note to Teacher: You are encouraged to review all design plans before allowing students to move on to build. This will help you understand the plans for each group, what materials they may need and to help you anticipate and guide them through any challenges they face as they begin to build in the next classes.

CLOSURE
(Check for Understanding)

Closure: (5 minutes)

Ask students/groups to show you and turn in their Design Plans/journals as their ticket to leave the class.