RUBE GOLDBERG MACHINES

LESSON 4: My Rube Goldberg Machine

LESSON OVERVIEW	GRADE LEVEL	BASE LESSON TIME
In this lesson, students will be given time to build their own Rube Goldberg Machine. Using knowledge gained from previous lessons, students will go through the engineering design process. They will design, build, and test, fix and then re-test their machines	K-8	120+ minutes (Lesson should be taught across multiple days)

TEACHER/LEADER TIPS

This lesson focuses on the building of the student's own original Rube Goldberg Machine. It may be done in class or outside of class depending on your approach to the Young Inventors' program and the rules of your School Invention Fair. If building is done in class, it is strongly recommended that teachers allow a minimum of two class periods for students to build, test, and fix their machines. There should be at least several chances to test their machine, so that students can determine what does and does not work and then practice and understand how to identify challenges, evaluate them, and respond with appropriate fixes. If building is completed at home or outside of class, teachers may skip or shorten this lesson.

Regarding supplies and materials used, duct tape will be prevalent in the students' builds. **One of the best ways to attach items together for Rube Goldberg Machines is using a Hot Glue Gun.** Hot glue can be applied to desktops or other surfaces without long term damage, while offering stronger attachment capability than regular glue. For example - popsicle sticks hot glued to a light switch creates a longer lever, making it easier to turn on or off the lights. A hot glue station is recommended to be set up where teachers may assist the students with any gluing needs depending on the grade level.

If preparing students for local school Invention Fairs, Northern New England Invention Convention, and/or the National Rube Goldberg Machine Contest, it is strongly encouraged that teachers explain the rules and requirements for the Rube Goldberg Machine category of competition so that student projects are eligible in their respective grade divisions.

Teachers may choose to show the accompanying Google Slides: YIP RGM Lesson 4 with the class .

TEACHER RESOURCES

Suggested materials to be used for building the students' machines are common everyday objects. Whether it be items around the classroom, from home, or purchased - the common items seen everyday should be the focus of the machine. Teachers looking to source materials may look in "Dollar Stores" for items (such as: popsicle sticks, kitchen utensils, styrofoam crockery, toys, string, etc). Food packaging, unopened or destined for recycling, are excellent components in a RGM (soup cans, food boxes, tuna

cans, paper towel rolls - full or empty, etc). A typical classroom budget may only require ~$50 in supplies.

Generally, the best objects are the ones students bring in themselves. Encourage students to fill 1-2 shopping bags with items from home they wish to try and incorporate into their design, especially if students will be transporting their machines to the Northern New England Invention Convention or other events.

GETTING YOURSELF READY		
Materials:	**Your Preparation:**	**Agenda:**
• Google Slides: YIP RGM Lesson 4: My Rube Goldberg Machine • Rube Goldberg Cartoon **"A Perfect Way to Put Toothpaste onto a Toothbrush"** (included in Google Slides: Lesson 4) • **Materials for Rube Goldberg machine building:** recycled products, materials students bring from home, scissors, hot glue, string, tape, paper, everyday objects, etc. • **Tools for building:** Hot glue gun + hot glue sticks, scissors • Changes to My Rube Goldberg Machine worksheet (included in YIP RGM Inventor's Journal) • Rube Goldberg Machine Testing Feedback Grid worksheet (included in YIP RGM Inventor's Journal) • YIP RGM Inventor's Journals • Pens/pencils	• Set up Google Slides: Lesson 4 • Set up work space and materials • Set up a hot glue station	**Warm-Up:** Review Simple Machines (5 minutes) **Activity:** Building My Rube Goldberg Machine (90+ minutes, divided across multiple class sessions) **Activity:** Testing, Fixing, and Re-designing the Rube Goldberg Machine (this takes place throughout the lesson) **Closure** (5 minutes)

GETTING YOUR STUDENTS READY	
Objective: Students will be able to create a complex machine to complete the assigned simple task using a series of simple machines in a chain-reaction-effect to create a Rube Goldberg Machine. They will then evaluate how to modify their original design and materials based on testing. Students will continue to modify their design and test to develop a most successful invention. Finally, students will be able to explain the importance of testing, fixing, and re-designing in the invention process.	
CONTENT	
Warm Up: Review Simple	Show students a picture of the Rube Goldberg Cartoon "**A Perfect Way to Put Toothpaste on a Toothbrush"** (included in Google Slides: Lesson 4). Ask them to

<table>
<tr><td>Machines (5 minutes)</td><td>identify the simple machines. Highlight the relevance to the assigned task. Highlight the cartoonish humor exhibited in the cartoon to solve the task.</td></tr>
<tr><td>Activity:
Building My Rube Goldberg Machine

(90+ minutes, across multiple class sessions)</td><td>Tell students that they will now have time to begin building their Rube Goldberg Machine based on the ideas and their design they developed in Lesson 3.

Strongly emphasize to students that they MUST solve the 2024 assigned simple task: PUT TOOTHPASTE ONTO A TOOTHBRUSH (unless choosing an alternate task). Reminder: machines that solve alternate final tasks are disqualified from participating in Regional and National events.

Remind students of the requirements for their Rube Goldberg Machines:

<table>
<tr><th></th><th>Apprentice Level: Grades K - 5</th><th>Division I: Grades 6 - 8</th><th>Division II: Grades 9 -12</th></tr>
<tr><td>Maximum Physical Size</td><td>6ft (W) x 6ft (L) x 6ft (H)</td><td>8ft (W) x 8ft (L) x 8ft (H)</td><td>10ft (W) x 10ft (L) x 10ft (H)</td></tr>
<tr><td>Minimum Number of Steps (Transfers of Energy)</td><td>10 Steps</td><td>15 Steps</td><td>20 Steps</td></tr>
<tr><td>Number of Different Simple Machines Incorporated</td><td colspan="3">Four (4) Different Simple Machines
(ever, incline plane, wheel & axle screw, wedge, and pulley)</td></tr>
<tr><td>Group Size</td><td colspan="3">Up to 5 students per group
(Individual students are allowed)</td></tr>
</table>

Tell students where they can find materials and establish guidelines for safety and safety procedures as appropriate. Remind students to use their resource guide to view more RGMs at home for inspiration.

Allow for independent work time.

Note to Teacher: At certain points during the building process, ask students to test their machines. What is working well? What changes and modifications are required to make the machine successfully complete the steps and the entire task? Have students work together for feedback and use the Rube Goldberg Machine Testing Feedback Grid (several copies are included in the YIP RGM Inventor Journal) to record their observations. Then, ask them to draw their redesigned machines with the necessary changes on the Changes to My Rube Goldberg Machine worksheet (included in the YIP RGM Inventor Journal). Students may add additional pages to their journals if they need more space to draw and redraw their designs. Encourage students to continue to test, fix, and re-design throughout the building process until they are satisfied with the final result.

Use a Think-Pair-Share or group discussion to ask students:</td></tr>
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	Are dominoes and tiny marbles good or bad items to use in a Rube Goldberg Machine? Why? ***Note to Teacher:*** *Encourage students to* ***AVOID*** *marble run and domino topple style types steps. Allow students to try these step types, drawing notice to the frequency of failure each step type presents. Offer replacement of common dominoes with suitable everyday objects (such as textbooks) and larger rolling balls (such as basketballs) instead of marbles. Highlight the increased machine reliability with appropriate replacements.* *Highlight to students that no matter how long their domino run is (regardless of the style of domino) that a series of dominoes* ***ONLY*** *counts as one single step. Marble run tracks are the same - no matter how many turns or pieces used, the entire marble / ball run counts as a single step.* *Highlight to students that a step is defined as: "A transfer of energy from one object to another different object." Dominoes count as the same object and therefore only are considered one total step. Marbles / balls rolling are the same object traveling throughout the marble run and are counted as only one transfer of energy (step).* *Please see "Teacher/Leader Tips" for recommendations on using duct tape and hot glue guns to assist students in their builds.* When finished testing, students should run their machine several times to ensure that it works consistently. Again, making changes as needed. All design notes, as well as drawings and model descriptions may also be recorded in the YIP RGM Inventor's Journal.

CLOSURE
(Check for Understanding)

Closure for Work Session 1 (and any others that follow):
Have students reflect on what worked and what did not work during their build. Ask them to list 2 modifications they plan to implement in their next build session based on their progress today. Plans may be recorded in their YIP RGM Inventor's Journals.

Closure for Final Work Session:
Ask students to list their biggest challenge and their biggest success during their build. Responses may be recorded in their YIP RGM Inventor's Journals.