

STEM Engineering Challenge Workbook

MIDDLE SCHOOL

20 STEM Challenges + STEM Challenge Journal



- ✓ Detailed Challenge Guide
- ✓ Construction Strategy
- ✓ Reflective Questions
- ✓ Extension Research Questions

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Rube Goldberg Machine Engineering Challenge

Objective:
Create a Rube Goldberg machine that uses at least 5 different steps to accomplish the task of popping a balloon.

Educational Goals
This challenge aligns with Next Generation Science Standards (NGSS) and aims to:

- Foster an understanding of simple machines and mechanical advantage.
- Encourage problem-solving and critical thinking.
- Promote creativity in design and execution.
- Develop teamwork and project management skills.
- Apply concepts of energy transfer, motion, and forces.

Materials

- A variety of household or classroom items (e.g., dominoes, tubes, marbles, string, pulleys, balloons, tape, popsicle sticks).
- A balloon (the final target of your machine).
- Timer or stopwatch.
- Camera or smartphone to record the final machine in action.
- Additional items students bring in prior to starting.

Guidelines and Rules

1. Machine Requirements:
 - Your machine must complete the task of popping a balloon.
 - It must have a minimum of 5 distinct steps.
 - Each step must initiate the next step in the sequence (no human intervention allowed after the start).
2. Size Limit: The machine must fit within a 2-meter by 2-meter area.
3. Safety: All designs must be safe for both participants and spectators. No sharp objects, or anything that could be considered dangerous is strictly prohibited.

Judging Criteria

Your machine will be assessed on the following:

- Complexity: Number of steps and transitions between them.
- Creativity: Originality and resourcefulness of the design.
- Functionality: Successful completion of the task.
- Teamwork: Cooperation and coordination within your team.

Steps to Success

1. Brainstorm (15 - 20 min): Think about potential steps and how they connect.
2. Design (25 - 35 min): Plan your machine on paper, considering the order and how you will use your materials.
3. Build (70 - 120 min): Start constructing your machine, testing each step as you go.
4. Test and Iterate: Trial and error is part of the process. Keep tweaking your design until it works consistently.
5. Present: Present your successful Rube Goldberg machine.

Rube Goldberg Machine Extension Questions

1. Who was Rube Goldberg and how have his cartoons and machine concepts influenced modern entertainment, art, or engineering?
2. Are there any real-world applications of Rube Goldberg-like machines that serve practical purposes in industry or technology? Provide examples and explain their functions.
3. How do the principles of energy conservation and transfer play a role in the operation of a successful Rube Goldberg machine? Can you think of an example where a misunderstanding of these principles might cause a machine to fail?

Rube Goldberg Machine Reflection Questions

After the challenge, answer the following questions:

1. What were the most successful components of your Rube Goldberg machine and why do you think they worked so well?
2. Describe a problem you encountered during the construction of your machine. How did you solve it, and what did you learn from that experience?
3. If you had more time, materials, or could start over, what would you do differently in your design? How could you increase the complexity or efficiency of your machine?

Design Your Rube Goldberg Machine

Before you start building your **Rube Goldberg machine**, it's time to put on your engineer's hat and draw your design. This drawing will be your blueprint – the plan that guides your construction.

Here's Your Mission:

1. Imagine It: How will you use your materials to make it sturdy and strong?
2. Draw It: Sketch your **Rube Goldberg Machine** design.

Be Detailed: The more you show in your drawing, the easier it will be when you start building. Once you're happy with your blueprint, share it with a classmate or teacher to get their thoughts. Then, gather your materials, and get ready to build!