SCIENTIFIC AMERICAN FRONTIERS

TEACHING GUIDE

www.pbs.org/saf/1208

Games Machines Play

Activity 1: Grades 5-8

Building a Better Mousetrap Car

In "Teetering to Victory" you watched students patiently test and tweak their designs until they had constructed the optimal machine to do the task at hand. In this activity, you too will get to build and perfect your own creation, and then enter it in a race!

You are challenged to create a "mousetrap car" that can be entered into a classroom contest. The spring of a mousetrap can store a considerable amount of potential energy when it is pulled back and its tension is increased. When released, this energy can be transformed into the kinetic energy of movement, making the mousetrap the perfect "motor" for a homemade car. As the trap closes, the metal bar pulls a string that has been wound around the axle of the mousetrap car. This causes the axle and attached wheels to spin, propelling the car forward. While many aspects of the car's design can change, this will be the basic method of movement. Using your ingenuity, you will create a mousetrap car that will travel a fixed distance in the shortest amount of time. On your mark, get set, build!

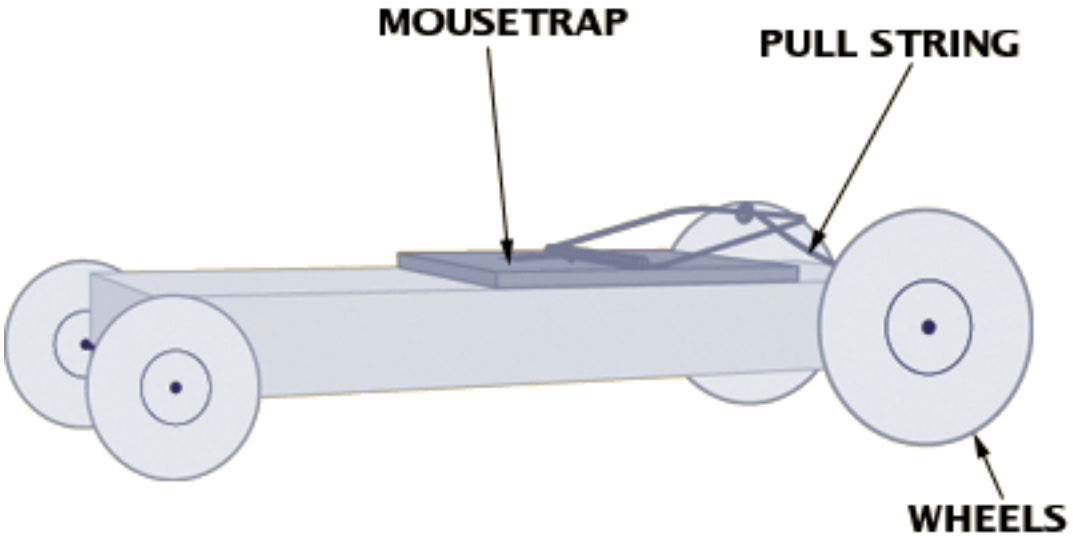
This activity page will offer:

- A mousetrap car construction challenge
- An arena for building and testing design ideas
- An opportunity to critique the mousetrap car's performance, redesign it, and retest it

Educator Note:
Use the following sites to obtain print outs of one or more designs to be shared among the students. These designs should be used to discuss the general components and universal construction techniques needed to assemble a basic mousetrap car.

http://library.thinkquest.org/50109/projects/mcars.html
Includes a QT movie of a mousetrap car in action.

http://216.166.134.3/mouset/fall98/
An online photo album of winning mousetrap car designs.



POSSIBLE MOUSETRAP CAR DESIGN

Contest Rules :

1. Design a vehicle powered by the release of a mousetrap spring.
2. The vehicle must cover a flat distance of 5-meters in the shortest amount of time.
3. No additional power source can be applied to the vehicle.
4. Teams of two students should work on each design.
5. You cannot use more than $5.00 worth of material in the construction of the car.
6. All teams must wear protective eye gear when assembling and launching the vehicle.

MATERIALS

- Mousetrap (about 2 inches by 4 inches)
- Maximum $5.00 value of construction materials
- Protective eye gear
- Sturdy candy box
- Tools for constructing car
- Meter stick (for measuring race track)
- Stopwatch to time the cars
- Video camcorder (optional)

Educator Warning:
It is essential that students wear protective eye gear when building and launching the mousetrap cars. They should also be mindful of the "snap" of the mousetrap bar and use caution when opening, setting, and releasing the tension bar. **Do not use rat traps. Rat traps can easily break a finger when snapped shut.**

PROCEDURE

Part 1- Candy Box Design

1. Work with a partner. Examine the images of mousetrap cars that have been printed out by your instructor.
2. With the entire class, discuss the basic elements of designing a mousetrap car. Make a list. What design elements should be common to all cars? What is the sequence for assembly? Is there only one way to build a mousetrap car? Which parts of the design can be customized? Share your ideas.
3. Break up into teams. Your first challenge is to build a non-powered vehicle. To get you started in the basic design, you'll use a flat, rectangular candy box. Since these boxes are constructed with heavy stock material, they will offer a stable platform on which to attach the trap and assemble the vehicle.
4. Discuss the placement and type of wheels that you will use. Will your car be supported by four wheels or will it have a tricycle design? Do large wheels work better than small ones? Does wheel width affect performance?
5. Use what you've learned to create a blueprint for your prototype mousetrap car. Don't be extravagant. Keep the design simple. Remember, this first test car is not powered.
6. Discuss your blueprints with your instructor. With you teacher's approval assemble this non-powered vehicle.
7. After testing your vehicle by pushing it along the ground, improve its performance. What changes can result in a more stable and longer traveling vehicle? How can those changes be implemented? With your instructor's approval, update your design.

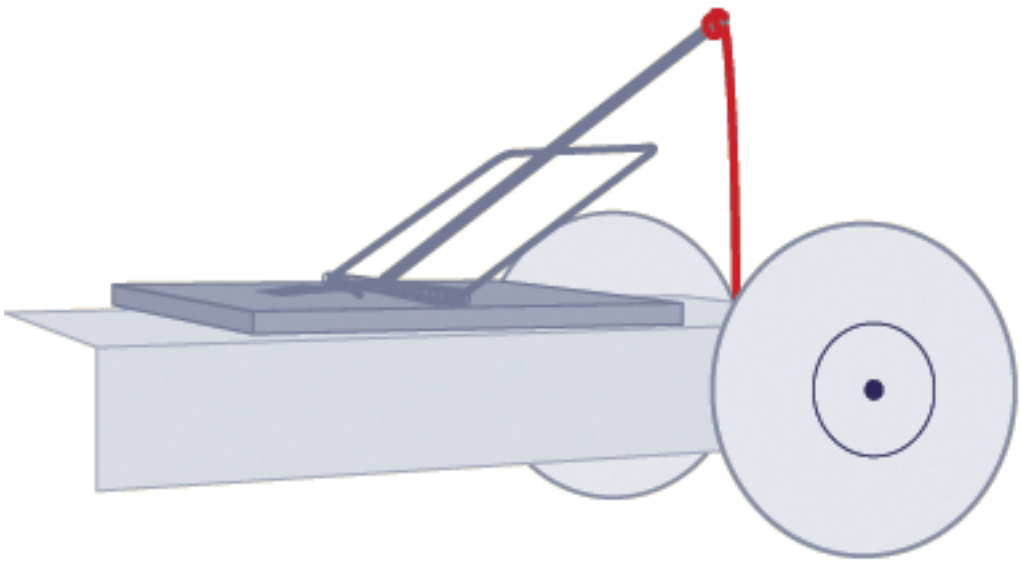
Part 2- The Power Plant

As you learned, the energy needed to propel the mousetrap car comes from the spring of the trap. When the spring is pulled back, it stores energy. With a controlled release of this tension, the energy can be transferred into the spin of the car's axle.

1. Review the design printouts so that you understand the nature and action of the mousetrap.
2. Compose a new blueprint that shows the placement of the mousetrap

on your candy box chassis. Include any design changes that are necessary to accommodate a pull string. Remember, one end of the pull string is tied to the spring bar of the trap. The free end is wrapped around the power axle. As the mousetrap spring shuts close, the movement of the controlled release is transferred to the spin of the axle.

3. Share this updated blueprint with your instructor. With his or her approval, assemble this powered version of the mousetrap car. Make sure that you adhere to the construction techniques and design you identified in your blueprints.
4. Test the design. Does the car travel the fixed distance of the track (5 meters)? How long does the car take to travel this distance? How can it move quicker? Where is energy lost? How can the action of the mousetrap more efficiently be converted into movement of the car? Think about these parameters. Redesign your car to test these factors and improve its performance.
5. Think about it. Can you gain an advantage with a longer "pull bar"? Will leverage increase the effectiveness of the mousetrap action? With you instructor's approval, design an experiment that would test if an extended bar would produce a more efficient car, then build your design.



EXTENSION OF MOUSETRAP BAR

Classroom Contest

Participate in a classroom contest. Have the instructor identify a flat race area that is five meters in length. See how long it takes each car to complete the distance. Keep tweaking the design. Which team improves the most? Which team has the best design? What design elements are most critical to the design of a mousetrap car?

EXTENSIONS

Videotape Your Race

If possible, use a video camera to capture a record of your winning design. Can you create a QuickTime movie of this event? If so, send it to FRONTIERS to enter a drawing for prizes! Please visit http://www.pbs.org/saf/1208/teaching/contest.htm for more information. Selected movies will be posted on our Web site at www.pbs.org/saf.

WEB CONNECTION

Mousetrap Car Guide

http://www.mike.lanham.com/mousetrap/student-guide/index.html
A wonderful student guide for assembling a mousetrap car.

Design Examples

http://216.166.134.3/mouset/fall98/
An online photo album of winning mousetrap car designs.

Mousetrap Car Movement

http://library.thinkquest.org/50109/projects/mcars.html
Shows a QT movie of a mousetrap car in action.

The activities in this guide were contributed by Michael DiSpezio, a Massachusetts-based science writer and author of "Critical Thinking Puzzles" and "Awesome Experiments in Light & Sound" (Sterling Publishing Co., NY).

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CURRICULUM LINKS

General Science & Technology:

Design, Test, Build

Physical Science:

Energy Transfer, Potential and Kinetic Energy, Spring Potential, Rate, Friction (Rolling/Sliding), Simple Machines (Wheel & Axle)

NATIONAL SCIENCE STANDARDS (Grades 5-8)

Science as Inquiry- Content Standard A

Students will learn to formulate questions, design an investigation, execute this investigation, interpret the data and use the evidence to generate explanations.

Students will practice communicating scientific procedures and explanations. They will gain competency in following instructions, describing observations, communicating experimental methods, and summarizing their results and the results of other groups.

Physical Science - Content Standard B

The student will observe the motion of an object and learn how this motion can be described by its position, direction of motion, and speed.

Students will examine and reduce forces that cause objects to deviate from a straight line and a constant speed.

Students will understand that unbalanced forces cause change in speed.

Student will further their understanding of energy as a property of many substances associated with mechanical motion, heat and sound. The transfer of energy from potential to kinetic is also investigated.

Science and Technology- Content Standard E

Students will communicate design ideas with blueprints and models.

Students will find that perfect designs do not exist because constraints such as friction and cost will always exist.

Students will observe and evaluate their design after each planned revision.