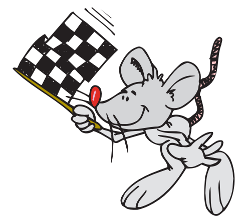
Mousetrap Cars

STEM Activity

Introduction

Design and build a car that runs on energy provided by a mousetrap! Use a prototype mousetrap car to test different variables and then modify the design of the car to optimize its performance. It's off to the races!

Concepts



- Energy transfer
- Problem solving
- Dependent and independent variables
- Engineering design

Background

A mousetrap car works on the principle of a lever. One end of the lever is connected to a spring. When a force is used to pull up the other end of the lever up, the spring tightens, storing energy. When the lever is released, the stored energy in the spring is transferred back to the lever, and the end snaps back. In order to use the energy stored in the spring to propel a car, the mousetrap must be modified.

Figure 1 illustrates a basic mousetrap car. The mousetrap is mounted on a chassis with front and rear wheels. The bar attached to the spring on the trap is extended or replaced by a longer lever arm. A string is attached to the lever arm and wrapped around the rear axle. As the rear axle is rotated backwards to take up the string, the lever arm is pulled back, winding the spring more tightly. The car is placed on the floor and released. As the lever arm snaps back, the potential energy from the tightened spring is transferred to kinetic energy, pulling the string, which in turn rotates the rear axle and the car is propelled forward.

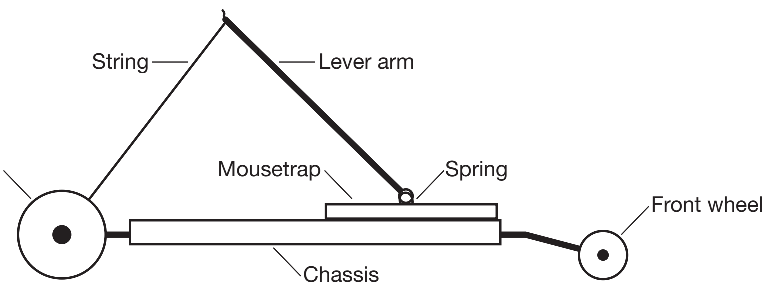


Figure 1.

Many factors, or *variables*, may affect the performance of the car. The final design of the car will depend on the desired outcome, or *design criteria*, and any limitations to the solution, or *design constraints*. Is the car's function to be speed, distance, towing power, or some other purpose? Is there a limit to the type or cost of materials? A decision on the final design cannot be made until the design criteria and constraints are understood. Since more than one solution may be possible, brainstorming to generate several ideas is an essential part of the design process. Next, experiments with a simple model are carefully planned and carried out to test variables that may affect the outcome. Only one factor should be varied during an experiment with all other factors remaining the same. The *independent variable* is the variable that is intentionally changed or manipulated for the test; whereas, the *dependent variable* is the variable being measured or observed, sometimes called the outcome or the responding variable. Any problems encountered during testing should be noted, a possible explanation made, and a remedy proposed. Then the model can be altered and a side-by-side comparison made with the data and observations from before and after the modification.

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Materials (for each mousetrap car)

Bushings, plastic, 2	Ruler, metric
Front wheel, 3-cm diameter	Screw
Meter stick or tape measure	Spring scale, 5-N
Mousetrap car chassis	Stopwatch
Mousetrap with lever arm	String, 52 cm
Rear wheels, large, 2	Tape, masking
Rear wheels, small, 2	Washers, metal, 2
Rubber stoppers, 1-hole, 2	Wing nut

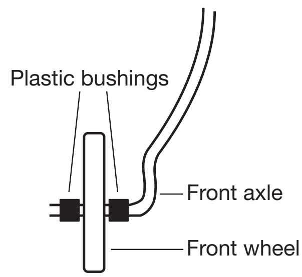
Safety Precautions

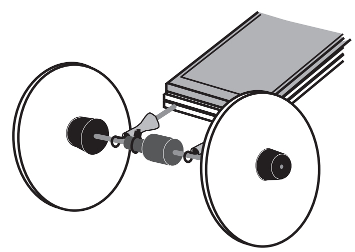
The mousetrap can snap with considerable force. Use caution when the spring is under tension. Wear safety glasses. Please follow all laboratory safety guidelines.

Procedure

Part I. Mousetrap Car Chassis Assembly

1. See Figure 2 for attachment of front wheel.
2. See Figure 3 for attachment of rubber stoppers and wheels to rear axle.





Part II. Testing Variables

A. Mousetrap Car Wheels

To test the effect of wheel diameter on the performance of the car, time how long it takes for the car to travel 4 meters with each set of rear wheels. Mark a starting line and 4-m finish line on the floor with tape. Use the longest lever arm and the small diameter hub for each trial.

1. Place the mousetrap on top of the chassis and align the hole in the mousetrap with the hole in the chassis that is closest to the front axle. Fasten with washers, screw amd wing nut. *Note:* The lever arm will extend over the front wheel.

2. Tie a loop knot at one end of the string as close to the end as possible (see Figure 4).

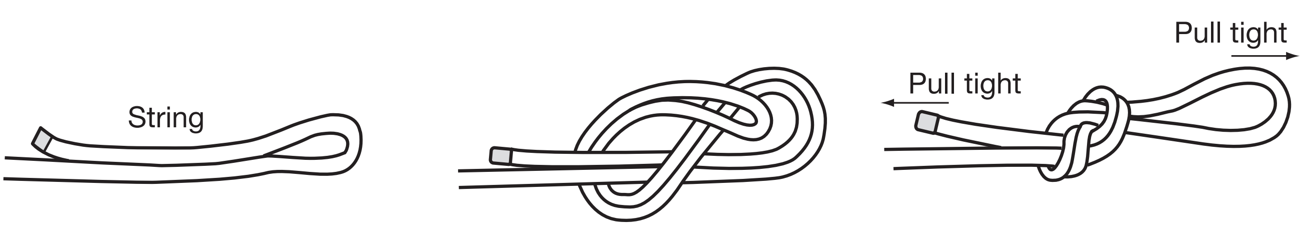
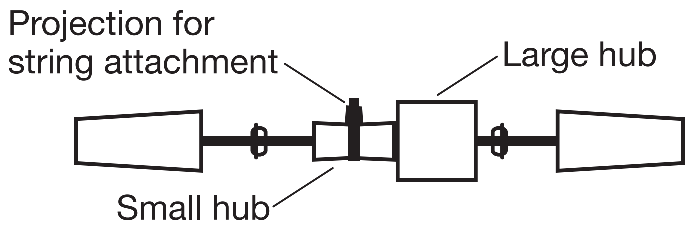


Figure 4.

3. Tie the free end of the string to eyelet #1, so that the string measures 40 cm between the eyelet and the projection on the small hub of the rear axle.

4. Attach the loop on the end of the string to the projection on the small hub. *Note:* Do NOT pass the string through the other two eyelets (see Figure 5).



B. Mousetrap Car Hub

To test the effect of hub diameter on the performance of the car, time how long it takes for the car to travel 4 meters with the string wrapped around each diameter hub. Mark a starting line and 4-m finish line on the floor with tape. Use the longest lever arm and the large diameter wheels for each trial. *Note:* Attach the loop of the string to the projection on the small diameter hub, and then guide the string over to the large hub as the rear axle is rotated.

C. Mousetrap Car Lever

1. Using the data you have gathered so far, predict what would happen to the performance of the car if you used the large diameter wheels and the large hub, but changed the point of force to the middle eyelet on the lever arm.
2. Test your prediction.

   a. Remove the mousetrap assembly from the chassis and reposition the mousetrap so the hole lines up with the middle hole in the chassis.

   b. Keep the string tied to eyelet #1 and wind it around the lever arm between eyelets #1 and #2 until the loop end of the string just reaches the projection on the small hub. Thread the string through eyelet #2. *Note:* The string should measure 30 cm from the hub to eyelet #2 (see Figure 6).

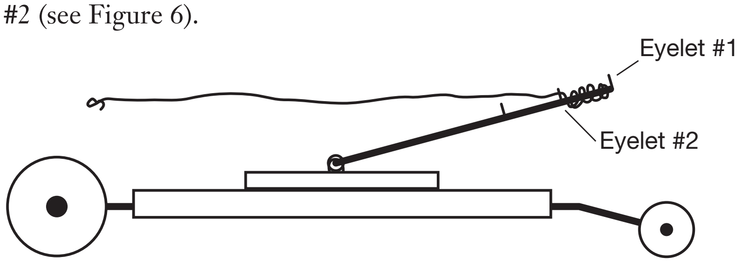


Figure 6.

   c. Time the car over a 4-meter distance for three trials. Design a data table on a separate sheet of paper to record the time for each trial and any observations made.

   d. Repeat steps a–c above with the point of force closest to the rear axle. Attach the mousetrap to the chassis at the hole closest to the rear axle. Wind the string around the lever arm between eyelets #2 and #3 until the string measures 20 cm from the hub to eyelet #3. Thread the string through eyelet #3.

Part III. Design Challenge

- The specific design challenge may be changed from year to year or class to class. Options may include the following:
  - —Cross the finish line of a 6–meter race last
  - —Tow a certain weight a set distance
  - —Run uphill at a specific angle
  - —Fastest car over either short or long distance
  - —Travel through grass or other uneven surface
  - —Entire class challenge where cars travel one behind the other, keeping an even pace with lead car designed by instructor.

- Be sure to give students any design constraints you deem appropriate. May they modify the wheels in any way? Increase traction or size? Larger wheels may be made by taping large plastic lids to the wheels, cutting a hole in the center of each. May they add weight to the car? How much time will be given to design the car? Will they be able to run a practice test once the design is final?

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Systems, order, and organization
Evidence, models, and explanation
Constancy, change, and measurement
Form and function
Content Standards: Grades 5–8
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, motions and forces, transfer of energy
Content Standard E: Science and Technology
Content Standards: Grades 9–12
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, motions and forces, conservation of energy and increase in disorder, interactions of energy and matter
Content Standard E: Science and Technology

Acknowledgment

Special thanks to Brad Christensen, Center for Mathematics, Science, and Technology, Normal, IL for providing the idea and the instructions for this activity to Flinn Scientific.

Materials for *Mousetrap Cars—STEM Activity* are available from Flinn Scientific, Inc.

Catalog No.	Description
AP7667	**Mousetrap Cars—Super Value Guided-Inquiry Kit**
AP4837	**Spring Scale, 500 g/5N, Pull-Type**

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.