

## Teacher Information

# Newton Car

### Objective:

To investigate how increasing the mass of an object thrown from a Newton Car affects the car's acceleration over a rolling track (Newton's Second Law of Motion).

### Description:

In this activity, students test a slingshot-like device that throws a mass causing the car to move in the opposite direction.

### Science Standards:

Science as Inquiry  
Physical Science - Properties of objects and materials  
Unifying Concepts and Processes - Evidence, models, and explanation  
Unifying Concepts and Processes - Change, constancy, and measurement

### Science Process Skills:

Observing  
Communicating  
Measuring  
Collecting Data  
Inferring  
Predicting  
Interpreting Data  
Making Graphs  
Controlling Variables  
Defining Operationally  
Investigating

### Mathematics Standards:

Mathematics as Problem Solving  
Mathematics as Communication  
Mathematical Connections  
Measurement  
Statistics and Probability  
Patterns and Relationships

### Management:

Conduct this activity in groups of three students. Use a smooth testing surface such as a long, level table top or uncarpeted floor. The experiment has many variables that students must control including: the

size of the string loop they tie, the placement of the mass on the car, and the placement of the dowels. Discuss the importance of controlling the variables in the experiment with your students.

Making the Newton Car involves cutting blocks of wood and driving three screws into each block. Refer to the diagram on this page for the placement of the screws as well as how the Newton Car is set up for the experiment. Place the dowels in a row like railroad ties and extend them to one side as shown in the picture. If you have access to a

### Materials and Tools:

- 1 Wooden block about 10 x 20 x 2.5 cm
- 3 3-inch No. 10 wood screws (round head)
- 12 Round pencils or short lengths of similar dowel
- Plastic film canister
- Assorted materials for filling canister (e.g. washers, nuts, etc.)
- 3 Rubber bands
- Cotton string
- Matches
- Eye protection for each student
- Metric beam balance (Primer Balance)
- Vice
- Screwdriver
- Meter stick



drill press, you can substitute short dowels for the screws. It is important to drill the holes for the dowels perpendicular into the block with the drill press. Add a drop of glue to each hole.

The activity requires students to load their "slingshot" by stretching the rubber bands back to the third screw and holding it in place with the string. The simplest way of doing this is to tie the loop first and slide the rubber bands through the loop before placing the rubber bands over the two screws. Loop the string over the third screw after stretching the rubber bands back.

Use stick matches to burn the string. The small ends of string left over from the knot acts as a fuse that permits the students to remove the match before the string burns through. Teachers may want to give student groups only a few matches at a time. To completely conduct this experiment, student groups will need six matches. It may be necessary for a practice run before starting the experiment. As an alternative to the matches, students can use blunt nose scissors to cut the string. This requires some fast movement on the part of the student doing the cutting. The student needs to move the scissors quickly out of the way after cutting the string.

Tell the students to tie all the string loops they need before beginning the experiment. The loops should be as close to the same size as possible. Refer to the diagram on the student pages for the actual size of the loops. Loops of different sizes will introduce a significant variable into the experiment, causing the rubber bands to be stretched different amounts. This will lead to different accelerations with the mass each time the experiment is conducted.

Use plastic 35 millimeter film canisters for the mass in the experiments. Direct students to

completely fill the canister with various materials, such as seeds, small nails, metal washers, sand, etc. This will enable them to vary the mass twice during the experiment. Have students weigh the canister after it is filled and record the mass on the student sheet. After using the canister three times, first with one rubber band and then two and three rubber bands, students should refill the canister with new material for the next three tests.

Refer to the sample graph for recording data. The bottom of the graph is the distance the car travels in each test. Students should plot a dot on the graph for the distance the car traveled. The dot should fall on the y-axis line representing the number of rubber bands used and on the x-axis for the distance the car traveled. After plotting three tests with a particular mass, connect the dots with lines. The students should use a solid line for Mass 1 and a line with large dashes for Mass 2. If the students have carefully controlled their variables, they should observe that the car traveled the greatest distance using the greatest mass and three rubber bands. This conclusion will help them conceptualize Newton's Second Law of Motion.

### **Background Information:**

The Newton car provides an excellent tool for investigating Isaac Newton's Second Law of Motion. The law states that force equals mass times acceleration. In rockets, the force is the action produced by gas expelled from the engines. According to the law, the greater the gas that is expelled and the faster it accelerates out of the engine, the greater the force or thrust. More details on this law can be found on page 16 of this guide.

The Newton Car is a kind of a slingshot. A wooden block with three screws driven into it forms the slingshot frame. Rubber bands



stretch from two of the screws and hold to the third by a string loop. A mass sits between the rubber bands. When the string is cut, the rubber bands throw the block to produce an action force. The reaction force propels the block in the opposite direction over some dowels that act as rollers (Newton's Third Law of Motion).

This experiment directs students to launch the car while varying the number of rubber bands and the quantity of mass thrown off. They will measure how far the car travels in the opposite direction and plot the data on a graph. Repeated runs of the experiment should show that the distance the car travels depends on the number of rubber bands used and the quantity of the mass being expelled. Comparing the graph lines will lead students to Newton's Second Law of Motion.

**Discussion:**

1. How is the Newton Car similar to rockets?
2. How do rocket engines increase their thrust?
3. Why is it important to control variables in an experiment?

**Assessment:**

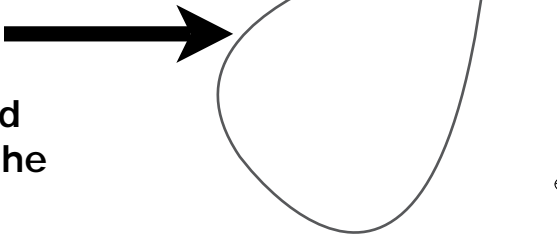
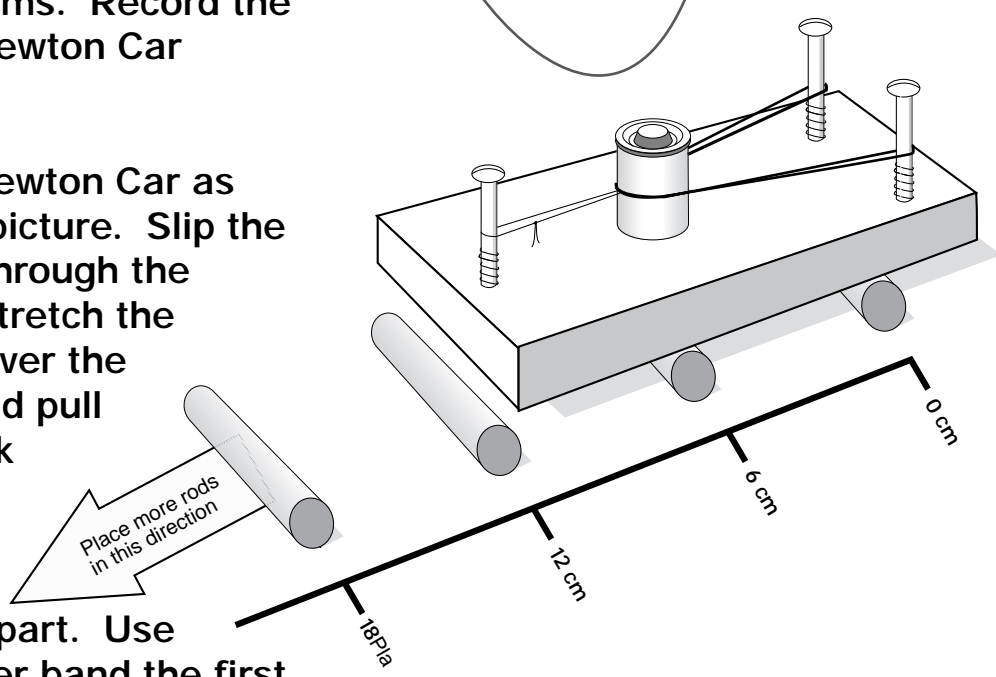
Conduct a class discussion where students share their findings about Newton's Laws of Motion. Ask them to compare their results with those from previous activities such as Pop Can Hero Engine. Collect and review completed student pages.

**Extensions:**

Obtain a toy water rocket from a toy store. Try launching the rocket with only air and then with water and air and observe how far the rocket travels.



# Newton Car

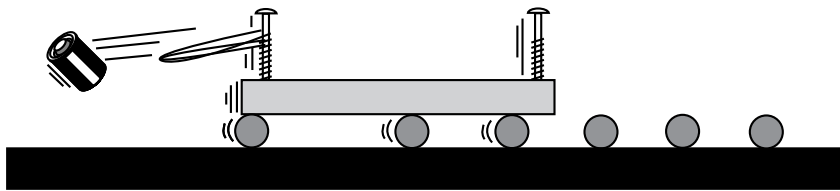
1. Tie 6 string loops this size. 
2. Fill up your film canister and weigh it in grams. Record the mass in the Newton Car Report chart.
3. Set up your Newton Car as shown in the picture. Slip the rubber band through the string loop. Stretch the rubber band over the two screws and pull the string back over the third screw. Place the rods 6 centimeters apart. Use only one rubber band the first time. 
4. Put on your eye protection!
5. Light the string and stand back. Record the distance the car traveled on the chart.
6. Reset the car and rods. Make sure the rods are 6 centimeters apart! Use two rubber bands. Record the distance the car travels.
7. Reset the car with three rubber bands. Record the distance it travels.
8. Refill the canister and record its new mass.
9. Test the car with the new canister and with 1, 2, and 3 rubber bands. Record the distances the car moves each time.
10. Plot your results on the graph. Use one line for the first set of measurements and a different line for the second set.



# Newton Car Report

Team

Members:



**MASS 1**



Rubber Bands Distance Traveled

|  |                   |
|--|-------------------|
|  | _____ centimeters |
|  | _____ centimeters |
|  | _____ centimeters |

Describe what happened when you tested the car with 1, 2, and 3 rubber bands.

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**MASS 2**



Rubber Bands Distance Traveled

|  |                   |
|--|-------------------|
|  | _____ centimeters |
|  | _____ centimeters |
|  | _____ centimeters |

Describe what happened when you tested the car with 1, 2, and 3 rubber bands.

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Write a short statement explaining the relationship between the amount of mass in the canister, the number of rubber bands, and the distance the car traveled.

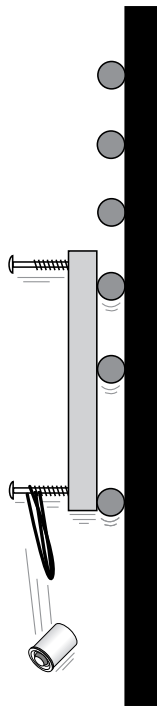
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# Newton Car Test Results



Mass 1 = \_\_\_\_\_ gms

Mass 2 = \_\_\_\_\_ gms

