Gravity-Powered Car

Challenge

Design and build a model car that can roll as far as possible across a floor, propelled solely by rolling down an inclined ramp.

Overview

Although conceptually simple, gravity-powered cars are engaging projects. Students enjoy making and testing them, and they learn the construction techniques required for the more complex vehicles that follow. Gravity-powered cars are ideal for teaching the methods of science, which include independent research, data collection, graphing, and interpretation of graphs and data. I suggest specific materials to use, but a wide variety of materials, some free and most inexpensive, will work.

Materials

Cardboard (1 large box or 2 small boxes)
Fat straws (1–2 per team)
¼″ dowels (budget 8″ per team)
Wooden wheels (4 per team) or plastic wheels with ⅛″ dowels and regular straw
Hot glue or masking tape
Sandpaper or sanding blocks (1 per two teams)
Inclined ramp
Meter sticks (2–3)

CDs make great plastic wheels if you have plastic inserts to fit inside the center hole. The inserts fit a ¼-inch dowel. Since these are much larger than the other wheels, cars using them can roll easily. The Web site www.Kelvin.com sells plastic inserts, and your postal carrier probably delivers free CDs, such as those offering Internet services.

A pine board with one-inch by four-inch sideboards (to keep cars from falling off the edge) makes a great ramp. To reduce the gap between the ramp and floor, plane or rasp wood off the bottom edge of the ramp. Cardboard, reinforced with strips of cardboard, also works. Prop up one end of the ramp with a chair or table and secure it with duct tape to prevent movement.

Design Concept

Attach sections of straw to the bottom of the chassis (made from a rectangular piece of cardboard). Run dowels through the straws and outfit the dowels with two wheels each. Students can also try the more challenging design of three-wheeled cars.

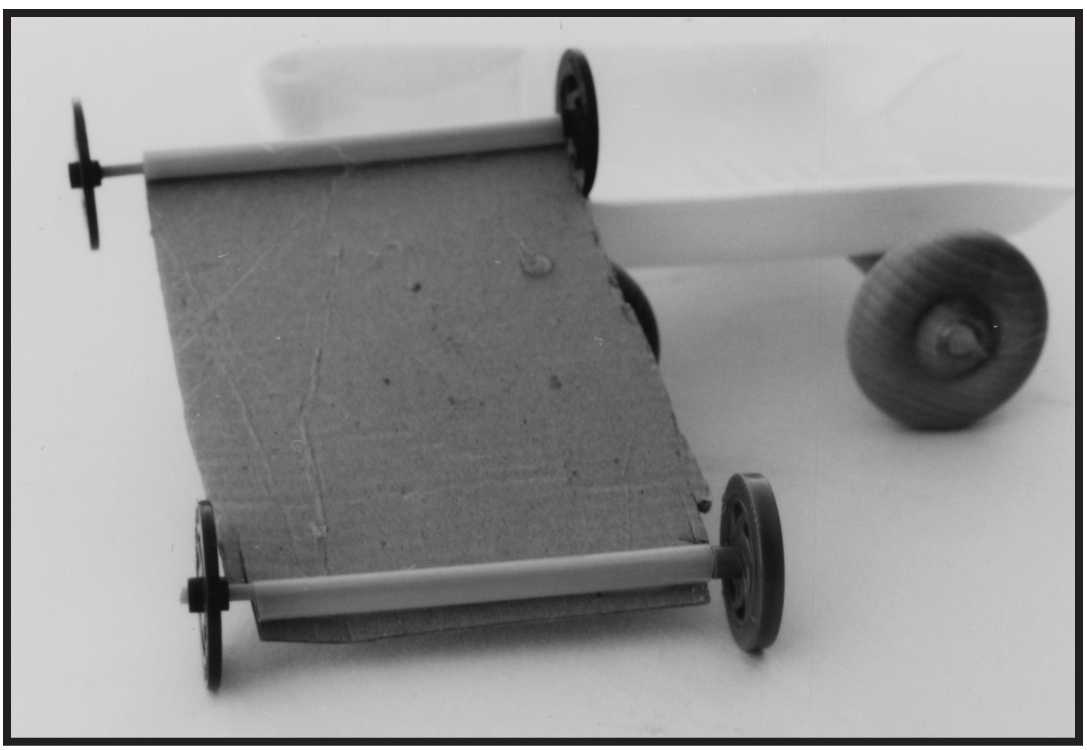
The Details

Ask students to choose their own teams, each with a maximum of three kids.

Cut a rectangle about four-inches by six-inches from a piece of corrugated cardboard. (This chassis needs to be small enough to fit on the ramp.) Cut two sections of straw as long as the chassis is wide. Tape or glue them to the bottom carefully, making sure they're parallel to each other. Start by aligning the chassis with a square or the edge of the worktable. Eyeball the perpendicular direction by looking at the perpendicular edge of the table or square. Glue the first straw in place.

To make sure the second straw is parallel to the first, make a jig (a device that holds component parts in their correct position) that is as wide as the distance you want between the two straws. A two-by-four-inch piece of lumber would work. Align one side of the two-by-four with the glued straw, and glue the second straw aligned with the other edge of the board.

Cut two dowels three-quarters of an inch longer that the length of the straw bearings. Sand the cut ends and attach one wheel. In most cases the dowel will make a tight fit with the wheel and you won't need (or want) to glue it. Then slide the axles through the bearings and attach the other wheels.



Straws are taped or secured with hot glue to the bottom of the chassis to make cars. Dowels fit through the straws and serve as axles to hold the wheels in place.

If the axles don't fit the wheels, you'll need to do some adjusting. If the axles are too big (in diameter), try sharpening the ends in a pencil sharpener and jamming them through the wheel opening. Once the wheel is centered on the axle, add a drop of hot glue to hold it in place.

If the axles are too small for the wheels—a common problem if you're substituting CDs for wooden wheels—you can add an insert or attachment to the wheel. Use lids from milk cartons or small wooden wheels to hold the axles. Then tape the lids or small wheels to the CD. Spin the axle to see if it is centered and adjust as necessary. Once it is centered, use a felt tip pen to draw a circle around the small wheel to guide you when you glue it. Hot glue doesn't hold well to the CDs; try using a general purpose glue instead.

Getting Started

Let students discover how to design and build the cars to the greatest extent possible. It can be helpful, however, to show them how the straws act as bearings for the dowels. Suggest that they attach straws to the bottom of the car chassis (with glue or tape) to secure the sections of dowel that serve as axles. The wooden wheels slide snugly onto the axles.

Teachable Moments

Once students undertake this project, your role is to help them understand the science of what's happening by asking questions. I am always amazed that students cannot answer the most basic questions about the experiment, such as "What did the car do?" Until they understand that you will hold them responsible for looking, listening, and understanding, they will take the easy way out: "I don't know."

If they say they didn't see what happened, direct them to run the experiment again with the forewarning that you will ask the same question immediately afterward. This sharpens their acumen.

Why this emphasis on observing? It is the most fundamental skill in science and yet it is often overlooked. Kids aren't used to observing and reporting what they see. If they learn nothing else from this project, they should learn how to observe and report.

Here are a few questions to ask:

What did the car do?
Why did the car turn?
Why did it jump at the end of the ramp?
Why didn't the car go farther?
How can you get the car to travel farther?

After observation, the second most important skill students will build in this project is the ability to look for the causes of observed effects. Kids will give the strangest answers when you ask why a car did something. Get them to look at the car and the ramp and come up with a plausible answer for your "why" question. When they have a plausible answer, ask them how to confirm if the answer is right. They could run a scientific experiment to verify their answer!

Testing

Cars should roll easily across a smooth floor or down a cardboard or wooden ramp propped up on stairs. If not, check that the wheels are free to turn (the wheels aren't rubbing on the chassis and the axles aren't rubbing on the bearings) and that the axles are parallel.

Building a small fleet of these cars provides opportunities to race them, either for speed down a ramp or for distance from the base of the ramp to the far reaches of the classroom or gym. Add weights (fishing weights, metal washers, etc.) to see if the cars perform better. Measure and record each trial run.

Record the best distance each team achieves by writing the team name and distance on the board. This simple act will provide additional incentive for teams to keep working to improve their models.

Teachers in a *Loco-Motion* workshop test their gravity car on a wooden ramp.

Variations

Make cars of different widths and lengths, and use different materials for the chassis. Try different wheel sizes and placements.

Gravity cars can be made from a variety of inexpensive materials. Wooden wheels use ¼-inch axles and fat straws for bearings. Plastic wheels use ⅛-inch dowels and regular straws.

Then get creative with the number of wheels. Making a car with four wheels is simple. Try making one with three wheels.

The next several projects use the gravity-powered car as a platform for different power sources.

Name: ______________________________

Gravity-Powered Car

CHALLENGE

Design, build, and demonstrate a model car that is powered by gravity. It should roll down a ramp and across the floor as far as possible. Keep improving your car to make it go farther.

DESIGN

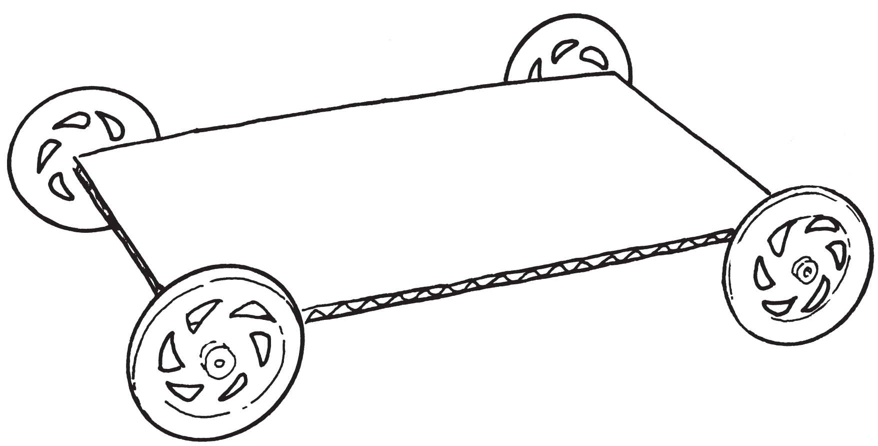
Sketch a picture of your car below, showing the number and placement of wheels and axles and the size and shape of the car body.

Name: ______________________

Gravity-Powered Car

INSTRUCTIONS FOR INVENTORS

1. With approval from the design chief (your teacher), use cardboard and scissors to cut out the car body. Use the materials your teacher provides to make wheels, axles, and bearings.
2. Add bearings. To align the bearings (straws), draw 2 straight lines parallel to each other on the bottom of the car body. If the bearings and axles aren't parallel, the car won't travel far.
3. Cut two bearings from a straw. They should be about as wide as the car body. Glue or tape them onto the car along the lines you drew.
4. Add axles. Cut axles or ask your design chief to cut them. Axles need to be longer than the bearings. Slide the axles into the bearings and check to see if they turn easily.
5. Add wheels. Fit wheels onto the axles. You can tap them on with your hand.
6. Test your car. Roll it on the floor. Does it travel in a straight line? If not, find the problem and correct it. Does it roll easily, or does it stop as soon as you stop pushing it? If it stops soon, find the problem and fix it.



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Name: ______________________________

TEST

Release your car from the top of the ramp and watch what it does. If your car travels more than a few feet beyond the end of the ramp, measure the distance it covers and record it below. If not, figure out what is preventing the car from going farther and fix it.

Record the distance your car travels. Then make improvements to your car so it will travel farther. Record what you did and how far the car went.

Experiment number	What was changed?	Distance (include units)
1	Initial design (no change)	
2		
3		
4		
5		
6		
7		

Name: ______________________________

Gravity-Powered Car

In the preceding experiments you released your car from the top of the ramp to give it maximum energy. Now try releasing the car from lower heights and measuring how far your car will travel. As you use lower starting locations—and, therefore, lower energies—what do you think will happen to the resulting distance the car travels?

Run the experiments at 10 different heights, measured vertically from the floor to the place on the ramp where you release the car. Be consistent in how you take the measurements. For example, you might measure from the floor to the ramp and place the front wheels at that point. Whatever method you choose for the first measurement, repeat this action for each subsequent measurement.

Height above the floor (units)	Distance the car travels (units)

Name: ______________________

Gravity-Powered Car

REFLECT

What was the source of energy that propelled your car?

What was the effect of friction on your car's progress?

What could you do to make the car go farther?