DragonflyTV: GPS Activity 9
Chain Gang

MIT Museum
Cambridge, MA
www.mit.edu/museum

Kinetic Sculpture Challenge

We're John, Elly, Nick, and Linnea—and we're the F.A.T. 4! What's that? We're an engineering squad that's participating in the MIT Museum's 4th Annual Friday-After-Thanksgiving Chain Reaction event. It's a crazy science fun-for-all where teams of inventors create kinetic sculptures of everyday items. Kinetic sculptures are sculptures that move. All the teams hook their chain reactions together for one, big extravaganza. Our question: How can we make a cool chain reaction sculpture?

First we went to the MIT Museum to look at the Gestural Engineering exhibit, which features the work of Arthur Ganson. His sculptures are a cross between machines and really intricate works of art. We thought they might inspire us! Then we took some time to brainstorm what we wanted to do. We came up with three basic parts: falling dominos, a soda and mint eruption, and the firing of a straw rocket. Next we drew a diagram and used it as our blueprint to start building.

Icebreaker

Discover the basics of friction with this not-so-slippery activity.

30-45 minutes

DragonflyTV Skill: Predicting

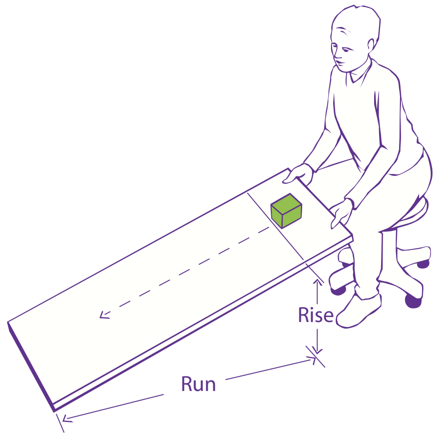
Guide your kids as they

1) Predict which objects will have the most amount of friction on the ramp and which will have the least.

2) Choose one object to place on the ramp. Record the choice in a notebook in a data table.

3) Place the object near the top end of the shelf and slowly incline the shelf until the object just about begins to slide down the track. Hold the ramp in that position while a partner measures a "rise" and "run" (in centimeters) for the ramp.

4) Calculate the ratio of rise to run and record it in the table. The larger the ratio, the greater amount of static friction there is between this object and the ramp.



5) Repeat for different objects. Which objects, on this particular ramp surface, have the least amount of static friction? Which combinations have the most?

For more simple activities like this one, surf to pbskidsgo.org/dragonflytv/superdoit/index.html

You'll need:

- objects that slide, not roll, on a ramp, such as: a paperback book; coins; a ceramic mug; a rubber eraser; a poker chip; a six-sided die.
- a shelf or plank to act as a ramp surface, approximately 4 feet long
- a metric ruler or meter stick
- a calculator
- optional: a large protractor

DFTV Science Helper

There are two types of friction that one can deal with. One is called static friction, the other is called kinetic friction. When a block is resting on a ramp, static friction must be overcome in order to set the block in motion on the ramp. This activity examines static friction only.

Investigation
Swing That Pendulum

60+ minutes

You'll need, for each group:

- a spool of string, one per group
- scissors
- 9 washers, 1 inch diameter
- a metric ruler
- masking tape
- a stopwatch

Guide your kids as they

Explore mass

1) Make a prediction of how a heavy pendulum mass will swing compared to a middleweight and lightweight one. Record their predictions in their notebooks.
2) Cut a length of string approximately 5 centimeters. Tie 3 washers to the end of the string.
3) Tape the other end of the string to the edge of a table (not the top), so that the washers can swing freely in pendulum fashion. Measure the length of string from the tape to the middle of the washers. Record this measurement in centimeters.
4) With a stopwatch ready, pull the washers a set distance away from vertical, and release them to start them swinging. Start the watch at the top of the next swing, rather than trying to coordinate the start of the watch with the release of the pendulum. Stop the watch after 10 completed swings. Record the time.
5) Grasp the washers, pull the pendulum back to the same starting point as before, release, and start timing again after the first swing. Stop the watch after 10 swings, and record the time again. Do at least 10 repetitions.
6) Repeat steps 3–5, with 6 washers tied to the end of the string (to create a heavier pendulum). Confirm that the length of the pendulum, once taped to the table, is the same as before. If not, make the necessary adjustments to keep the lengths the same.
7) Repeat with 9 washers tied to the end of the string.

Explore length

1) Make a prediction of how a long pendulum will swing compared to a middle-length and short-length one. Record their predictions in their notebooks.
2) Use the pendulum from the previous experiment, with 3 washers on the end. Data from the 3-washer experiment can be used in this phase of the experiment.
3) Tape the pendulum string to the edge of a table (not the top), but tape it in a way that effectively shortens the pendulum from approximately 25 centimeters to about 20 centimeters. Measure and record this new length.
4) With a stopwatch ready, pull the washers a set distance away from vertical, and release them to start them swinging. Start the watch at the top of the next swing, rather than trying to coordinate the start of the watch with the release of the pendulum. Stop the watch after 10 completed swings. Record the time. Repeat for a total of 10 trials.
5) Re-tape the pendulum string, shortening it to 15 cm. Conduct the swing measurements as before.

DFTV Science Helper

Invite your kids to make a prediction about which feature of a pendulum—its mass, or its length, or both—has any effect on its rate of swinging (i.e., its period). The experimentation is most manageable with groups of 3 or less.

DFTV Kids Synthesize

Data and Analysis

For each set of 10 trials, calculate an average length of time for the 10 swings to occur. Example data tables:

Mass Investigations

Number of washers	String length	Average time for 10 swings
3	24.0 cm	9.8 seconds
6	23.8 cm	9.6 seconds
9	24.1 cm	9.9 seconds

Length Investigations

Number of washers	String length	Average time for 10 swings
3	24.0 cm	9.8 seconds
3	19.7 cm	8.9 seconds
3	14.9 cm	7.6 seconds

DFTV Adult Tip

This presentation of the pendulum investigation purposefully omits the standard use of the conventional terms "period" and "frequency," and does not present the standard mathematical equation of a pendulum. These adjustments keep the activity accessible to younger students. You may introduce the mathematics and vocabulary if you are working with older students.

Keep Exploring!

A third feature of a swinging pendulum you can explore is how far back from vertical you pull it to set it swinging. Explore whether this variable has a significant effect on the swing time of the pendulum.