DragonflyTV: GPS Activity 1

Rockin' and Rollin'

Carnegie Science Center

Pittsburgh, PA

carnegiesciencecenter.org

Roller Coaster Design

We're Tyler and Aditya and we're roller coaster maniacs! We especially love steep hills, sharp turns, and crazy loop-de-loops. But we couldn't agree on which of these things makes a ride the most exciting. Here's our question: Where do you feel the most g's on a roller coaster?

We went the Carnegie Science Center in Pittsburgh to ride their roller coaster simulator. It can be programmed to simulate the hills, turns, and loop-de-loops we wanted to study. We took a measuring device called an accelerometer to find out which part of the simulation gave us the most g-forces. The simulator doesn't produce the actual g's of a roller coaster, so we decided to take our accelerometers to a real roller coaster at a local amusement park called Kennywood. We rode the Phantom's Revenge a bunch of times, recording the number of g's on the accelerometer at different places along the ride.

CARNEGIE SCIENCE CENTER

One of the four Carnegie Museums of Pittsburgh

Icebreaker

Develop some "souper" engineering know-how with the Soup Can Derby activity!

1 hour

DragonflyTV Skill: Predicting

Guide your kids as they

1) Stack a few books and lay one end of the shelf on them to make a ramp.
2) Grab food cans of many different sizes, shapes, and weights. We're talking everything from stew to broth to tuna to peaches. Make some predictions about which cans will be the "winners."
3) Now it's race time. Take two cans at a time, set them on their sides at the top of the ramp, and let them roll.
4) Which can is the fastest? Find the speediest can in the cupboard! Why was this can the real grocery go-getter?

You'll need:

- a shelf or board to use as a ramp, wide enough for two cans to race side-by-side
- books or blocks, to stack about a foot high
- cans of food out of the cupboard, various sizes, shapes, and weights

DFTV Science Helper

This is a great group activity. Encourage kids to switch off between roles of timer, recorder, ramp design tweaker, etc. Talk about why they think the first can across the finish line was the winner. Help your kids develop a hypothesis about what property of the can makes it the speediest. (Consider properties such as diameter, weight, or even consistency of the contents.)

For more information on this can-do activity, surf to pbskidsgo.org/dragonflytv/superdoit/soup_can.html

Investigation
Roller Coaster Design

1 hour to make accelerometers; full day to spend at an amusement park

Get out to the amusement park and investigate the wild motions of a roller coaster!

You'll need:

- a homemade accelerometer, made from a clear plastic cylinder with end caps, a light spring, and two or more fishing sinkers.
- permission from your local amusement park to carry the accelerometer with you on the roller coaster rides. Many amusement parks cooperate with school science programs to let kids study the physics of roller coasters.

Guide your kids as they

1) Build an accelerometer. Acquire a clear plastic tube, approximately 8 inches long and 1 inch in diameter, with endcaps that fit snugly. Also acquire a brass cotter pin, a light-duty extension spring (3/8 inch diameter, 3/4 inch body length), a "Dipsey Swivel" style fishing sinker, a plastic or metal washer (outside diameter small enough to fit in the tube, inside diameter sized to receive the body of the sinker), hot glue or model glue. [Kits with all these materials included are available from sciencekit.com, keyword: Amusement Park Physics.]
2) Carefully drill a 1/8 inch hole in the center of one end cap. Insert the brass cotter pin through the hole from the inside, so the head of the pin is on the inner side of the cap. Spread the pin ends apart, to keep the pin in place. Secure the pin with a drop of glue, placed where the pin enters the hole. Affix one loop end of the spring through the head of the cotter pin.
3) Use glue to affix the washer to the body of the sinker. Hook the loop at the top of the sinker through the free end of the spring. [Figures 1 and 2]
4) Dangle the sinker inside the tube, and secure the endcap. Use a black marker to draw a line around the body of the cylinder at the position of the washer's edge, when the tube is held vertically. Label this line as "1 g."
5) Remove the endcap once again, and clip a second sinker onto the free end of the spring. Again, dangle the sinkers in the tube, secure the cap, and mark the position of the washer's edge. It should be below the first line, as the weight of two sinkers stretches the spring. Label this line as "2 g."

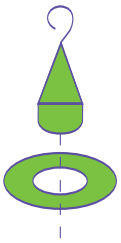

figure 1

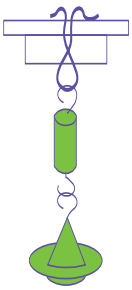

figure 2

figure 3

6) To mark the cylinder for the lines representing 3, 4, and 5 g, you may either attach a third, fourth, and fifth sinker and mark the lines as in Step 5, or simply measure the interval between the first two lines. Make the interval from Line 2 to Line 3 the same size, and continue for Lines 4 and 5.
7) Remove all sinkers from the spring except the one with the washer and resecure the endcap. Your accelerometer is ready for use! [Figure 3]
8) The amusement park may require you to wear a wrist tether attached to your accelerometer to prevent the accelerometer from falling or flying around should you lose your grip on it. A tether can be made by securing a large rubber band around the body of the accelerometer and around your wrist.

Now that you have your accelerometer, get busy!

Guide your kids as they

1) Select which portions of the roller coaster they wish to investigate. Places of interest on a ride include: a) the bottom of the launch hill; b) sharp turns; c) the tops of other hills; d) drop-offs.
2) Hold the accelerometer vertically throughout the ride. As you go through the part of the ride you are interested in, read the position on the scale where the washer edge appears. Remember to write the number down at the end of the ride.
3) Investigate several parts of the coaster, and take several rides to see if you get repeatable readings. Look for the maximum number of g's you experience on the ride.

DFTV Kids Synthesize
Data and Analysis

In their investigation, Tyler and Aditya learned that acceleration is speeding up, slowing down, or changing direction. They experienced the greatest g's at the bottom of the steep hill, when their direction changed quickly… almost 5 g's! They measured less than 1 g going over the top of another hill, where you get that funny feeling in your stomach.

DFTV Adult Tip

This activity is best suited for modern roller coasters, or "steel" coasters, where the coaster car tilts on banked turns. Older, "wooden" coasters don't allow the car to tilt on a turn, so the rider has the experience of being thrown from side-to-side in their car as they go along. This accelerometer is not designed to measure those side-to-side accelerations. It may be used successfully on any thrill ride where the accelerations are directed "up and down," such as vertical drop towers, but will not function properly on rides based on spinning or side-to-side motions.

Keep Exploring!

Acceleration is speeding up, slowing down, or changing direction. Kids can explore acceleration at school! They'll need a bungee cord, a skateboard, and access to the gymnasium. Have one child sit on the skateboard, holding one end of the bungee cord. A second child takes the other end. Make sure the person riding the skateboard wears a helmet, knee pads, goggles, and gloves. The puller should also wear goggles and gloves, and neither person should let go of the cord while it is stretched. Starting at one end of the gym, the puller begins pulling, watching the bungee cord stretch. Increase speed as needed to keep the bungee cord stretched out. As long as the cord is stretched, the kids are accelerating. Can they accelerate the entire way across the gym? What happens?

Even More to Explore!

Here's another activity related to roller coasters that you'll want to try!

DragonflyTV investigators Christopher and Zahabiya spend as much time as they can at their favorite amusement park. Since they especially love the more "wild" rides, they wondered if they could actually measure a ride's "thrill factor." Their question: How does your pulse rate correspond to the scariness of a roller coaster ride?

Guide your kids as they

1) Gather a bunch of friends and go on three different rides at the local amusement park.
2) Teach their friends how to find their pulse rates. You can count a pulse for 15 seconds, then multiply the number by four to get the pulse rate for a minute.
3) Instruct each person to take a pulse rate before going on each ride and again right after the ride is over. Subtract the two readings to find the increase in each person's pulse rate.
4) Ask each person to rank the ride on a thrill scale of 1-5, with 1 being "not so thrilling" and 5 being "the most thrilling ever."
5) Calculate an average of everybody's pulse rate changes and thrill rankings, for one ride at a time. Look for a relationship between thrill ranking and pulse rate.