Roller Coaster of Motion – Energy in Motion

Ramp up the fun and get it moving! This activity, provided by the Shell Summer Intern Program, will explore the science and energy transformations involved with roller coasters and ramps.

Materials Needed

- Cardboard boxes
- Items to provide height (chairs, tables, books, additional boxes, etc.)
- Golf ball, ping pong ball, bouncy ball, or marble
- Towel or blanket
- Scissors
- Marker
- Tape (duct, masking, etc.)

Content:
- Energy transformations
- Friction
- Gravity

Questions:
- Why does a roller coaster have different hills?
- How does energy transform during a roller coaster ride?

Grades:
4-5 and above!
Time:
30-45 minutes

Safety Notes:
Use caution when cutting cardboard with scissors.

Ramp Construction Procedure

1. Flatten the boxes. Use scissors to cut the sides or any tape on the boxes as necessary. Be careful when cutting. Make the box into one flat plane, by cutting one corner.
2. If constructing a long ramp using more than one box, make sure your boxes overlap slightly. Tape the boxes together at the overlap so that a smoother surface is created.
3. Curve your ramp by holding up one end and moving the flaps inward. Tape the flaps of the box so the curved shape remains and the ramp is smooth.
4. Depending on the size of your ramp, gather two chairs, two stacks of books, or two pieces of furniture that are equal in height and big enough to support the ramp . Space them equally so that each end of your box ramp will be lifted off of the ground. Lay your box on top of the two items. A natural curve should occur in your box ramp. If necessary, place a stack of books under the bottom point in your ramp.
5. Label one end of your ramp "1." Label the other end "2."

Testing!

1. Start with your ramp so that the markings for ends 1 & 2 are at about the same height.
2. Hold your ball at end 1 and drop it from this point. Watch how fast the ball goes and how high it travels once it gets to end 2.
3. Lift end 2 so that it is higher than end 1. Release the ball from end 1. Watch how fast the ball goes and how high it travels towards end 2. Does it travel as far and as high as when the ends were equal heights?
4. Pull the support under end 1 back so that this end of your ramp is lower and flatter, but not completely flat. Release the ball from end 1. Watch how fast the ball goes and how high it travels once it gets to end 2. How does the motion compare to steps 2 and 3?
5. Lower end 2 so that it is now lower than end 1. Drop the ball from end 1 again. What do observe, and how does it compare to the original scenario?
6. Place a blanket or towel down on your ramp at the lowest point. Repeat the trial you did in step 5. What do you notice?

How Does it Work?

Roller coasters are much longer and larger than the ramp built for this experiment. However, the same science still applies. Roller coasters are constantly transforming energy from kinetic to potential, and back to kinetic energy. As a roller coaster starts, a chain pulls the cart to the top. At the top of the hill it has a lot of potential or stored energy that will convert to kinetic energy as gravity pulls the car down the other side of the hill. The higher the hill is, the more potential energy the car will have. This energy will help carry the ride forward.

The first hill is usually the tallest hill. This is because the car will lose some energy as it travels and not be able to get over the second hill if they are the same height. The experiment in steps 1 and 2, with each end at the same height, shows that the ball will not quite meet end 2 when dropped from end 1. Could you imagine being on a roller coaster like this, where the hills were the same height? The car would not make it up the second hill and would fall right back down. If the second hill is slightly lower, the roller coaster will continue much longer and faster, like you saw in step 5.

The car in the roller coaster, and the ball on your ramp experience some friction as they move. Friction is a force that tries to stop moving things. This friction comes from air pushing against the car as it travels. If you ride a roller coaster, your face will feel this air pushing back on you and the skin on your face might fly back. This air resistance or friction helps to slow down the ride a little bit which is why the ball never travels the same height up the other side of the ramp. If the first hill is higher than the second, the energy transformation from the first hill is always enough to keep the ride going, even if there is friction from the air trying to slow it down. At the end of most roller coasters, there are brakes or bumpers that help to slow the car down by adding extra friction. If there was no friction the roller coaster would continue on and go off the tracks! In step 6 the added towel or blanket helps show how extra friction might be added to a roller coaster to help slow it down at the end.

Going Forward!

- Build your own complete roller coaster using materials from around your home or classroom. Incorporate hills, turns, and even loops using the energy transformations to guide you.