RAMPS & FRICTION

THE CHALLENGE
Determine the angle and material covering on a ramp that results in a vehicle’s moving the fastest. Young kids learn by exploring, observing, and figuring out the way things work by experimenting, and exploring ramps and friction encourages this.

GRADE LEVEL
Elementary School

ACTIVITY DURATION
About 30-45 minutes, depending on the length of the discussion and the amount of observations done.

MATERIALS
- Wood for ramps
- Different toy cars
- Materials to wrap ramps
- Items to set up different angles for the ramps (books, chairs, tables, boxes, etc.)

SET UP
This activity requires unobstructed areas for each group. A classroom setting would be appropriate.

Determine how many materials you want to test and how many ramps and cars you want to have available. This will depend on the number of students and time available for the activity. This activity could be done inside or outside. It is important to leave one ramp free of materials as a test ramp. Secure your materials to the other ramps as needed. Determine how you will set up the ramps (e.g., stairs or a stack of books).

ACTIVITY
The children will be super excited to play, so it is often best to let them explore the activity freely first. Let the students explore how the cars work on the bare ramp (with no covering material). This will allow the students to discover the differences among the speed of the cars. Which cars move faster? Why? There are various reasons that cars would move at different speeds, including a car’s mass (which could increase friction and slow it down), the car’s aerodynamics (a sleek car would have less air friction), and wheel axle and tire friction, which may be independent of the car’s size.

Next, have the students test out different angles using the bare ramp. It’s important that the kids just place the cars at the top of the ramp, and not push them (so that gravity is the only force). Which ramp angles are faster or slower? Why?

This is actually an advanced concept for younger kids, but you can try to explain using the following logic. If a car isn’t pushed, then gravity is the only force causing it to travel down toward the earth. The less that the ramp interferes with the downward pull of gravity, the faster the car will move toward the ground. So, if the ramp is straight up-and-down, the car would travel the fastest, because there is no ramp interfering with the pull of gravity. On the other hand, if the ramp is horizontal, the car would not move (would go the slowest), because the ramp is completely interfering with the pull of gravity.
Finally, have the students explore friction using the ramps covered with different materials. Let the students feel the textures and describe them to you. Introduce the term “friction,” keeping it simple for young students.

Students should learn that friction can be two surfaces rubbing against one another. We experience this when we rub our hands together when they are cold. Students should also learn that friction is the resistance an object meets when moving over another surface. Explain to the students that the materials you attached to the ramps changes the surface of the ramp. Different cars will experience different amounts of friction when going down these ramps causing the cars to speed up or slow down.

**FOR DISCUSSION**
Ask lots of questions! Before they test out the cars, invite the students to guess which texture might slow down the car or speed it up as it goes down the ramp. Make predictions on which cars will go faster or slower. Provide a table to record observations. Let the kids race cars down the different ramps. If appropriate, you can use a measuring tape to see how far the cars travel off the ramp. Which car goes the farthest? Which car is the slowest? Which car crashes, falls off the ramp, or doesn’t make it to the end?

**LEVEL OF DIFFICULTY**
To increase difficulty:

- Add wind (another force) by using a fan.

- Introduce types of friction by adding different materials (e.g., water, mud, playdough, Styrofoam vs wood ramps).

- Have students use the scientific method. Encourage students to define hypothesis, enumerate their procedures, record observations and present conclusions.

- Present the outcome of the experiment and have the students determine the procedure. For example, pre-measure the distance that a car must travel. Have students experiment with different ramp angles, different ramp materials, different coverings for ramps, different cars, etc. to arrive to that distance. Have the students record their observations, trials and testing of their hypothesis.

- Have students measure the angle of the ramp using a protractor. For older students, teach them how to calculate the angle of a ramp as a function of the ramp’s length and its distance off the ground. (As a reminder, the sine of the angle is a ratio of the height of the ramp off the ground to the length of the ramp!)

To decrease difficulty:

- Use only one variable with the materials for the ramps (e.g., only wood ramps)

- Only test one question. For example, “What is the difference between a steep ramp and a flat ramp and why?”

- Provide pre-made charts for children to record observations.

- Provide a blank sheet of paper and have students draw a picture of their observations.